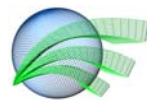


## ESPON 2.1.4

# Territorial trends of energy services and networks and territorial impact of EU energy policy



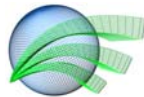
CEEETA



**ESPON 2.1.4**

**Territorial trends of energy services and  
networks and territorial impact of EU  
energy policy**

**Final Report**



**CEEETA**

Research Centre for Energy, Transport and Environment  
Economics

This report represents the final results of a research project conducted within the framework of the ESPON 2000-2006 programme, partly financed through by the ERDF through the Interreg III ESPON 2006 programme.

The Member States of the EU25, plus Norway and Switzerland and the EU Commission are carrying through the ESPON programme. Each country and the Commission are represented in the ESPON Monitoring Committee.

This report does not necessarily reflect the opinion of the members of the Monitoring Committee.

Information on the ESPON programme and projects can be found on [www.espon.lu](http://www.espon.lu)

The web site provides the possibility to download and examine the most recent document produced by finalised and ongoing ESPON projects.

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Lisbon, Portugal, 2005

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## Foreword

The present final report attempts to present the results from the ESPON project 2.1.4 entitled "*Territorial Trends of Energy Services and Networks and Territorial Impact of EU Energy Policy*" which was conducted within the ESPON 2000-2006 Programme.

The objective of the study has been to provide the background for a more informed discussion of energy policy impact in Europe. This, on the one hand, has implied providing an overview of the European energy picture with regards to current degrees of development, as well as a prospective analysis of possible effects of regional energy policy impact in different parts of Europe.

This report is divided into the following parts:

Part 1 consists of an executive summary and an overview of concepts and methodology.

Part 2 is results of the project.

Part 3 presents relevant additional lists of data, maps and other information.

Three interim reports have been produced prior to this final report.

COMPOSITION OF CONSORTIUM:

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CEEETA – Centro de Estudos em Economia da Energia, dos Transportes e do Ambiente, PORTUGAL

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UMM - University of Mining and Metallurgy, POLAND

The project report and the annex report are available at  
<http://www.espon.lu>

2005

The content of this report does not necessarily reflect the opinion of the  
ESPON Monitoring Committee

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# **Territorial trends of energy services and networks and territorial impact of EU energy policy**

## **Part One: Summary**

## Part One: Summary

### Executive summary

#### Energy policy in Europe

The European Union is still far from a common energy policy but a number of important EU legislative initiatives have been taken to strengthen supranational initiatives in the energy field.

In recent years the following general areas of debate have been of particular importance for shaping a common EU energy policy:

- the internal-market for energy (electricity and gas),
- the environmental policy, and
- the European Energy Charter.

Security of energy supply and a better environment are the main objectives which have tailored some important strategies – promotion of renewable sources, promotion of energy efficiency and energy networks development.

Energy is a commodity that can be produced in large or small scales, in a centralized or decentralized way. Energy is everywhere and is, nowadays, as essential for human life as water or telecommunications and all of them are based on a network philosophy.

To produce and transport energy very huge investments are needed and at the same time the energy activities have an important role on job creation and represent an important part of GDP of the nations.

Because of energy dependence of final consumers and economic activities a price variation of energy products will have an *income and a substitution effect* with an important impact on the welfare of the people.

Energy is a production factor and as such its availability with quality and at a competitive price in a region will be a positive factor to attract new economic activities and inhabitants.

Because the importance of energy in the social and economic tissue and the huge investments to produce and transport energy to the consumers, the question of the impact of the energy sector on regional development deserves attention.

The aim of the study is to identify and measure, whenever possible, the links between energy policy and local development in the European Union regions.

According to the terms of reference, this research project must address five main issues:

1. Analyse the territorial trends of energy supply & demand and their spatial pattern, while identifying indicators and mapping methods for quantifying and representing them, taking into account the progress and results of projects currently developed in the framework of ESPON;
2. Design and carry out a territory impact analysis of the energy policy, seeking to quantify impacts from energy-related spatial development policies and identify a set of parameters that may apply to policy decision-making;
3. Define a typology of regions in terms of infrastructures and energy services, with reference to the database and processing techniques. Such typology should clearly define the relationship between energy and polycentric development and identify the regions that are seriously affected by the spatial trends in the field of energy;
4. Identify ESDP options relevant to the energy policy and submit proposals to make them operational and ensure their territorial diversification;
5. Identify the infrastructures and energy services required to provide development conditions to the most backward regions and to those regions marked by specific handicaps (i.e. islands, mountains).

The possibility to go in a deep analysis of the impact of energy policy at territorial level, NUT3 or even NUT2, has two main barriers: the availability of information and the nature of some important items of the energy policy. The lack of data at regional level is the first handicap faced to develop the project. In fact the information doesn't exist at all or frequently if it exists it is not made available by its owners.

When dealing with energy policy indicators we have to take into account that most of them only have sense at national or EU level: dependence of imported oil, dependence of fossil fuels, target for electricity produced from renewable sources, target for green house gases emissions. At local level our concerns are the access to or the availability of energy on a competitive basis, the use of local energy resources as an economic activity important for job creation and income generation, the local emissions from energy use

with impact on the air quality (acidification effects), availability of energy transport and distribution infrastructures, education support to population on rational use of energy.

### **Key messages**

The main findings of our research come as follows:

- There is a severe lack of statistical data on energy sector: systematic energy data gathering at regional level (NUTS 2) is scarce and in many countries no recent regional data is available; in some cases only recently was established the need for sub-national data on energy consumption.
- The absence of reliable and consistent statistical data under NUTS 0 level is a key issue in this research project. It is strongly recommended that the national and European authorities coordinate serious efforts in the development of data production for the energy sector (resources, production, consumption and prices) in order to render viable future research in this key area.
- There is little evidence and research of the effects of energy on development. Mainstream models assume an adaptation of energy supply to energy demand which is determined by economic growth: energy is assumed, at most, as a limiting factor not as a leading location factor.
- Anyway energy achievements represent key phenomena in economic development. Industrial revolutions are closely linked with new energy sources and natural energy endowments can represent key issues in regional or national development patterns.
- Regions that “export” energy may have in this activity an important source of income, although in most cases, mainly in cases of nuclear, oil, hydro-electricity or wind or solar energy, the revenue for producing regions may be extremely weak in as much as these facilities are owned by non-residents in the region.
- An exception must be emphasized for biomass renewable energy sources. In these cases strong impacts can be noted, in direct employment and specially in indirect agriculture and like employments.
- Fiscal policy can be used as a way to provide producing regions of a share of the generated income, avoiding the “off-shore” effect that

energy infrastructures seem to have regarding the neighbouring territories.

- In average, energy has not an important weight in production costs of industry: as there is access to energy, only very important differences in price and access conditions will have a significant impact on the spatial pattern of economic activities.
- Large disparities exist on energy consumption between European countries with a major contrast between EU 15 countries (0.14 toe per 1000 € of GDP) and New Member States (0.42 toe per 1000 € of GDP).
- Economic development is associated to a decrease in energy intensity: increasing energy efficiency is embedded in economic development and, if we exclude some extreme country situations, in Europe it seems to exist an inverse relation between development levels and the intensity uses of energy.
- Energy intensity shows a clear decreasing trend. Transport shows the most significant growth of energy consumption between 1995 and 2002.
- Most countries have reduced their dependence on fossil fuels since 1995. Oil is the most significant energy source in EU 15, while in the New Member States the energy consumption is more differentiated among sources.
- There is no clear relation between energy self-sufficiency and development. European countries were able to answer their energy needs through energy imports: no statistical relation exists between energetic self-sufficiency and GDP per capita. This result seems to hold at regional level where it seems there to be a non-coincidence between energy production and energy consumption.
- Households' energy consumption seems to have a major determinant: wealth level.
- Although climatic conditions have a visible influence, there is a clear and linear relation between domestic and tertiary per capita energy consumption and GDP per capita (ppp).
- In Europe, there are heavy differences on energy prices between industry and household uses. There are, also, strong disparities of conditions (namely price) of access to energy between different EU countries and between energy sources. Price differences between



countries are much higher in what concerns households consumption than industrial consumption.

- Prices seem not discriminate between levels of energy consumption. Smooth prices variations seem not to have any impact on households' energy consumption.
- Industry electricity consumption seems to be more responsive to energy prices: figures point to an inverse relation between prices growth and growth of energy consumption by industry. But, here, we can expect some effect of substitution among energy sources.
- Energy market opening is a major component of European energy policy but it is far from being completed.
- Energy market opening has associated a decrease in energy prices either for households or for industry.
- It seems that a trend for increased energy prices disparities among countries in what concerns industrial sector do exist, although in a context of price decrease.
- Most of the energy policy measures will impact territorial development through energy prices variation.
- Studies found a significant but small impact of energy prices on economic growth: the studies analysed point to an elasticity of GDP to energy prices of about 0.02 or 0.03.
- We found no conclusive evidence of the impact of energy prices disparities on location of industrial activities even in the case of energy-intensive industries.
- The EU energy policy is now relying on renewables development and energy efficiency. Both can have an important impact at local level by increasing the use of endogenous energy resources. Biofuels for transport, biomass, wind and small hydro power for electricity production are among the main drivers of such a policy for years to come.
- Regional energy agencies have now a good coverage of the EU territory and their importance is growing in the N10 countries. These agencies are a driving force for the development of renewables as well as for providing support to the local agents on the energy supply and demand opportunities.

Summing up, in what spatial development and cohesion are concerned energy can be seen from different angles:

- energy as an economic activity, which asks for investments and can have an interesting impact in terms of job creation at local level;
- energy as a production factor for the economy, and as such its price, quality and diversity can influence location of activities and have a strong impact on competitiveness;
- energy as a source of gas emissions that is responsible for global warming, acidification, eutrophication and ground-level ozone.

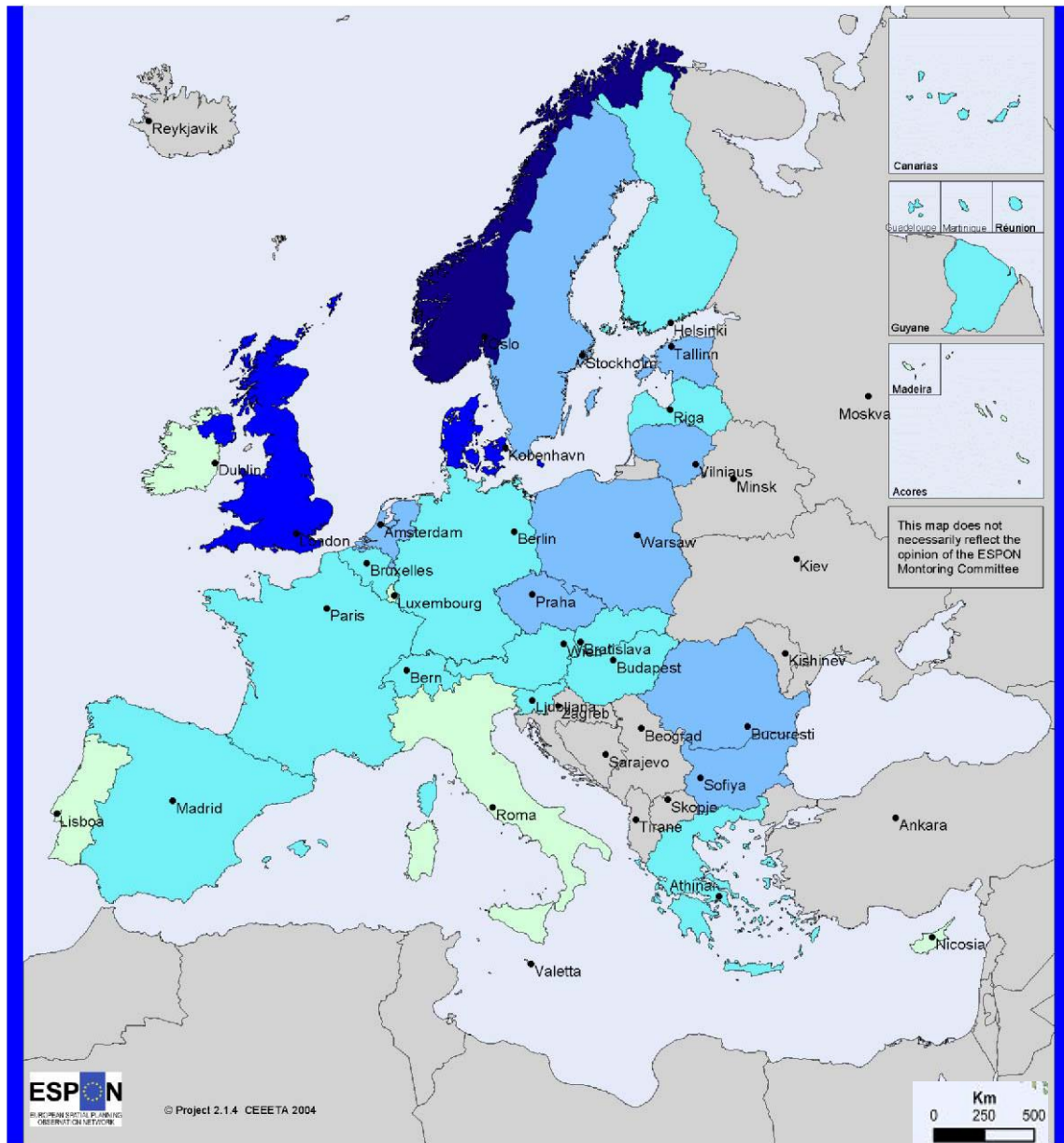
Among the main challenges facing the European Union countries, we must point out:

- Kyoto targets for greenhouse gas emissions and ceilings for the acidification gases (Gothenburg agreements), implying strong actions on rational use of energy, renewables development, changing the energy mix towards less oil products and coal and more natural gas;
- Renewables development for electricity generation, in line with the directive for electricity from renewables energy sources;
- Liberalization of the energy markets with free access to suppliers as a condition to achieve a successful internal market for energy;
- Trans European networks availability as a condition for providing access to energy at competitive prices to consumers of the enlarged Europe.

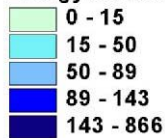
### **Main Maps**

Main maps will be related to the core indicators and to the main findings of the research. They will cover both the country and the region perspective, depending on data availability.

Energy self sufficiency in Europe 2002 (%)



Energy self sufficiency in 2002



© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat

It is an objective, per se, to increase the self-sufficiency, either by developing new energy sources or by placing a stronger emphasis in more efficient use of energy resources.

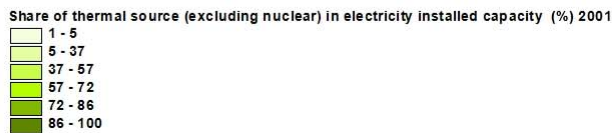
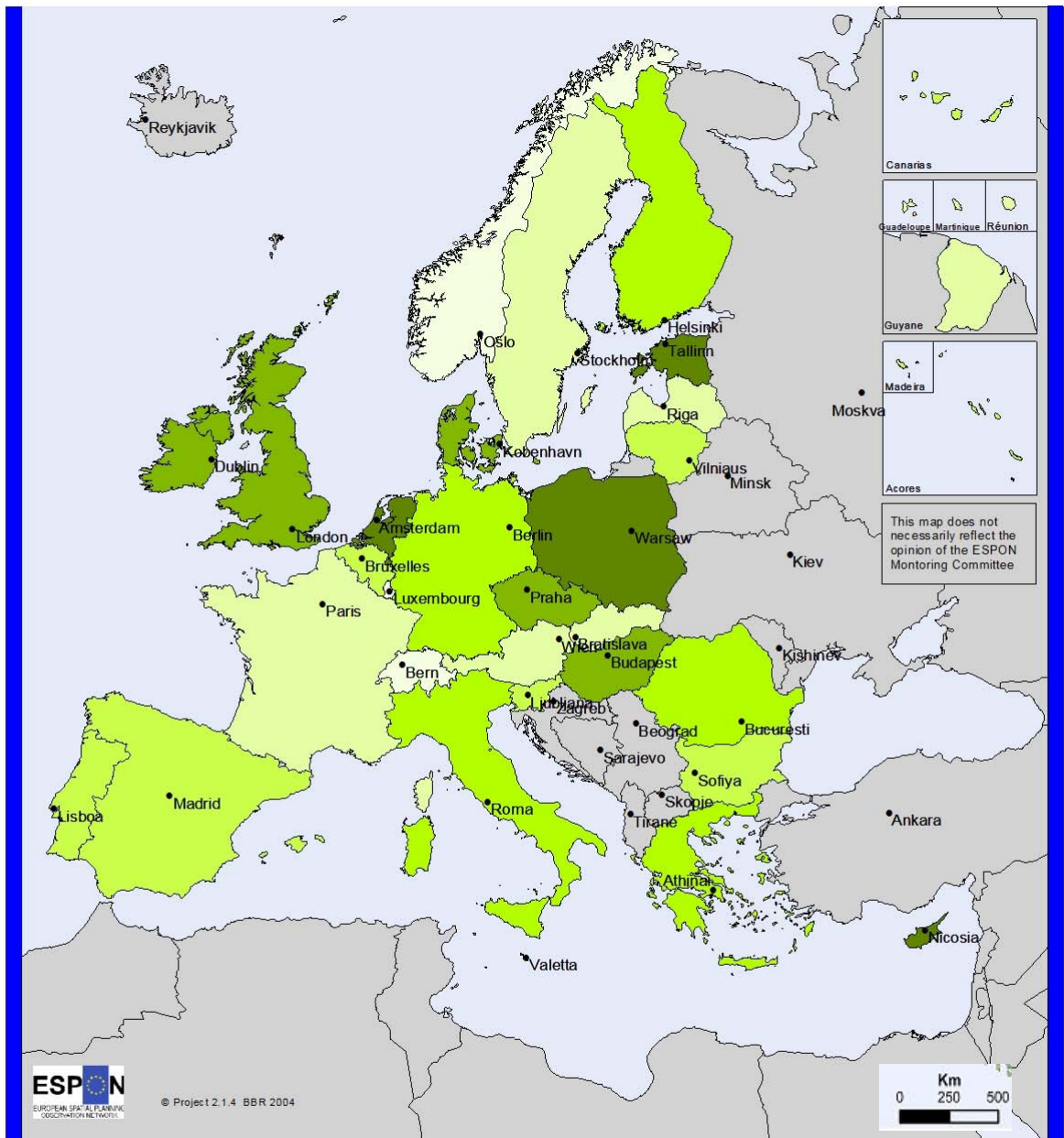
The image is very clear when boundaries are set trying to highlight groups of countries with different energetic resources capabilities.

Countries with less endogenous resources for mainstream energy sources (oil, coal, large hydro) should reinforce their means of getting access to new forms of producing energy. The most important cases in this situation are Ireland, Germany, Austria, Slovakia, Italy, Portugal, Spain, Greece, Cyprus and Malta.

This is a task that can be dealt at European level (reinforcing interlinks), but can be obtained at national level, by means of diversification of sources, especially by boosting renewal sources (wind, biomass and solar) that are available in larger or lesser extent to all of them.

On the other end of the scale, Norway, UK and Denmark (net oil exporters) and Estonia, Poland, Czech Republic and Romania are well equipped countries to better satisfy their energy needs.

Share of thermal source (excluding nuclear) in electricity installed capacity in 2001 (%)



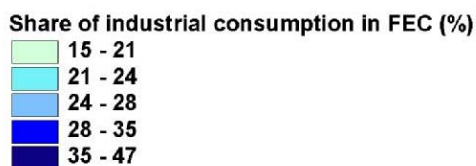
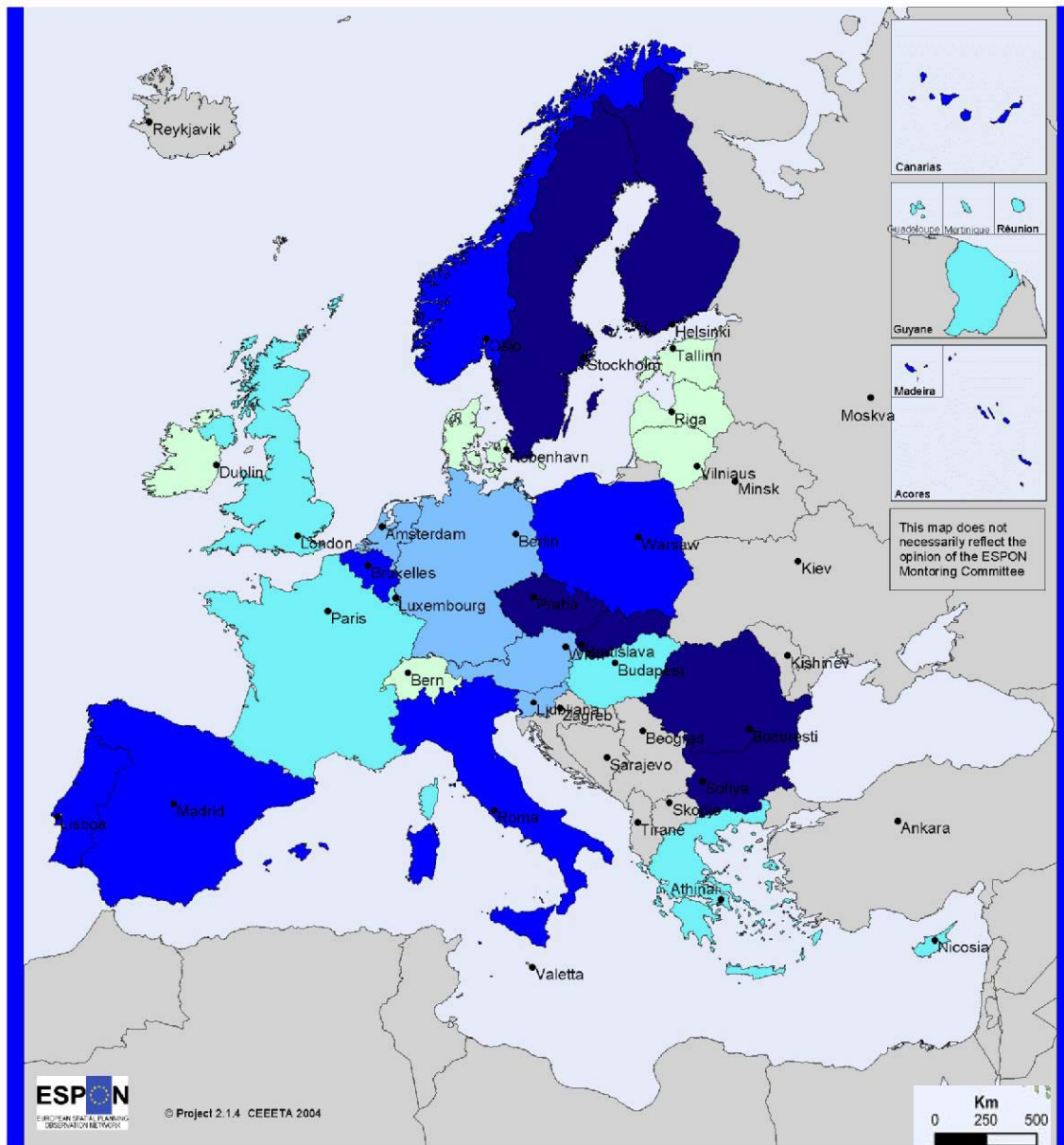
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Source: DGET, Eurostat

France, Luxembourg, Norway and Sweden are highlights for the lowest shares of thermal producing sources in total electricity production (France trading off with nuclear sources and the others with hydro). On the other hand Ireland, Netherlands, Cyprus, Estonia, Malta and Poland are

highlighted for its dependency of above 80% on thermal power plants for electricity production.

Share of industrial consumption in Final Energy Consumption at NUTS 0 level in 2002 (%)



© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat

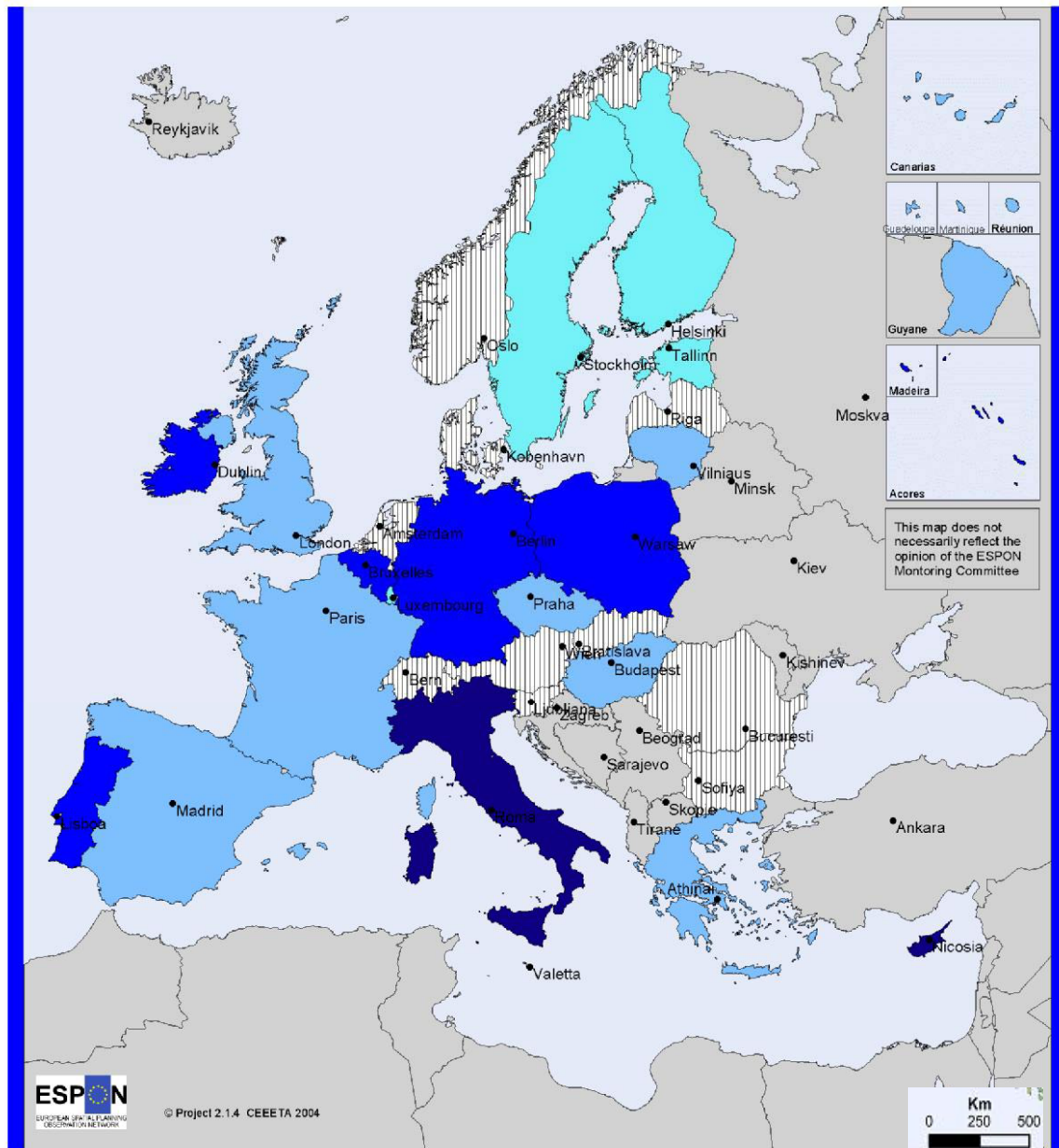
The share of each sector in energy consumption is a key issue for energy policy. In fact, having (in average) less than one third of the total FEC, industry has been so far the target of the emissions control because of the efficiency gains that exist in some energy intensive industries.

However transport, services and households as the most important consuming sectors deserve more attention in what energy efficiency policies are concerned. Candidate policies and measures are regulations for the buildings, more use of passenger mass transportation instead of the individual cars, more railways than road. A tax reform and a price system to take into account energy use externalities are instruments of great value to influence the citizens' way of life towards more rational use of energy.

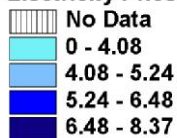
Only in Romania, Bulgaria, Slovakia, Czech Republic, Sweden and Finland industry is responsible for more than 35% of the total final energy consumption.



Electricity prices for industry (Excise taxes included) at NUTS 0 in 2002 (Current prices in € per 100 kWh)



Electricity Prices for Industry in 2002



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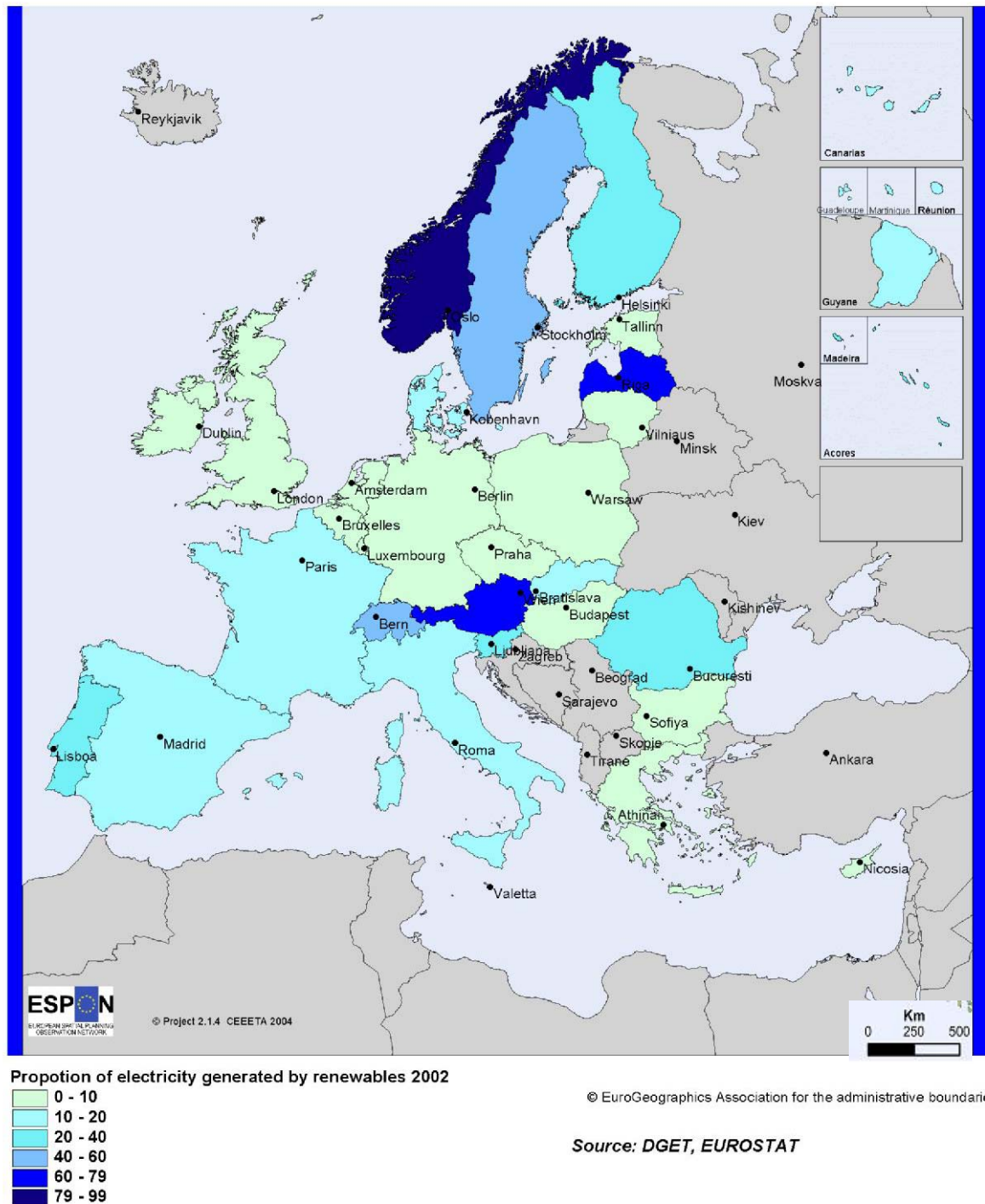
Source: DGET, Eurostat



This core indicator has little sense at regional level because price level and composition depend mainly on national policies, resources location and technologies. We have pictured the prices of electricity and natural gas for industry as the relevant indicators.

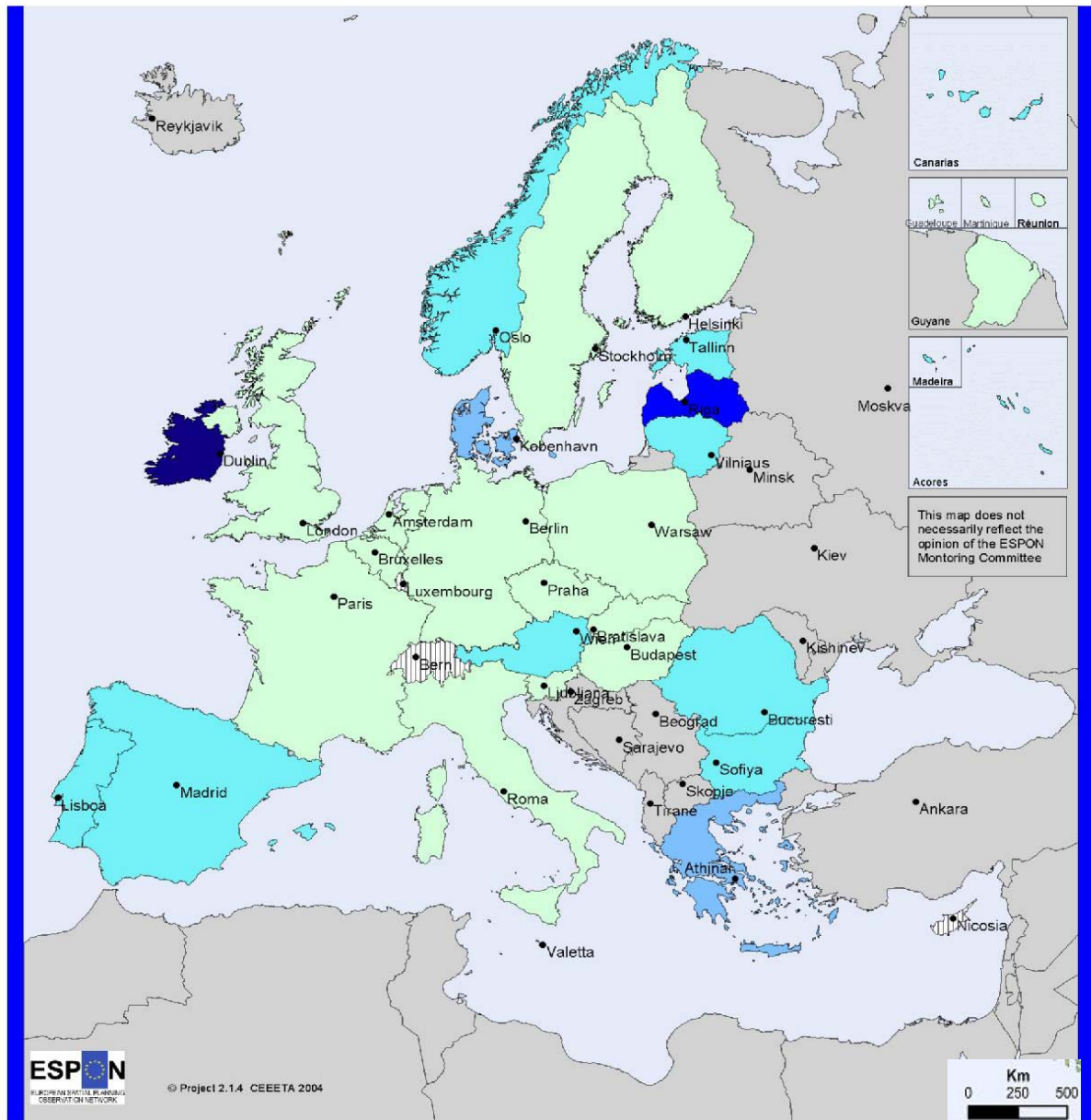
Among the countries under review, the prices in 2002 for industrial electricity consumption (excise taxes included) are higher than the average in Belgium, Germany, Ireland, Italy, Portugal, Cyprus and Poland.

Proportion of electricity generated by renewables in 2002 (%)



For 2002 the proportion of electricity generated by renewables is significant in countries such as Norway and Austria for example, although it must be understood that the nature of renewable energy in this context is very different among countries.

Wind & Biomass potential in final electricity consumption at NUTS 0 in 2002 (%)



**Wind & Biomass Potential / Final electricity consumption in 2002 (%)**

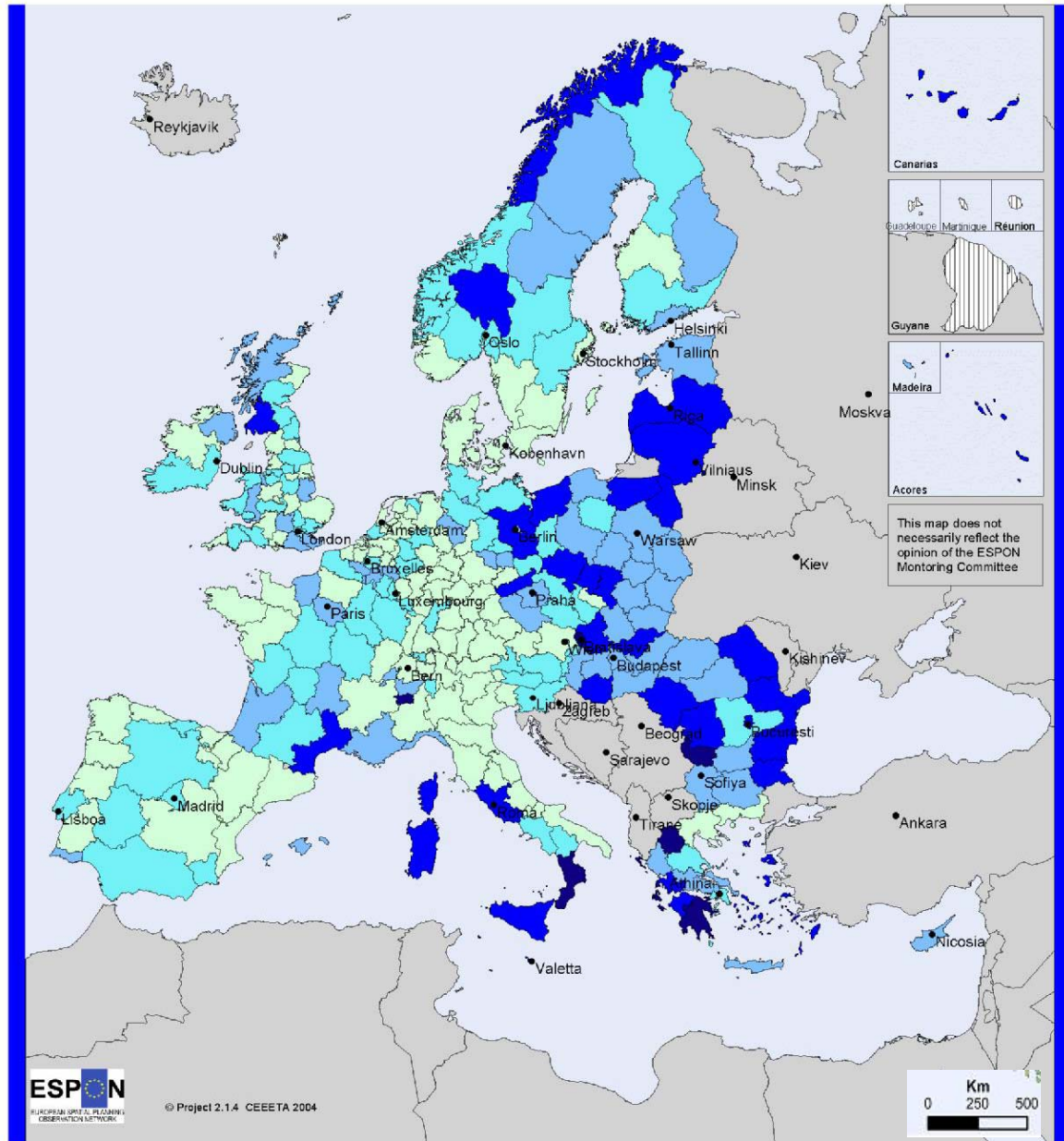
Light Green	15 - 56
Light Blue	56 - 97
Medium Blue	97 - 138
Dark Blue	138 - 179
Very Dark Blue	179 - 219
White with hatching	No Data

© EuroGeographics Association for the administrative boundaries

Source: DGET, EUROSTAT.  
 "Biomass availability in Europe" 2003,  
 EWEA

Considering the biomass potential together with wind potential and related both with final electricity consumption, we can see some exceptions of countries with a considering potential, like Ireland and Latvia.

Share of employed persons in energy sector in total industrial employment at NUTS 2 in 2001 (%)



Share of employed persons in energy sector in total industrial employment

□	No data
□	0 - 3
□	3 - 5
□	5 - 8
□	8 - 12
□	12 - 22

© EuroGeographics Association for the administrative boundaries  
Source: Eurostat, National Statistic for Switzerland (2001) and Malta (2000)

In 2001 around two million people were directly employed in the energy sector in the EU29 countries. About a quarter of the total employment in energy sector are in Germany (14%) and Poland (13%).

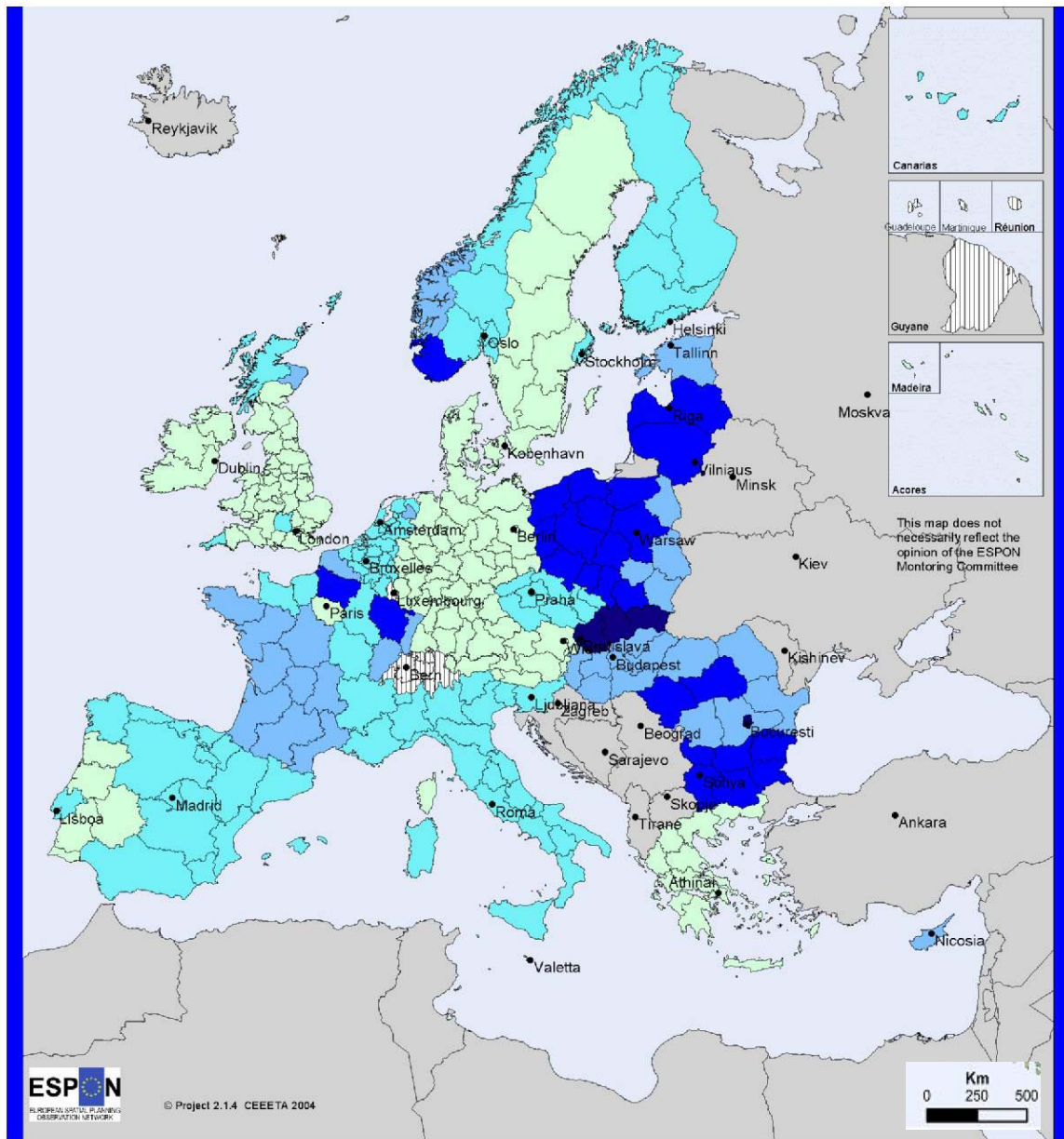
Once again the absolute size of the sector reflects the size of the countries. But if we take the weight of energy sector employment towards total industrial employment efficiency differences became evident.

In 2001 employment in energy sector represented in average five per cent of total industrial employment with more significant importance in N10 countries (the greatest weights were in Lithuania and Latvia with 12% and 11% respectively).

At regional level NUTS 2 the differences are greater with a range of weight between regions from 1% to 22% of total industrial employment.



Estimated impact of 10% decrease in energy prices on regional GDP (percentage points)



**Regional impact estimate of energy prices variation**

- 0.16 - 0.46
- 0.46 - 0.64
- 0.64 - 0.88
- 0.88 - 1.19
- 1.19 - 1.82
- No Data

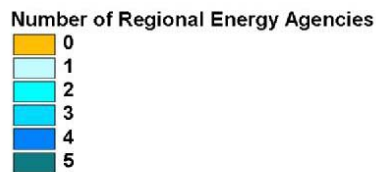
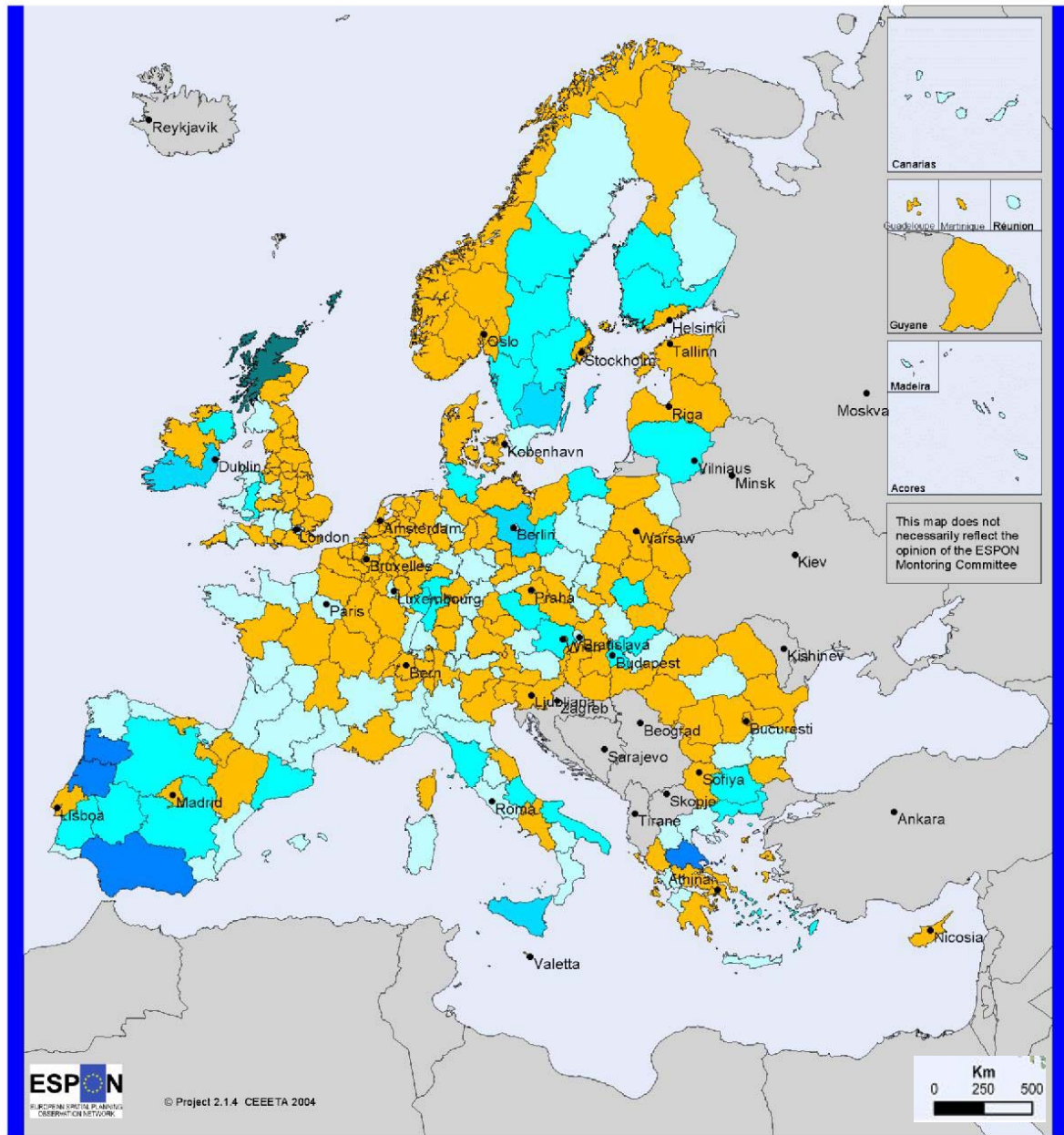
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Source: Eurostat, National Statistics

The aim is to construct an index of the sensibility of different regions to a decrease in the price of final energy. It must be stressed that regional results are dependent on the regional pattern of employment of branches more impacted by energy prices and are distributed around the national value.

The impacts vary significantly among countries: in 3 countries the impact would be less than 0,4%; in 12 between 0,4% and 0,6%, in another 8 between 0,6% and 1% and in 3 countries impact could be more than 1%.

Distribution of regional energy agencies



© EuroGeographics Association for the administrative boundaries  
 Source: European Commission  
 ManagEnergy Initiative

Energy and Transport DG of the European Commission supports the creation of regional and local energy agencies through the Save Program. These

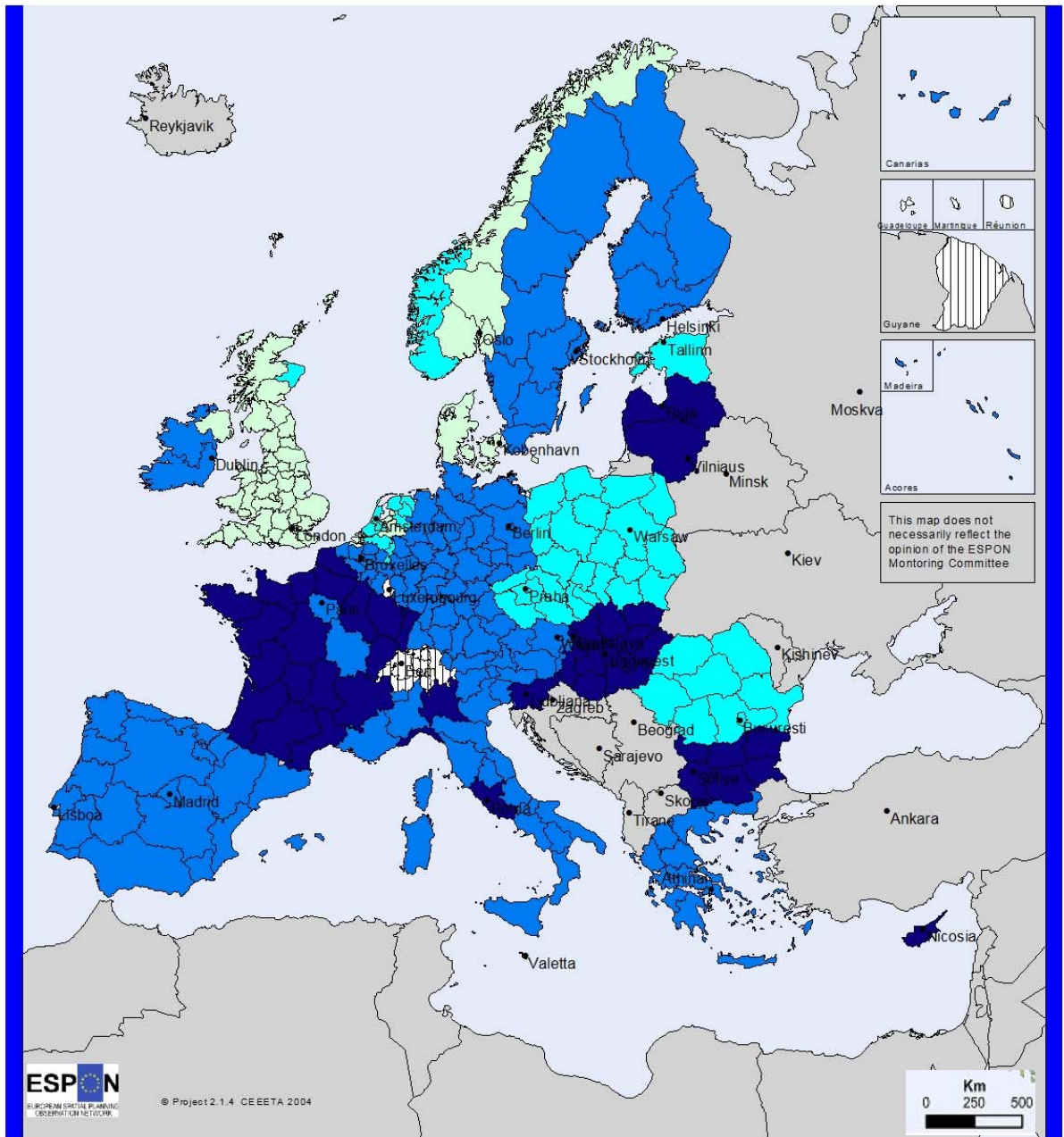


agencies have as main objective to advise local decision makers on local energy policy.

There are agencies established and developing action on good energy management practices, sustainability at local level, information and guidance to the public and other specific services.

The existence of such expertise is of great value for the implementation of policies that can have an impact on the welfare of the population and on the use of local energy resources.

Sensibility to variations on energy prices and energy self-sufficiency



**Sensibility to variations on energy prices and energy self-sufficiency** © EuroGeographics Association for the administrative boundaries  
 Source: Eurostat, National Statistics

Low Sensibility and High Self-sufficiency  
 High Sensibility and High Self-sufficiency  
 Low Sensibility and Low Self-sufficiency  
 High Sensibility and Low Self-sufficiency  
 No Data

The rationale behind this typology is that achieving a higher degree of self sufficiency has a price tag on it. Energy could become more expensive if less obvious energy sources are used.

But the less self-sufficient a country is, the more costly it could be the change.

Classifying regions by having a sensibility to price change above (high) or below (low) European average, and classifying regions in highly self-sufficient (above average) and lowly self-sufficient (below average), we have a fourfold typology that may be helpful designing dependency policies.

Regions with low price sensibility and high national self-sufficiency (pictured light green) are the ones that may have fewer problems deepening their energy self-reliance, and are regions that may contribute positively for the development of other European regions, not so well suited. These regions are located in the UK, Denmark and Norway, not surprisingly countries that are actually net exporters of oil.

In the other extreme we can find regions that are simultaneously highly sensible to price change, and are located in countries that have a low level of self-sufficiency. These are problem regions and are located in Latvia, Lithuania, Hungary, Slovenia, Cyprus, and (to some extent surprisingly) parts of France and Italy.

The remaining two sets of countries deserve different energy policy priorities.

The most important part of EU 15 (all regions of Portugal, Spain, Ireland, Sweden, Finland, Germany, Austria, Belgium, most of Italy, parts of France, all Greece) are regions that have a relative low sensibility to price changes, and have low self-sufficiency.

For these cases, investing in renewables can be a reasonable way of achieving more self-sufficient and reliable energy supply, without facing excessive problems in the economy.

The third group of regions (mainly from Poland, Czech Republic, Romania, Estonia) are characterized by low dependency, but high sensibility to price shocks. In this case the recommended policies should focus on energy efficiency as the key policy target, before important change can be obtained into renewable development, since price is an important issue.

## **Key policy recommendations**

Policy recommendations are a result of the main conclusions from the assessment.

### ***i) Availability of statistical data***

Difficulties of adequate statistical data are reported along the study. To carry out research in order to understand the main problems concerned, complete data bases with adequate desegregation have to be available. The existing public data bases have to be improved.

### ***ii) Local energy agencies***

The movement towards the creation of such agencies at local level must be encouraged. Their vocation is to disseminate information on rational use of energy, thus contributing to the efficiency of the energy system.

Local energy agencies can be key players on the promotion of rational use of energy in industry and buildings, along with the promotion of renewable local sources of energy promotion.

### ***iii) Local versus national policies***

The policies concerned with the energy sector and its impact on the economic activities and on the welfare of the populations are for the most part nationally formulated rather than regionally formulated.

The distinction between these two levels is of the utmost importance for policy formulation. The price policy is national based while the incentives for bio fuels crops must be more regional based.

### ***iv) Renewable energy development***

Renewable energy by its decentralized nature can have a very positive impact on local job creation and revenue generation. The target for electricity production from renewable sources must be achieved in 2010. Fighting Green House Gases emissions and the high dependency on oil in almost all the countries considered both call for an active strategy on renewables development at local level.

Local impacts of energy policy are only clearly visible in the promotion of renewable sources, providing local income, entrepreneurship and

employment opportunities. Thus the strategy for the promotion of renewable can be of high importance in the creation of conditions for a polycentric Europe.

***v) Flexibility in price policy***

There are heavy differences of electricity prices for industry and for households at country level. In several countries the gap between prices for industry and for households is widening. However energy prices seem not relevant to explain either energy consumption or development differences between countries. These results are very important for pricing policy.

Pricing policy can and must be used to generate financial resources to be diverted to areas such as: promotion of renewables, energy efficiency, and consumer's information policy.

***vi) Promoting full costing of energy use***

By full costing in this context we mean the internalization of externalities in the market price for energy products.

Competitiveness of renewable sources compared with fossil sources will be easily achieved if the externalities of energy used are fully transferred to final prices. In fact energy obtained from fossil fuels has negative impacts on the environment such as CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>2</sub> emissions. On the contrary energy from renewable sources is emissions free.

The valuation of the burdens caused in terms of impacts on human health and on economic activity is not an easy task but some research has been done in the past. Prices of energy must take into account the value of the negative externalities on the environment and on the human health.

The low price elasticity of energy and the low level of energy costs in economic activity will cushion the impacts of such pricing policy.

Only in a limited number of European regions these policy changes must be done with care in order to avoid major social and economic impacts. Transfer of resources from most advanced and less sensible regions to those more at risk to energy shocks could be used.

***vii) Promote R&D on energy efficiency and use of renewables***

Europe has considerable energy resources in renewable sources such as biomass, wind, hydro and solar. However there are presently technical limits to the extent in which renewables potential can be used. For instance the share of electricity produced from wind farms has an upper limit set by technical grid constraints. Overcoming these limits is a key issue on the promotion of renewables and European energy self-reliance.

This is particularly sensitive item for the energy production structure of islands and more remote regions to whom links with Trans-European grids are impossible or not cost effective.

***viii) The need for an integrated approach to energy policy***

So far, EU (and in many cases national policies as well) have been "*piece meal*" policies. Competitiveness, environment and local development could in most cases present conflicting objectives and perverse effects.

This is very clear when looking at policy prices. Whilst low energy prices seem to be appealing to promote European competitiveness in global markets (and liberalization of markets has been the key policy to achieve lower prices) this clearly leads to higher levels of consumption and less incentive towards energy efficiency.

At the present state of the technology and global markets, lower prices are an important boost for increased demand for fossil and nuclear energy sources.

Setting the right balance among competitiveness, environment and local development requires an integrated approach where these three objectives are considered together and the costs of present decisions on the medium run are accounted.

TEN-E and liberalized markets are only sensible policy options if a strong regulation policy environment is set in order to reduce room for undesirable outcomes.

## Methodology

The methodologies were selected according to type of data availability and to type of theoretical research to conduct in order to isolate the adequate results to answer the questions the project was asked for.

The methodologies used in different stages of the research were the following:

### ■ **Data analysis and construction of a battery of indicators**

A range of indicators to measure and compare the different aspects of the energy sector in the countries and regions concerned has been proposed:

1. Core Indicators related to energy consumption, energy production and energy prices
2. Economy, society and energy (indicators A)
3. Reliable supplies of energy (indicators B)
4. Competitive energy markets (indicators C)
5. Environmental objectives (indicators D)
6. Other set of indicators related to energy dependency and renewables potential

Full definitions for these indicators, together with data sources and analysis of data availability, are provided in the main report.

- **Regression Analysis techniques** - used to examine the relationships between energy and development;
- **Territorial impact analysis** of energy prices variations using Input-Output modelling;
- **Definition of Typologies** - the data collected was used to develop a typology of regions as a tool for identifying regional "types" and assist consideration of the policy implications.
- **Qualitative data analysis** through case studies for assessment of specific regional impacts in different countries.

## Typologies

Developing methodologies was aimed at establishing relations among energy indicators, territorial development and energy policy, in a way that these would be “easy to use” indicators that may help to define policy orientations.

In the case of project 2.1.4, not having basic indicators at NUTS 2 and 3 levels was, from the beginning, a major problem for this exercise. But, even if those indicators were available, energy issues are most of them placed at the national level or, sometimes even at European level. Thus trying to discuss the local level in this framework would be most of the times unfruitful, if not misleading.

From this standing point, our efforts have been to provide typologies that would be able to provide highlights about the following issues:

- a) Level of energy self-sufficiency;
- b) Pressure on GHG (derived from the share of fossil primary energy in TPES);
- c) Potential share of electricity consumption replaceable by renewable energy sources;
- d) Level of sensibility to energy price changes by regions (NUTS 2);
- e) Sensibility of regions to energy price changes and country energy self-sufficiency;
- f) Sensibility of regions to energy price changes and country pressure on GHG emissions.

## Indicators

Energy indicators are estimated from basic data on the structure of economic and human activity, combined with measurements of the energy use for those activities. Indicators link energy use to economic and human activity.

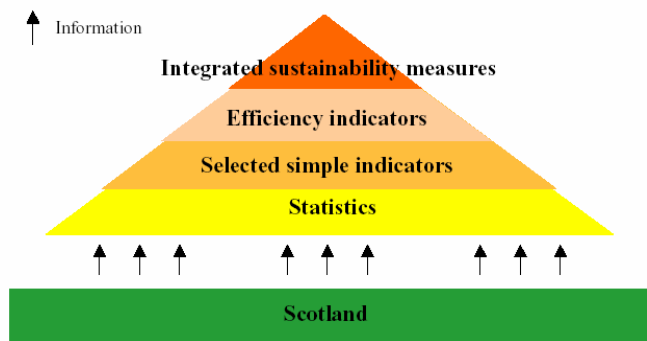
Our goal in the framework of the ESPON project is to use disaggregated indicators to show how energy infrastructures and energy production and



consumption are linked with economic and human activity, and to understand how spatial development depend or is influenced by the energy sector development and/or by energy availability.

With the set of indicators proposed we must be able to measure, namely, the degree of regional development among the 29 countries of the study seen from the energy point of view, the strong and weak points of the energy sector, including infrastructures, the potential for regional development, and the bottlenecks for spatial development. Some common links among subsets of indicators were established, according to the types of answers and/or problems to be studied and the type of information embodied in each subset.

**Figure 1 From raw statistics to summary indicators**



Source: Sustainability indicators for waste, energy and travel for Scotland - Scottish Executive Central Research Unit 2001

The final set of indicators obtained was the result of the following process:

- i) at a first stage, where data availability was not completely assessed, it was proposed a first and complete set of variables and indicators, an ambitious proposal as we were in an ideal world in terms of information availability;
- ii) in a second step the assessment on the possibility to estimate the indicators proposed was done taking into account data availability and quality. A second stage set of indicators was proposed, trying to take into consideration the possibility to answer the main questions concerned with the aims of the ESPON project with the constraints of data availability;
- iii) in a final step the quality of the indicators estimated was assessed, based on the criteria of information content, adequacy to answer the main policy questions, possibility of interregional comparisons.

For data collection of raw statistical information a set of core indicators has been defined having in mind the proposed set of indicators presented ahead. Some adjustments were made since our interim reports taking into account data availability and quality.

**Table 1 Core Indicators provided to the ESPON database**

<b>Core Indicator 1 (CI 1)</b>	<b>Electricity production by power source</b> (hydroelectric, nuclear, thermal power and other)		
<b>Core Indicator 2 (CI 2)</b>	<p><b>Final energy consumption by energy type and consumption sector</b></p> <p><i>We must retain the classifications available in statistical sources, in order to have flexibility for other aggregation.</i></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-right: 1px dotted black; padding: 5px;"> <u>Energy type:</u>  . Solid Fuels  . Oil  . Gas  . Electricity  . Derived Heat  . Renewables </td> <td style="width: 50%; padding: 5px;"> <u>Consumption sector:</u>  . Industry  . Transport  . Households  . Commerce and others </td> </tr> </table>	<u>Energy type:</u> . Solid Fuels . Oil . Gas . Electricity . Derived Heat . Renewables	<u>Consumption sector:</u> . Industry . Transport . Households . Commerce and others
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<b>Core Indicator 3 (CI 3)</b>	<b>Energy prices for industry (tax included)</b>		

The core indicators mentioned above are simple raw statistical variables that will be used with other variables to express the reality in relative terms (e.g. productivities, per capita ratios, relative prices).

Beyond the core indicators a complete set of indicators grouped in 4 domains has been proposed covering different aspects of the energy sector and were calculated when possible for the 29 countries of the study:

- ❖ Economy, society and energy (*indicators A*)
- ❖ Reliable supplies of energy (*indicators B*)
- ❖ Competitive energy markets (*indicators C*)
- ❖ Environmental objectives (*indicators D*)

As a starting point we got access to the energy balances of all the countries considered, which is a good statistical base for regional data validation.

The main characteristics of the reality to be studied are supposed to emerge from the indicators. To be reliable the indicators battery must also enable decision makers and researchers to follow and measure the adequacy and

impact of energy policies both at country and region level. The energy policies at EU and country levels have nowadays some common goals: security of supply, competitive energy markets, environment sustainability.

We propose a range of indicators to measure and compare the different aspects of the energy sector in the countries and regions concerned. A detailed description of this indicators battery is presented in Annex 1.

The dataset supplied to the ESPON Database is accompanied by proper METADATA descriptions.

### **Data Gaps**

The main difficulty related to data collection is the severe lack of statistical information. This has limited the scope of analysis making impossible, in some cases, to calculate the proposed energy indicators at regional level and therefore hindering the elaboration of a detailed and complete assessment of the energy sector in a global regional perspective.

The data collected and used to construct the energy database and to calculate the energy indicators comes from different sources where definitions and measure units are not always homogeneous, thus delivering different results for the same items.

Additionally, establishing contact with the appropriate persons in each country was often an unfruitful and time consuming activity. Frequently the received data was incomplete for the country level and in other cases there were no answers at all. Moreover, the data from different sources vary and it is hard (if possible at all) to verify its quality and comparability.

Systematic energy data at the regional level is still scarce and in many countries no recent data regarding the intended territorial desegregation is available. For instance, in United Kingdom the Department of Trade and Industry had established the need for sub-national information on energy consumption and only recently is studying how to compile such estimates including, in particular, how to collect such information on electricity use.

In the case of the New Member States the problems are even more relevant due to the fact that some data is not produced and many of the energy indicators even do not exist (or at least are not available). This concerns either NUTS 2 or country level.

The Statistics of the New Member States are considerably affected by the transition in the past ten years. There are also changes year by year in how they are drawn up. In the newest statistics some data for NUTS 2 level is included, but this is only for the last year or the last two years.

The scarce availability of comparable data on regional level hampers the analysis of energy policies impact in Europe.

At the beginning of our project the quality and coverage of the collected data proved to be very heterogeneous. Data gaps appeared concerning:

- the temporal requirement (1990-2002): data is not always available for all years or data is only available for other years, e.g. 2001
- the spatial level (NUTS): data is not always available at national level and data for some NUTS 2 units is missing, e.g. United Kingdom
- the spatial scope (EU 29): data gaps especially in the New European countries, e.g. no reaction of some national statistics institutes to the data request that was sent several times, difficulty in communication due to language skills.

After searching data in each country contacting several institutions like energy regulators, government departments and other sources, we decided to choose a stable data source like Eurostat Newcronos, although some data sets are really far from complete, but they were considered important.

Accordingly to Eurostat Metadata the European regional energy statistics contain data at NUTS level 2, and partially also on NUTS level 3. These statistics cover energy data and the following variables:

- Electricity production capacity (in MW) (table en2celec for Member States and table "xencelec" for Candidate Countries);
- Electricity consumption by sector (in GWh) (table en2cons for Member States and table "xencons" for Candidate Countries).

Regarding time coverage, this data is available:

- for old Member States<sup>1</sup>: from 1986 to 2000
- for new Member States<sup>2</sup>: from 1995 to 2000

---

<sup>1</sup> old Member States: the 15 MS that acceded before 1 May 2004.

<sup>2</sup> new Member States: the 10 MS that acceded on 1 May 2004.

National data is collected by the Eurostat unit Energy and Transport Statistics by means of a questionnaire which is normally sent to energy ministries or similar. Those questionnaires do not include regional tables, therefore regional energy data is not updated regularly but only occasionally by consultation of energy-related statistical publications.

All data supply of regional energy statistics is based on a voluntary agreement<sup>3</sup>.

In our project data collected at regional level for Core Indicator 1 (electricity production) comes mainly from Eurostat Newcronos database recent output<sup>4</sup> and refers to installed electricity net capacity production by power source since 1986 to 2000 (yearly) for member states and 1995 to 2000 (yearly) for new member states.

For some cases there is no data for all energy sources in the same year, and for other cases the information is not available at all. The analysis reports to 21 countries with NUTS 2 but only for 13 countries it is possible to have comparable data. Besides that, for example Germany has only 8 regions with available data in a total of 40 regions. So, the comparative analysis is strongly limited.

According to this Eurostat source<sup>5</sup> there are some discrepancies of data, for example:

- In Czech Republic the hydro and thermal electricity production capacity are not collected at regional level;
- In Hungary the electric production capacity is the annual average of net production capacity;
- For Slovakia it is considered the installed energy production capacity.
- In the case of Slovenia, the sums of the regional data do not equal national data

Regarding Core Indicator 2 (final energy consumption) the main source was also the Eurostat Newcronos database recent output<sup>6</sup>. Regional data for final consumption by sector is available only for electricity from 1986 to 2000 for member states and from 1995 to 2000 for new member states. The

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<sup>3</sup> Regional transport and energy statistics: Eurostat Metadata in SDDS format – base page.

<sup>4</sup> updated in July of 2004

<sup>5</sup> European Regional Statistics, Reference Guide, 2004, Eurostat.

<sup>6</sup> updated in July of 2004

consuming sectors of electricity are: industry, energy, transport, households, agriculture, services and others sectors.

According to this Eurostat source<sup>7</sup> there are also some discrepancies of data, for example:

- In France electricity consumption by households includes low tension consumption in the agriculture sector.
- In Ireland and Netherlands electricity consumption by households includes agriculture consumption.
- For Denmark and Finland electricity consumption by industry includes construction consumption.
- In the case of Hungary there is only national data because regional data is not available.
- For Slovenia, industry and energy consumption of electricity regional sums do not equal national values.

Once again the problem of data availability is very significant, compromising any comparative analysis.

The analysis of energy policy impacts requires data to be gathered at regional scale (i.e. NUTS 2). Data at regional scale is not available for all countries of the study area; it still needs to be gathered in a systematic way, with adequate metadata indicating the differences in methodology from country to country.

Furthermore, coherent time series data at the regional scale need to be built up so as to allow for the analysis of trends.

Major steps are required in order to improve the situation. The data collected by the national statistical institutions should be subject to an international debate. Regional databases in Europe are a question of priority importance in a context of increasing demand for regional data, and several efforts are being undertaken<sup>8</sup>.

For future research programmes of the type of ESPON it is of major importance that projects such as Data Navigator or the coordinating project 3.1 start way before the thematic projects are initiated.

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<sup>7</sup> European Regional Statistics, Reference Guide, 2004, Eurostat.

<sup>8</sup> "Regional databases in Europe", Statistics in Focus Theme 1 – 3/2003, Eurostat.

## **Networking**

Project 2.1.4 exchanged information with the ESPON project 1.3.1 and 1.2.2.

With 1.3.1 it was possible to exchange data of common interest to be worked with (location of nuclear power stations at NUTS 2 level).

We have also exchanged data on Input/Output tables with project 1.2.2, thus reinforcing the quality and the availability of that in both projects.

ESPON Database was used to access basic information like population and GDP. Corine Database has allowed gathering information about land cover to identify potential resources for biomass for energy production.

ESPON seminars have functioned as crucial spaces for the exchange of information about the approaches and results achieved by various ESPON projects.

Some ESPON Contact Points (ECPs) also provided help in some specific project questions such as access to data.

Regarding the work undertaken in the TPG the project team consisted member institutions from four countries. The participating countries were: Portugal, Poland, Italy and Denmark.

The project partners undertook responsibility for specific working subjects. All partners were involved in discussions and provided data for the analysis. Two meetings of the full team were arranged during the course of the project, in Lisbon. The Polish partner has also attended the Matera ESPON meeting.

The main constraint, especially from the perspective of the Lead Partner, was the very limited budget of the project and the difficulties on obtaining interim payments scheduled in the contract.

The Lead Partner of this project participated in all ESPON seminars and lead partner meetings, as requested by the Managing Authority.

# **Territorial trends of energy services and networks and territorial impact of EU energy policy**

## **Part Two: Results of the Project**



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## 1 Energy in Europe

This chapter of the report presents the basic data for the characterization of the energy sector in Europe.

### 1.1 Concepts, methodologies and typologies used and developed

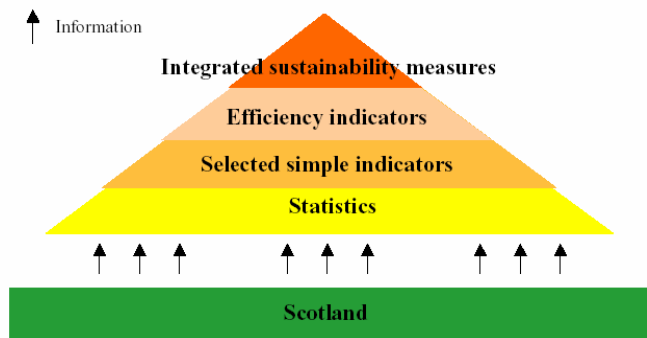
#### 1.1.1 The methodology

Energy indicators are estimated from basic data on the structure of economic and human activity, combined with measurements of the energy use for those activities. Indicators link energy use to economic and human activity.

Our goal in the framework of the ESPON project is to use disaggregated indicators to show how energy infrastructures and energy production and consumption are linked with economic and human activity, and to understand how spatial development depend or is influenced by the energy sector development and/or by energy availability.

With the set of indicators proposed we must be able to measure, namely, the degree of regional development among the 29 countries of the study seen from the energy point of view, the strong and weak points of the energy sector, including infrastructures, the potential for regional development, and the bottlenecks for spatial development. Some common links among subsets of indicators were established, according to the types of answers and/or problems to be studied and the type of information embodied in each subset.

**Figure 1 From raw statistics to summary indicators**



Source: Sustainability indicators for waste, energy and travel for Scotland - Scottish Executive Central Research Unit 2001

The final set of indicators obtained was the result of the following process:

- i) at a first stage, where data availability was not completely assessed, it was proposed a first and complete set of variables and indicators, an ambitious proposal as we were in an ideal world in terms of information availability;
- ii) in a second step the assessment on the possibility to estimate the indicators proposed was done taking into account data availability and quality. A second stage set of indicators was proposed, trying to take into consideration the possibility to answer the main questions concerned with the aims of the ESPON project with the constraints of data availability;
- iii) in a final step the quality of the indicators estimated was assessed, based on the criteria of information content, adequacy to answer the main policy questions, possibility of interregional comparisons.

### 1.1.2 The indicators

As a starting point we got access to the energy balances of all the countries considered, which is a good statistical base for regional data validation. We produced some indicators at country level considering primary and final energy consumption, energy imports, and energy sources and consuming sectors.

For data collection of raw statistical information a set of core indicators has been defined having in mind the proposed set of indicators presented ahead.

Some adjustments were made since our interim reports taking into account data availability and quality.

**Table 1 Core Indicators provided to the ESPON database**

<b>Core Indicator 1 (CI 1)</b>	<b>Electricity production by power source</b> (hydroelectric, nuclear, thermal power and other)	
<b>Core Indicator 2 (CI 2)</b>	<b>Final energy consumption by energy type and consumption sector</b> <i>We must retain the classifications available in statistical sources, in order to have flexibility for other aggregation.</i>	
	<u>Energy type:</u> . Solid Fuels . Oil . Gas . Electricity . Derived Heat . Renewables	<u>Consumption sector:</u> . Industry . Transport . Households . Commerce and others
<b>Core Indicator 3 (CI 3)</b>	<b>Energy prices for industry (tax included)</b>	

The core indicators mentioned above are simple raw statistical variables that will be used with other variables to express the reality in relative terms (e.g. productivities, per capita ratios, relative prices).

The dataset supplied to the ESPON Database is accompanied by proper METADATA descriptions.

The contribution of the energy sector for regional and social development can be assessed using a set of indicators covering the different aspects of the countries and regions concerned. The main limitation in designing such a battery of indicators is the availability of data at country and regional level enabling consistent comparisons.

The main characteristics of the reality to be studied are supposed to emerge from the indicators. To be reliable the indicators battery must also enable decision makers and researchers to follow and measure the adequacy and impact of energy policies both at country and region level. The energy policies at EU and country levels have nowadays some common goals: security of supply, competitive energy markets, environment sustainability.

We propose a range of indicators to measure and compare the different aspects of the energy sector in the countries and regions concerned.

The indicators have been grouped into four domains covering different aspects of the energy sector:

1. Economy, society and energy (*indicators A*)
2. Reliable supplies of energy (*indicators B*)
3. Competitive energy markets (*indicators C*)
4. Environmental objectives (*indicators D*)

A detailed description of this indicators battery is presented in Annex 1.

#### 1.1.3 Main difficulties related to data collection

The main difficulty related to data collection is the severe lack of statistical information. This has limited the scope of analysis making impossible, in some cases, to calculate the proposed energy indicators at regional level and therefore hindering the elaboration of a detailed and complete assessment of the energy sector in a global regional perspective.

The data collected and used to construct the energy database and to calculate the energy indicators comes from different sources where definitions and measure units are not always homogeneous, thus delivering different results for the same items.

Additionally, establishing contact with the appropriate persons in each country was often an unfruitful and time consuming activity. Frequently the received data was incomplete for the country level and in other cases there were no answers at all. Moreover, the data from different sources vary and it is hard (if possible at all) to verify its quality and comparability.

Systematic energy data at the regional level is still scarce and in many countries no recent data regarding the intended territorial desegregation is available. For instance, in United Kingdom the Department of Trade and Industry had established the need for sub-national information on energy consumption and only recently is studying how to compile such estimates including, in particular, how to collect such information on electricity use.

In the case of the New Member States the problems are even more relevant due to the fact that some data is not produced and many of the energy indicators even do not exist (or at least are not available). This concerns either NUTS 2 or country level.

The Statistics of the New Member States are considerably affected by the transition in the past ten years. There are also changes year by year in how they are drawn up. In the newest statistics some data for NUTS 2 level is included, but this is only for the last year or the last two years.

## 1.2 Energy in Europe overview

To measure and compare the different aspects of the energy sector in the countries and regions concerned in this study we established three core indicators and an associated battery of indicators. Along this section we will go through the core indicators and battery of indicators, trying to set a framework for the analysis of Energy themes and issues that are the results of our research.

### 1.2.1 Europe's energy dependency

The main issue about Energy in Europe is its dependency from imported fossil fuels.

In fact, from the 29 countries considered in this study, only Norway, UK and Denmark are net exporters of energy.

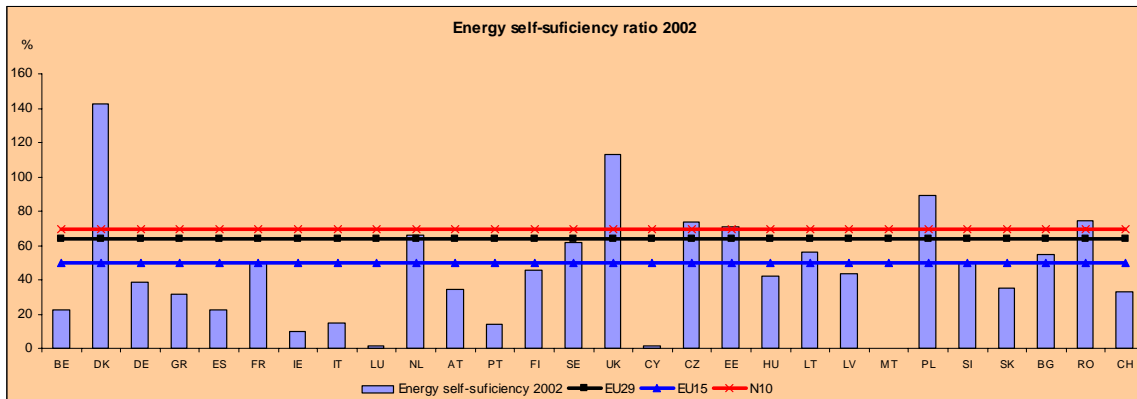
Has a whole in 2002, our country sample produced only 64% of its energy needs. But this figure is severely influenced by the data about Norway that produces 9 times more energy than it consumes. In fact EU 15 produces only about 50% of its energy needs and N10 has a better ratio of 70% of self sufficiency<sup>1</sup>.

Next figure and graph provide the overall picture of energy self-sufficiency across the 29 countries considered in our survey (Norway has not been considered because it distorts the overall picture).

---

<sup>1</sup> Energy self-sufficiency is measured here as the relation between the production with domestic energy resources and the total energy production, as provided by the energy balances of the Eurostat.

**Figure 2 Energy self-sufficiency in Europe in 2002 (%)**

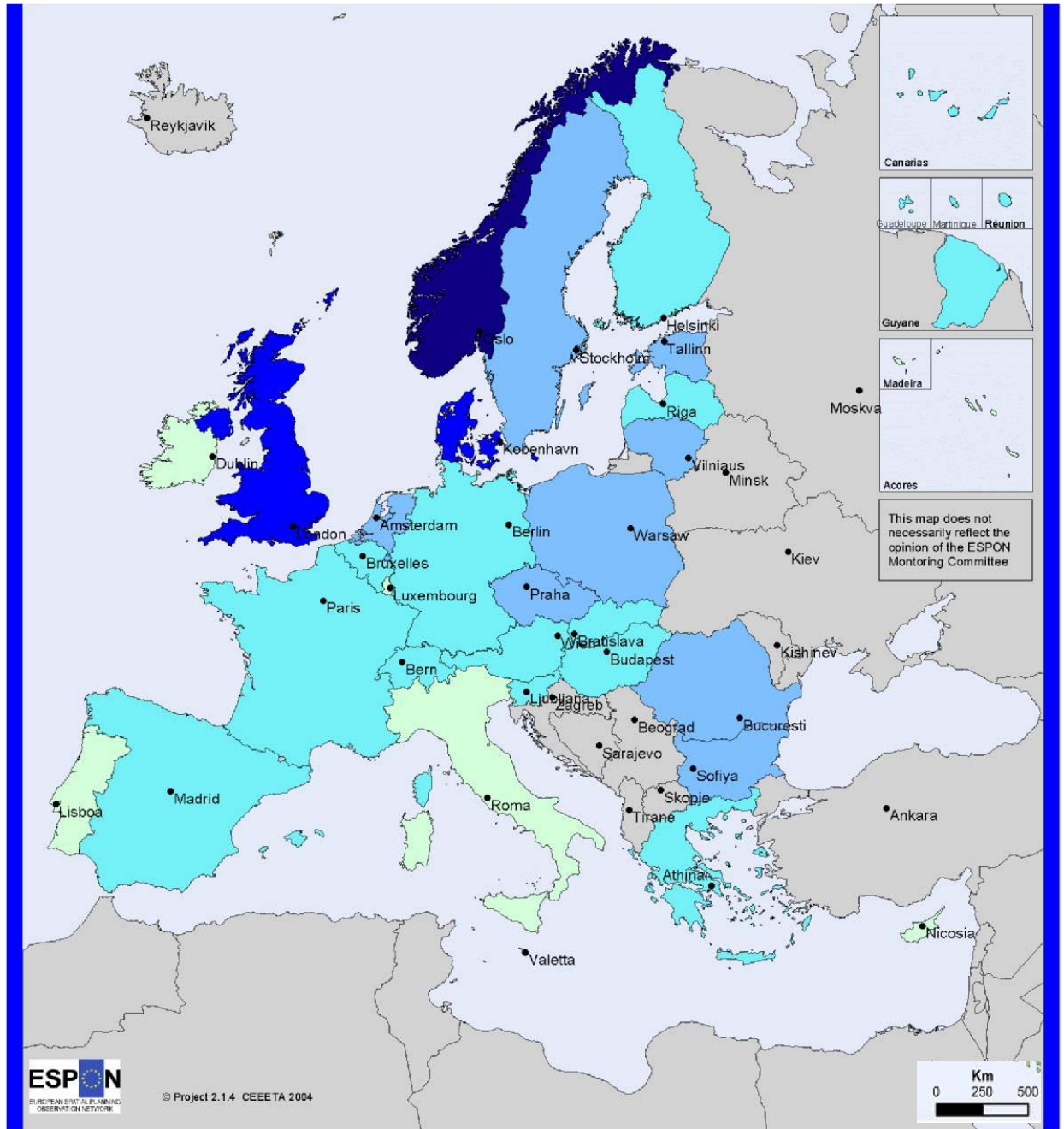


Source: DGET and Eurostat

As it may be seen, energy dependency is a key issue in Europe’s energy sector. It requires much more energy than it is able to produce with domestic resources. The smaller European countries reveal severe energy dependence (Luxembourg, Cyprus and Malta, producing less than 2% of its energy needs with domestic resources). Another five European countries have resources that are only enough to produce less than 25% of its energy needs (Belgium, Spain, Ireland, Italy and Portugal).



**Map 1 Energy self-sufficiency in Europe in 2002 (%)**



**Energy self-sufficiency in 2002**

- 0 - 15
- 15 - 50
- 50 - 89
- 89 - 143
- 143 - 866

© EuroGeographics Association for the administrative boundaries

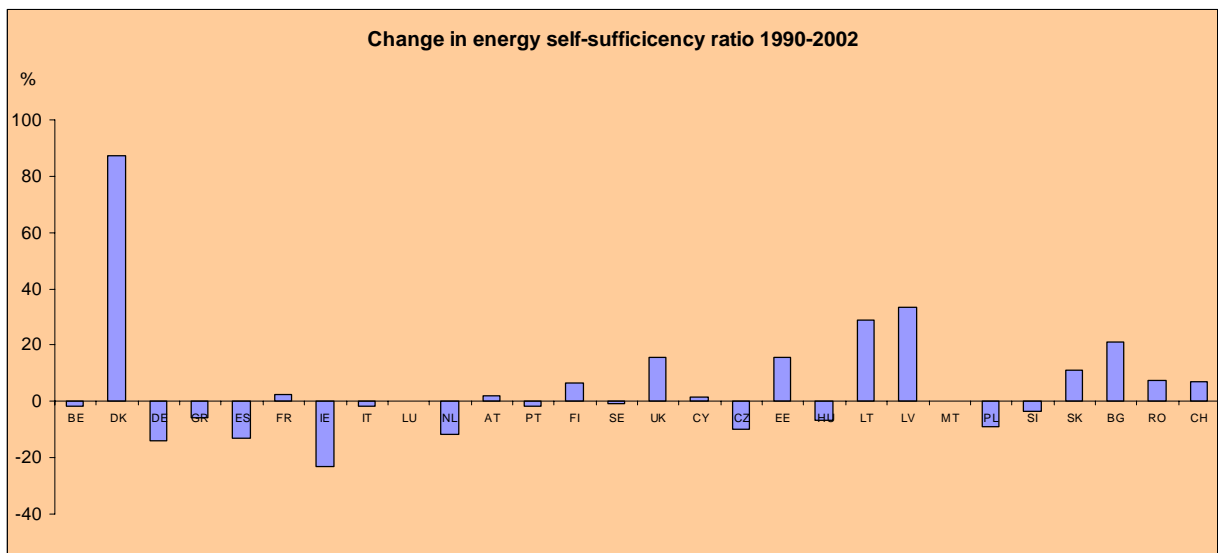
Source: DGET, Eurostat

Has a whole Europe's dependency has improved from 1990 to 2002, passing from an overall self-sufficiency ratio of 60.9% in 1990 to the above mentioned 64%. But this overall evolution hides strikingly different performances among countries. In fact EU 15 and N10 averages have both worsened (by 2,7% and 2,8% respectively). The better performers were Denmark (passing from a dependency of about 50% to an exporter of about 50% its production capacity) and Norway, enlarging its surplus by about 50% (from an excess of 500% to 865%).

Twelve countries have seen its dependency ratios worsened (Belgium, Germany, Spain, Ireland, Italy, Netherlands, Portugal, Sweden, Czech Republic, Hungary, Poland and Slovakia). The overall improvement in the dependency ratio was based in important positive changes in a small number of countries: Norway, Denmark, UK, Estonia, Latvia, Lithuania and Bulgaria (even though, the last four because its consumption has been diminished, as we will discuss later).

The following figure displays variations on the dependency ratio from 1990 to 2002 (once again excluding Norway for a clearer picture).

**Figure 3 Energy self-sufficiency evolution in Europe (1990 to 2002)**



Source: DGET and Eurostat

When dealing with energy, dependency is clearly a major trait that must be considered in every energy analysis, despite the large differences in country characteristics.

The high level of energy dependency on imported fossil fuels explains the concerns of the European Commission to improve energy efficiency and to increase the use of renewable energy resources. A number of Directives approved in the last years can be mentioned, having as main concerns energy efficiency, renewables and the environment:

- Directive 77/2001, on the promotion of electricity produced from renewable energy sources in the internal electricity market;
- Directive 30/2001, on the promotion of the use of biofuels or other renewable fuels for transport
- Directive 91/2002, on the energy performance of buildings
- Directive 87/2003, establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
- Directive 8/2004, on the promotion of cogeneration
- Proposal for a Directive, COM(2003)739, on energy end-use efficiency and energy services.

The development of renewable energy sources has a very strong impact at local level. Renewable sources are endogenous resources used for decentralized energy production. Energy from renewable energy sources is free from greenhouse gases emissions. As will be studied later the information and data available to characterise the distribution over the territory of renewable resources is very weak and some times very expensive because it has been developed by business firms.

### 1.2.2 Producing electricity in Europe

Common sense sometimes assimilates electricity and energy. In some regions and according to traditions people uses the word "light" instead of electricity. Being distributed in a grid, electricity seems to be a ubiquitous form of energy, available at every place and moment. It even more can easily be adapted to consumer's needs and requirements at relatively low costs and in a short period of time. We have to have in mind also that in general we can not stock electricity.

Our well being and the economic development are very much dependent on the availability and quality of electricity supply, probably more than anything

else in the world of energy. We will look at this in a more detailed manner later on. To start with we will focus on the energy sources used to produce electricity across Europe.

The power sources used in electricity production are the result of a long story that reflects natural endowments of the country (availability of the sources: coal, petroleum, water flows) and the past political options (that determine concerns about the environment and “acceptable” energy dependencies). The option by France to develop the nuclear *filière* done in the fifties strongly influences the actual situation in this country in what power installed for electricity production is concerned.

To set the framework for this analysis we have developed the first of our core indicators:

### **Core Indicator 1 - Electricity production by power source**

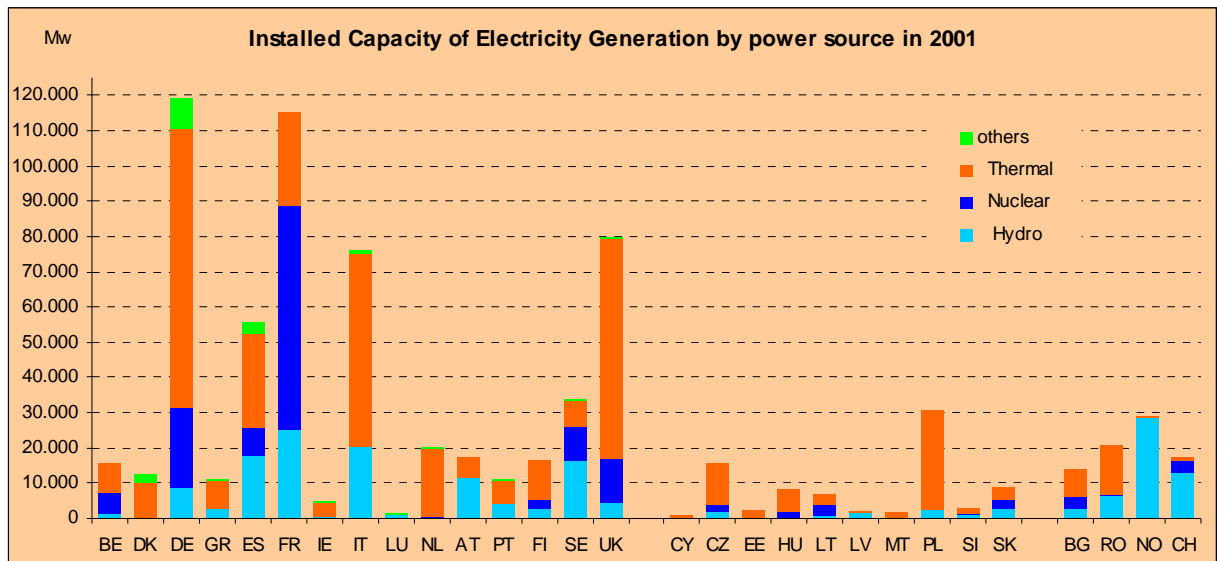
Installed capacity production of electricity generation plants is a close proxy of the size of the economies, but the structure of the production by source strongly varies among countries.

Germany and France have the largest installed capacity although with different contribution of power sources in each country. In Germany thermal power (excluding nuclear) is the main source representing 66% of the total energy supply and in France nuclear power represents 55% of total installed capacity (being the largest nuclear electricity producer in Europe).

Thermal production (using coal or oil) is present in all the countries in our sample. Nuclear power stations do exist in 13 out of the 29, whilst hydro power stations are present in 21 countries.

This is a good reflection on the situation: electricity production in Europe is still very much dependent on fossil fuels, and that is another major trait of Europe’s energy sector.

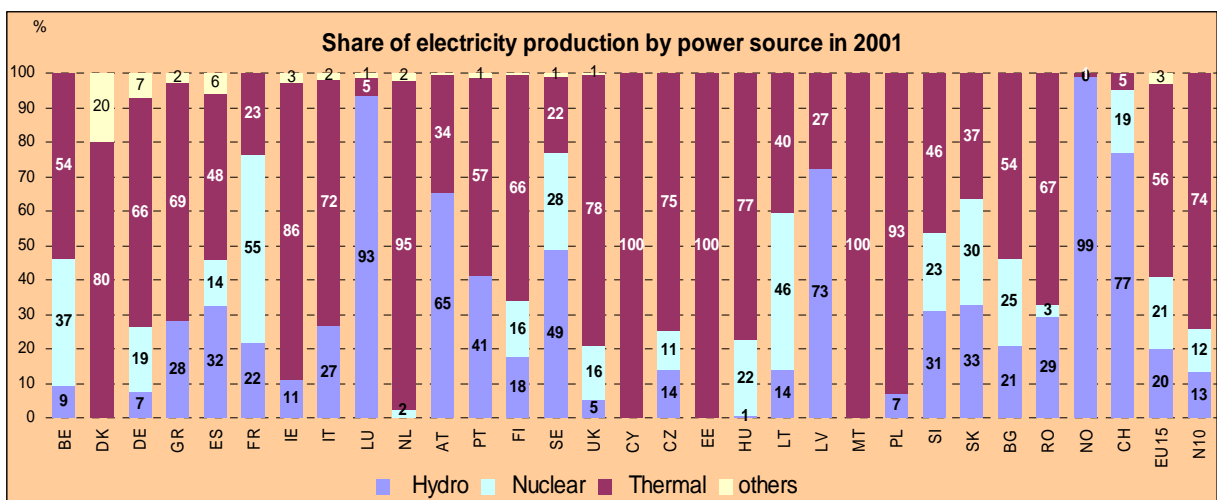
**Figure 4 (Core Indicator 1) Electric power by power source at NUTS 0 in 2001 (MW)**



Source: "Energy, transport and environment indicators 1991-2001" Eurostat and ECP Switzerland for CH

Looking at the data for 2001 at country level we observe that thermal power plants (excluding nuclear) provided the majority of capacity, representing 74% of total installed capacity in the N10 and 56% in EU15.

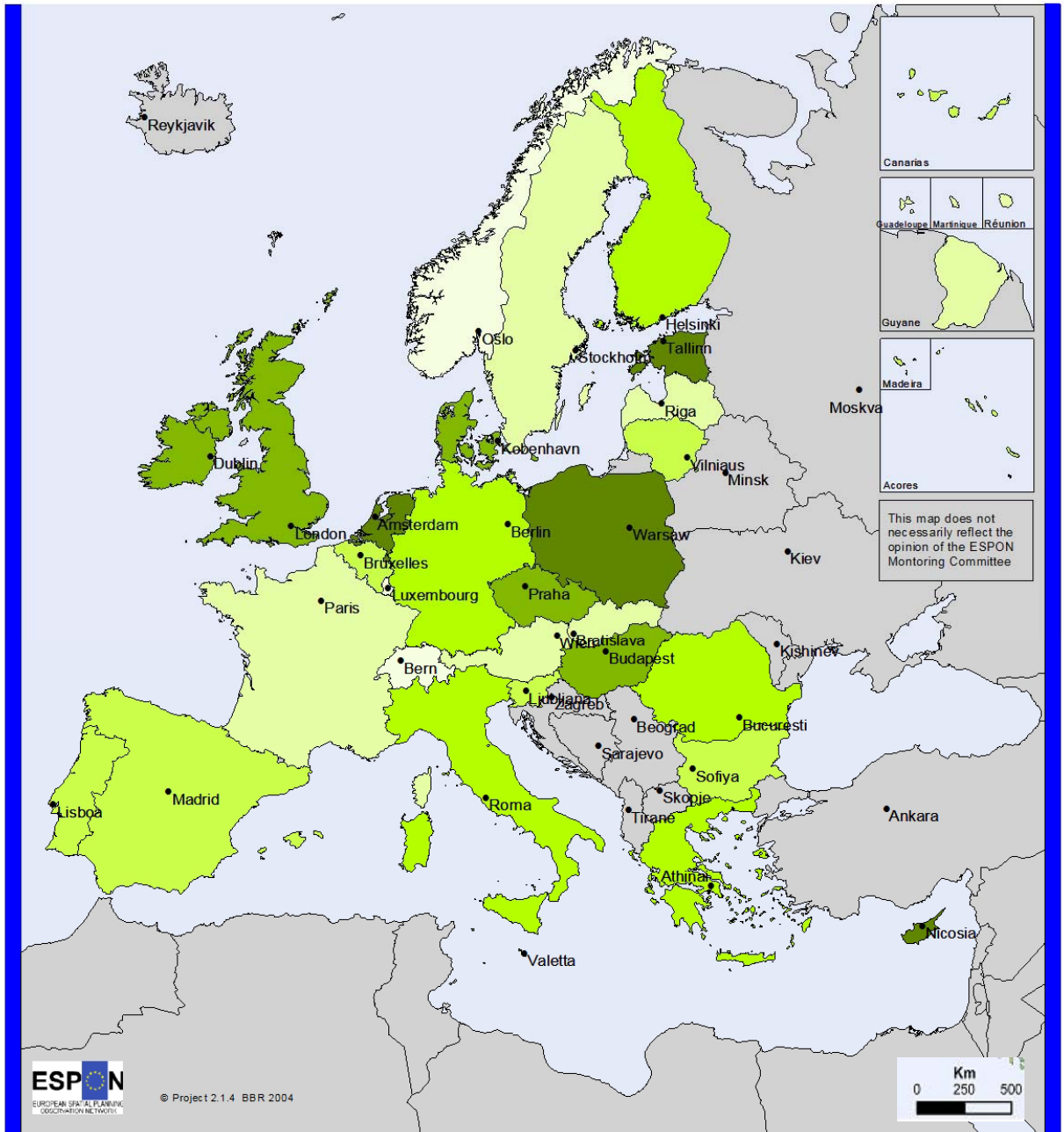
**Figure 5 (Core Indicator 1) Share of electricity production by power source at NUTS 0 in 2001 (%)**



Source: "Energy, transport and environment indicators 1991-2001" Eurostat and ECP Switzerland for CH

France, Luxembourg, Norway and Sweden are highlights for the lowest shares of thermal producing sources in total electricity production (France trading off with nuclear sources and the others with hydro). On the other hand Ireland, Netherlands, Cyprus, Estonia, Malta and Poland are highlighted for its dependency of above 80% on thermal power plants for electricity production.

**Map 2 Share of thermal source (excluding nuclear) in electricity installed capacity in 2001 (%)**



Share of thermal source (excluding nuclear) in electricity installed capacity (%) 2001

1 - 5
5 - 37
37 - 57
57 - 72
72 - 86
86 - 100

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Source: DGET, Eurostat

In the analysis at regional level, we registered difficulties in finding consistent data or data at all for the regions. We have used Eurostat Newcronos as the basic source and tried to complement the dataset with other sources. The effort was unprofitable, ending with many data gaps. A summary of data collected by NUTS 2 for this core indicator is presented in Annex 3. It must also be stressed that most part of the electric power is of a **centralized** nature, according to the power plants dimension. The sites for these power plants have been decided according to the local endowment of resources (hydro, coal) and according to the distribution of electricity demand. The establishment of a power plant in a certain region has, by itself, important economic and social impacts at local level. From the point of view of sustainable development of the regions the development of renewable energy sources for **decentralized** energy production must be encouraged.

### 1.2.3 What type of energy does Europe use?

But energy goes far beyond electricity. In fact electricity is only about 20% of the energy used in Europe.

We may look at the types of energy used in Europe splitting the Final Energy Consumption (FEC), either by the types of energy used (solid fuels, oil, natural gas, electricity, derived heat, and renewable sources) or by the sector that does that consumption (industry, transport, households and commerce & tertiary sector).

This is what is represented by the second of our core indicators:

#### **Core Indicator 2 - Final Energy Consumption by energy type and consumption sector**

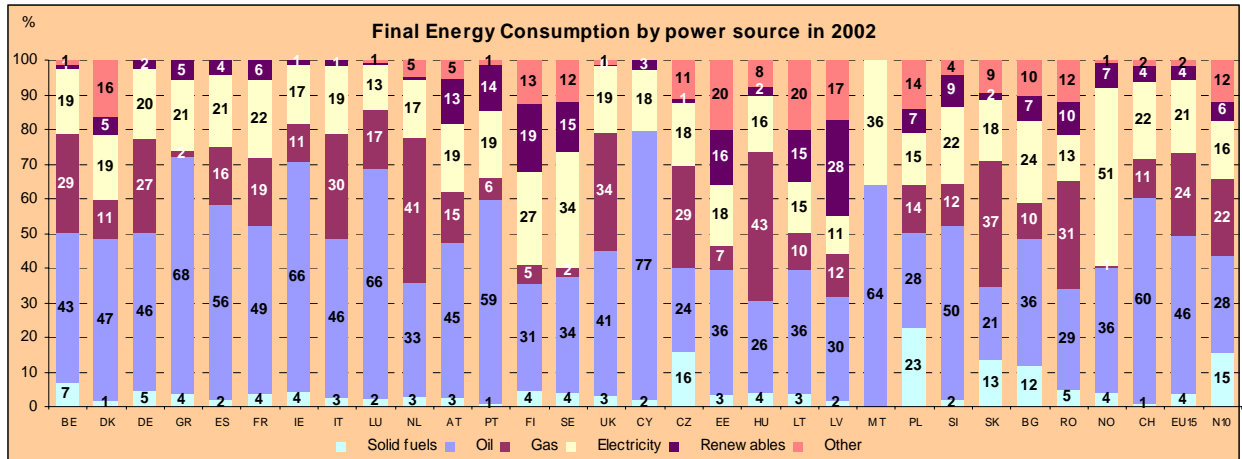
Again, diversity is the most visible trait, but the importance of oil as the most important energy source is absolutely visible.

In 2002 the most significant energy source consumed in EU15 countries was oil, representing about 46%, followed by gas with 24% and electricity with 21% of total average final consumption. In the N10 countries the final



energy consumption is more proportional among sources, although there are great disparities among countries as we can see in the figure below.

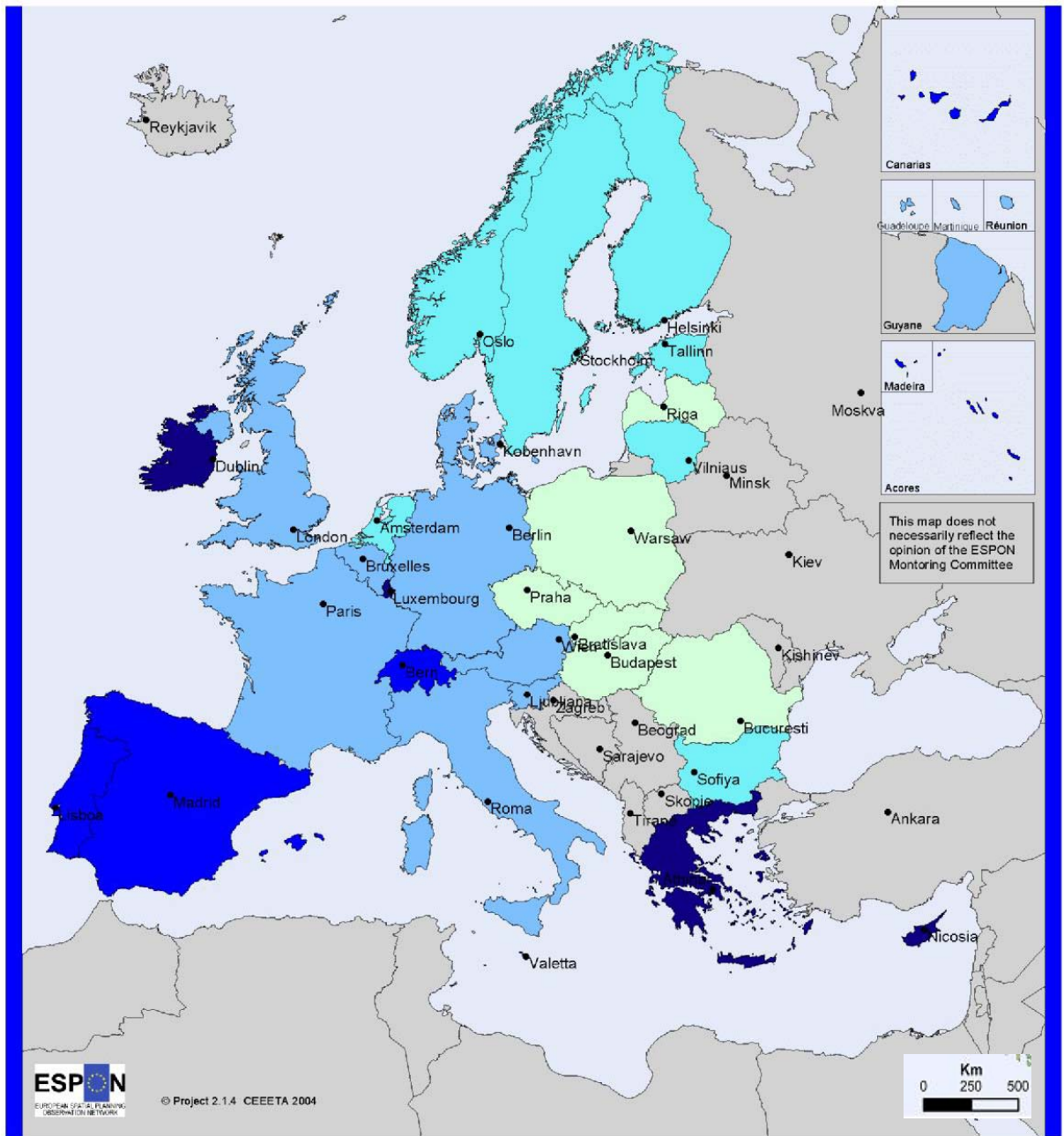
**Figure 6 Final Energy Consumption by energy type in 2002 (%)**



Source: DGET and Eurostat.

Oil represents more than 50% of the total final energy consumption in 2002 in Greece, Spain, Ireland, Luxembourg, Portugal, Cyprus, Malta, Slovenia and Switzerland. None of these nine countries produce any oil. In these countries security of supply and environment emissions from fossil fuels call for active policies to reduce this dependency.

**Map 3 Share of oil in Final Energy Consumption at NUTS 0 level in 2002 (%)**



**Share of oil in FEC (%)**

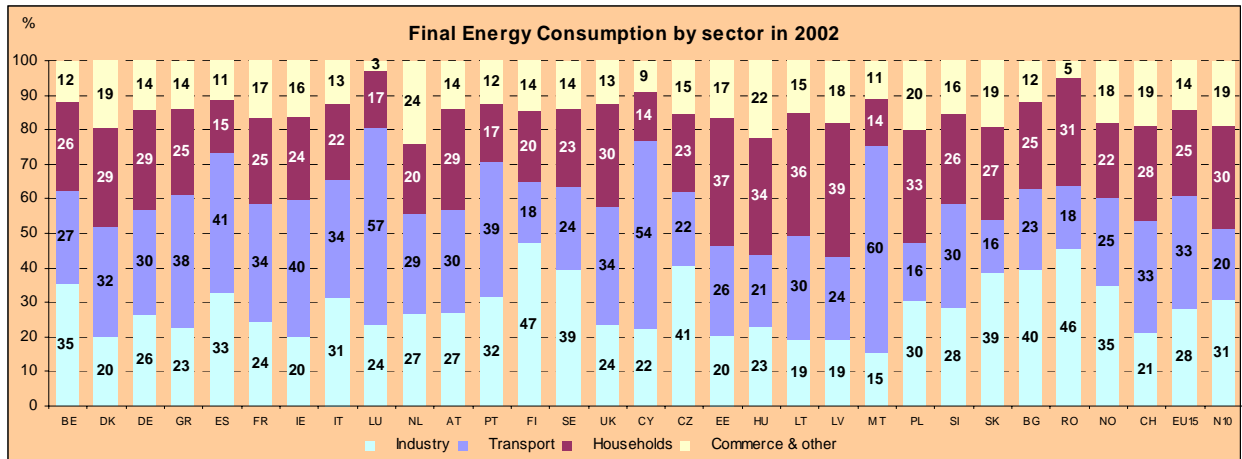
Light Green	21.13 - 29.93
Cyan	29.93 - 36.48
Blue	36.48 - 50.09
Dark Blue	50.09 - 63.96
Very Dark Blue	63.96 - 77.4

© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat

Regarding final energy consumption by sector, households and commerce & services sectors in EU15 were responsible for nearly 40% of the final energy consumption in 2002 and for 49% in N10 countries, making it the largest energy consuming sectors, ahead of the industrial sector and transport sector, in average terms.

**Figure 7 Final Energy Consumption by sector in 2002 (%)**

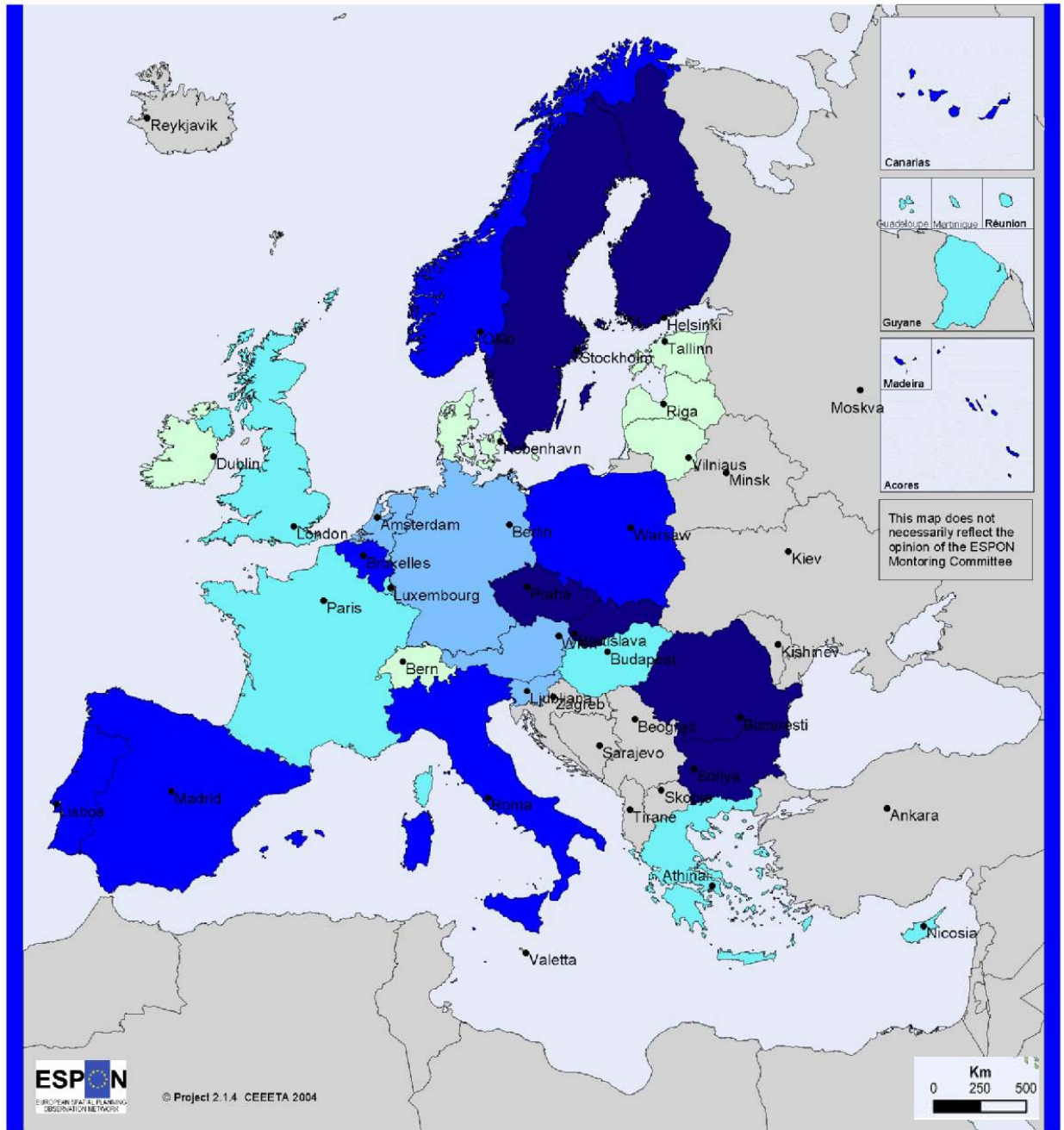


Source: DGET and Eurostat.

The share of each sector in energy consumption is a key issue for energy policy. In fact, having (in average) less than one third of the total FEC, industry has been so far the target of the emissions control because of the efficiency gains that exist in some energy intensive industries.

However transport, services and households as the most important consuming sectors deserve more attention in what energy efficiency policies are concerned. Candidate policies and measures are regulations for the buildings, more use of passenger mass transportation instead of the individual cars, more railways than road. A tax reform and a price system to take into account energy use externalities are instruments of great value to influence the citizens' way of life towards more rational use of energy.

**Map 4 Share of industrial consumption in Final Energy Consumption at NUTS 0 level in 2002 (%)**



**Share of industrial consumption in FEC (%)**

- 15 - 21
- 21 - 24
- 24 - 28
- 28 - 35
- 35 - 47

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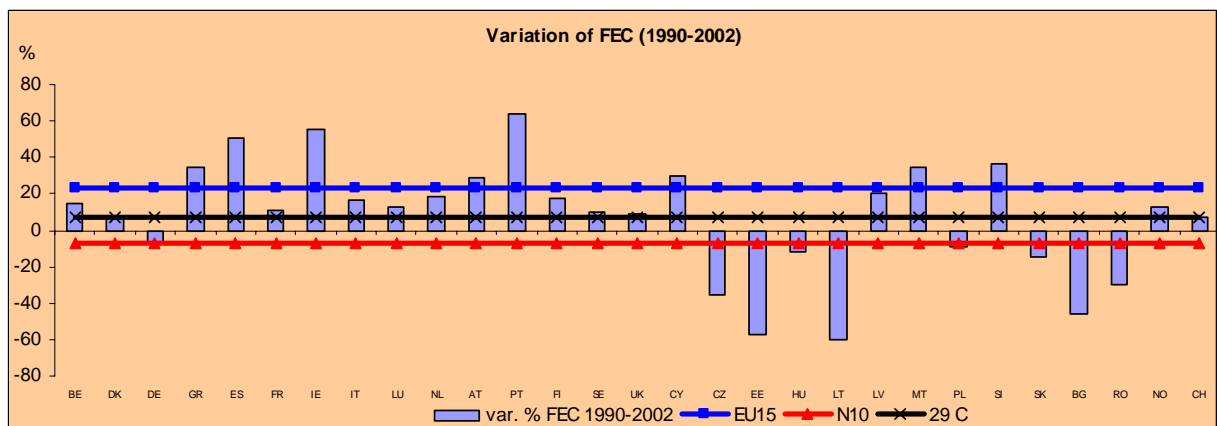
Source: DGET, Eurostat

Only in Romania, Bulgaria, Slovakia, Czech Republic, Sweden and Finland industry is responsible for more than 35% of the total final energy consumption.

If we take the evolution of Final Energy Consumption we may clearly see that commerce and services, transports and households are responsible for the growth in final energy consumption from 1990 to 2002 (plus 33%, 30% and 14% respectively), whereas industry, in average has decreased its energy consumption (less 10%).

Whilst overall FEC in our country sample has increase by 7,5%, it has increased 23% in EU 15 and decreased 7% in N10. The decrease in N10 comes from the economic crisis after the end of URSS and the COMECON, which explains also why these countries are in line with the targets of the Kyoto Protocol which have 1990 as the reference year.

**Figure 8 Final Energy Consumption variation by country (1990-2002) (%)**

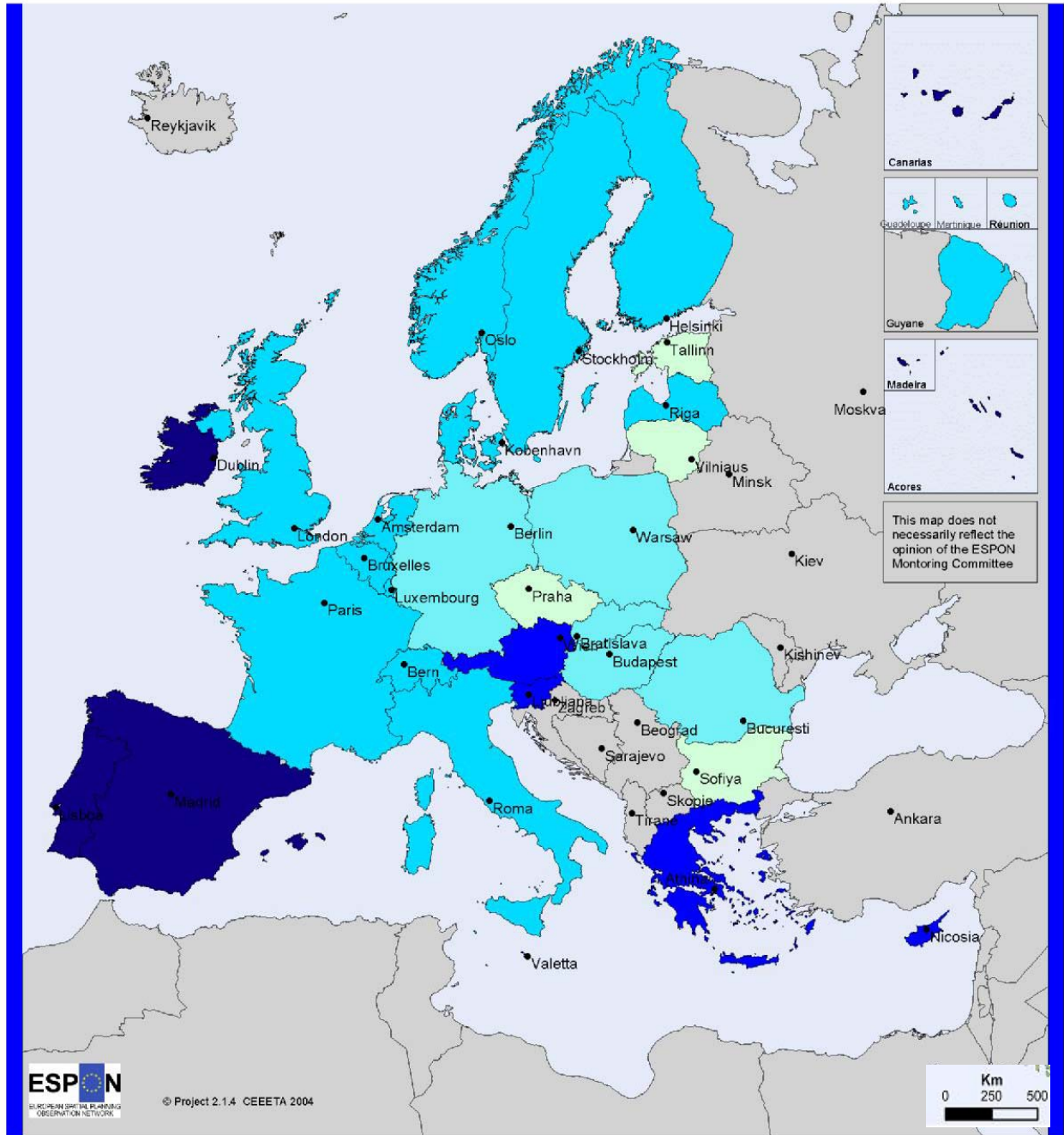


Source: DGET and Eurostat.

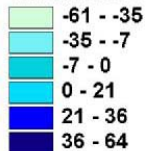
Individual countries show striking differences, with Portugal (+64%), Spain (+51%) and Ireland (+55%) registering spectacular rises in overall consumptions, and Lithuania (-61%), Estonia (-57%) and Bulgaria (-46%) having the most important reductions in FEC for the period.



**Map 5 Variation in FEC by country (1990-2002) (%)**



Variation in FEC by country (1990-2002) (%)



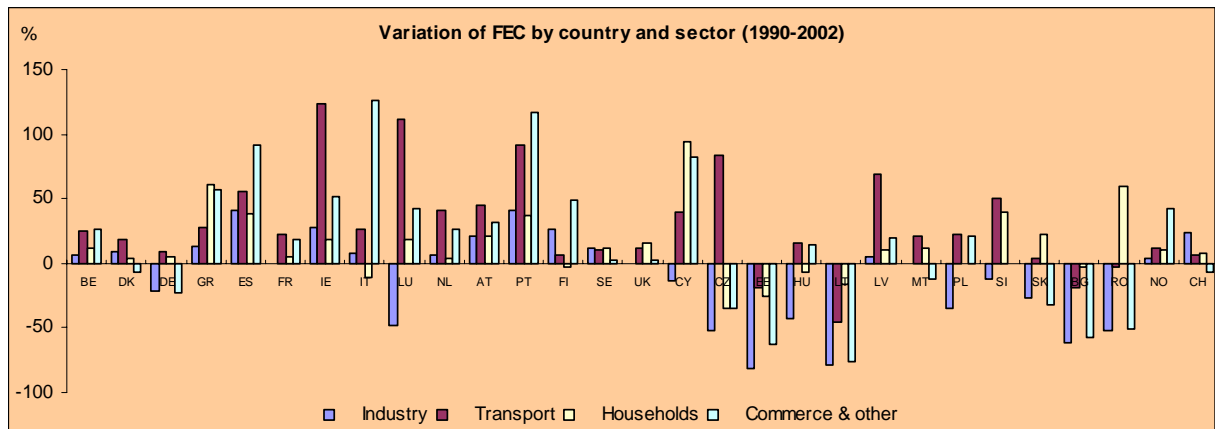
© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat

These variations are closely associated with increases in the transport, commerce and services sectors (although the fast growing countries also registered increases in industrial sectors in a lesser extent), and, for the countries with FEC decreases with reductions in industrial consumptions (although accompanied with lesser reductions in all other sectors).

As said, commerce and service sector is the fastest growing one, closely followed by transport. This is in line with what is expected along the modernization and development process: decreasing importance of agriculture and industry and increasing importance of services.

**Figure 9 Final Energy Consumption variation by country and sector (1990-2002) (%)**

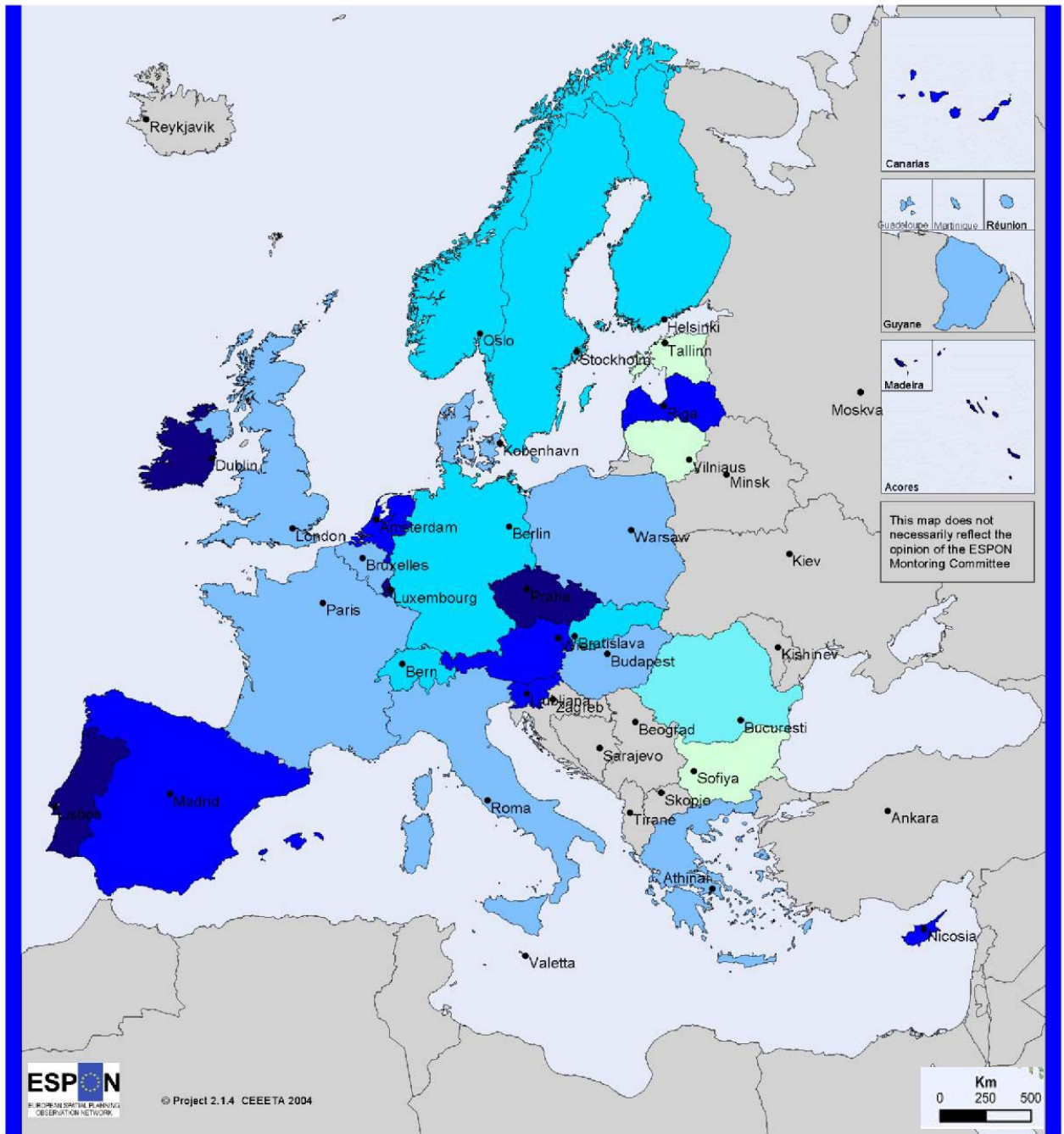


Source: DGET and Eurostat.

Note: For clarity of the figure, we have omitted a growth in Slovenia for the Commerce sector of 486%.

With the exceptions of Estonia, Lithuania, Bulgaria and Rumania, all countries in our sample have observed increases in the consumption of energy in the transport sector, as can also be seen in the following map.

**Map 6** Variation of final energy consumption in transport by country (1990-2002) (%)



Variation of final energy consumption in transport by country (1990-2002) (%)

- 46 - -18
- 18 - 0
- 0 - 12
- 12 - 28
- 28 - 69
- 69 - 123

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Source: DGET, Eurostat



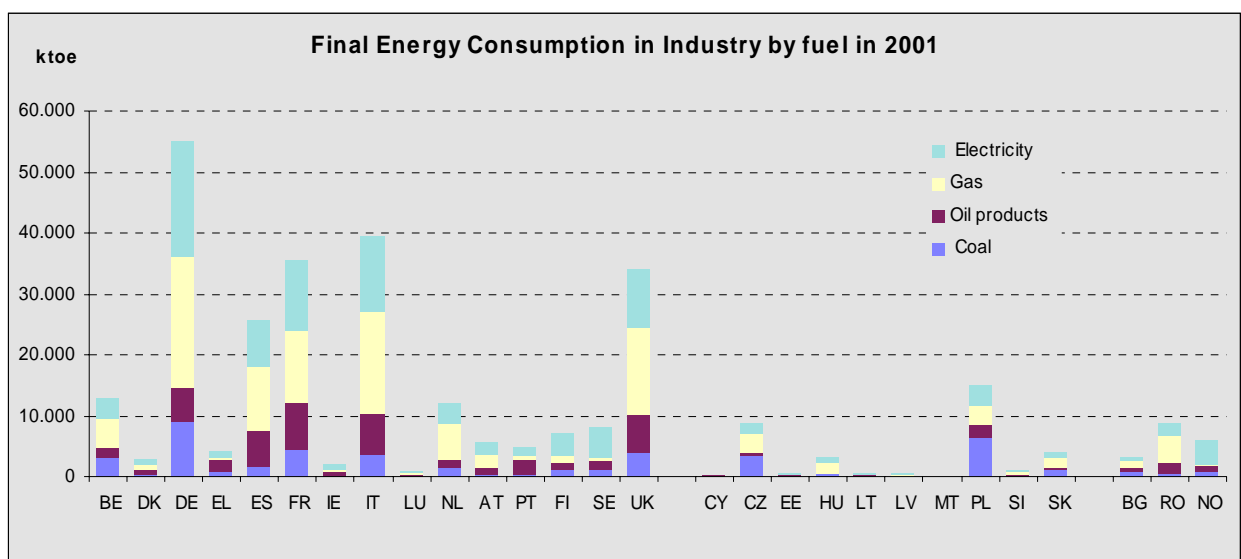
Growth in consumption in the transport sector is another key trait in energy sector in Europe.

Analysing the energy consumption of all industrial sectors by energy type in 2001, in EU15 the share of gas was 37%, followed by electricity with 33%. In the case of N10 countries the share of coal was 34% and natural gas 32%.

The figure below shows that in almost EU15 countries natural gas is the main source of energy for industrial sector, with exception of two groups of countries: Sweden, Finland and Denmark, where electricity share is larger, and Portugal, Ireland and Greece where oil represents the first source of industrial energy consumption.

In the New Member States, natural gas is the main source for industry with the exception of Poland and Czech Republic industry sectors, which consume mainly coal.

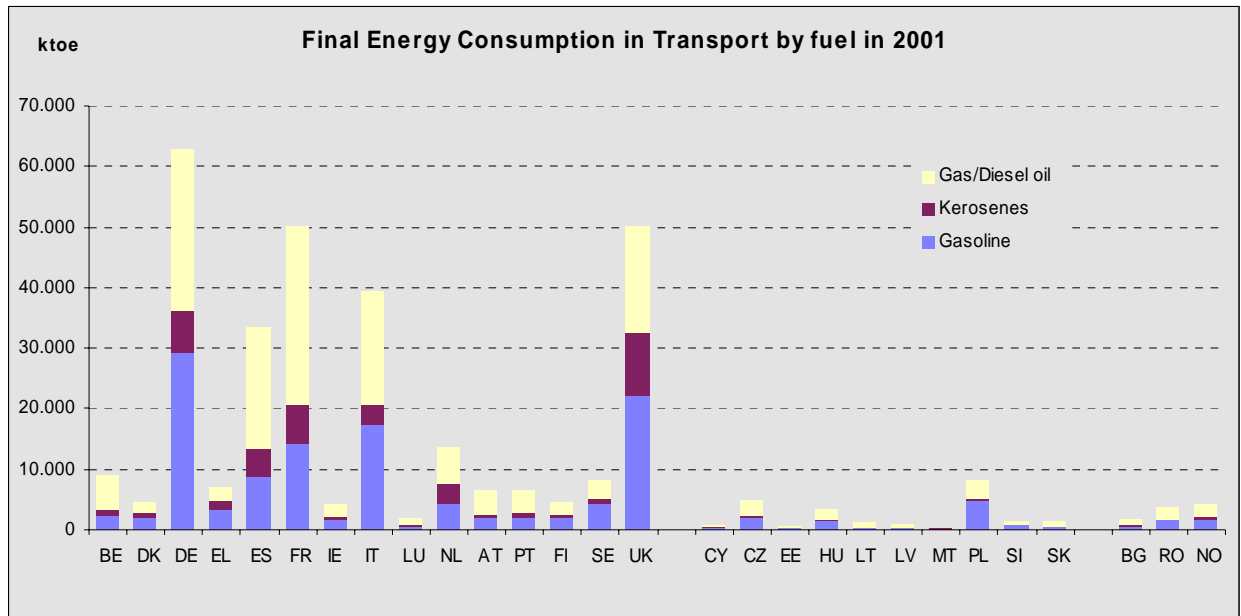
**Figure 10 Final Energy Consumption in Industry by fuel in 2001 (ktoe)**



Source: "Energy, transport and environment indicators 1991-2001", Eurostat. No available data for Switzerland.

In the case of the transport sector, the share of gas/diesel oil consumed in almost all the countries is significant, with few exceptions.

**Figure 11 Final Energy Consumption in Transport by fuel in 2001 (ktoe)**



Source: “Energy, transport and environment indicators 1991-2001”, Eurostat No available data for Switzerland.

At regional level, data collection for final energy consumption was not possible for each type of energy. Data is available only for electricity by sector between 1990 and 2000, using Eurostat Newcronos source, although with several data gaps among regions and years. Once again, like in the case of core indicator 1, the problem of data availability is very significant, compromising any comparative analysis. A summary of data collected by NUTS 2 for this core indicator is presented in Annex 3.

### 1.2.4 How much do we pay for the energy?

The third issue we have highlighted as core indicator is the price of energy. Energy price is a carrier through which incentives and disincentives for consumption are spread.

Prices can be an incentive for rational use of energy (in all sectors) but is an important link between the energy sector and economic activity, since every economic activity uses (in larger or lesser extent) energy.

#### 1.2.4.1 Industry sector

Since regional development is linked with economic activity we have chosen the final price of energy for industry as the more relevant indicator for pricing, as a fundamental trait of energy sector.

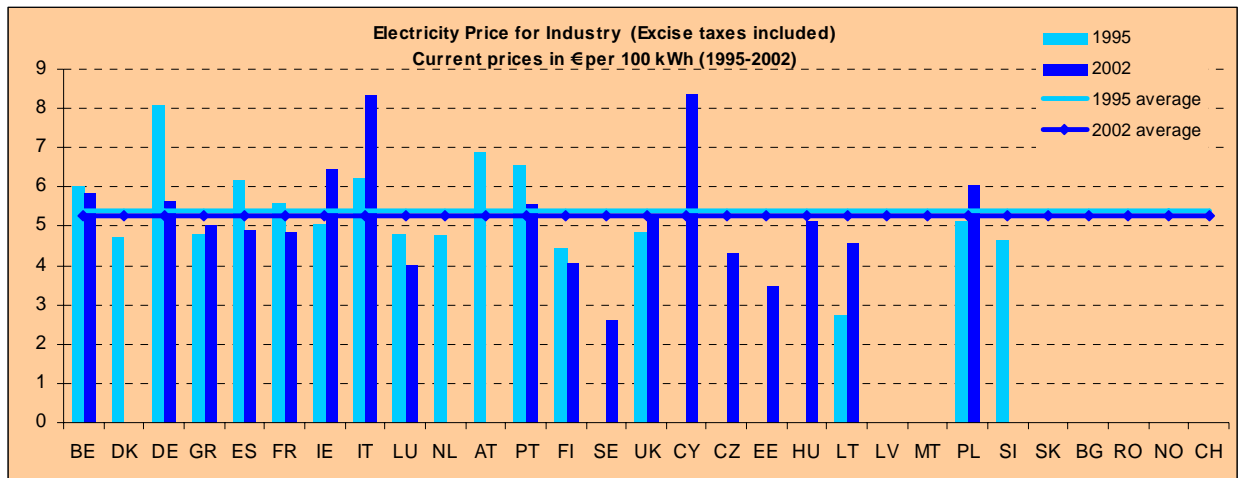
#### **Core Indicator 3 - Energy prices for industry (tax included)**

This core indicator has little sense at regional level because price level and composition depend mainly on national policies, resources location and technologies. We have pictured the prices of electricity and natural gas for industry as the relevant indicators.

Among the countries under review, the prices in 2002 for industrial electricity consumption (excise taxes included) are higher than the average in Belgium, Germany, Ireland, Italy, Portugal, Cyprus and Poland. The industrial electricity prices have declined in average by 3% between 1995 and 2002 in the countries for which we have data. We must stress also that energy prices are closely linked to the crude oil price and that the percentage of taxes in the consumer price of oil products (petrol and diesel) is in general very high, exceeding 50% or even more of the ex-refinery price.

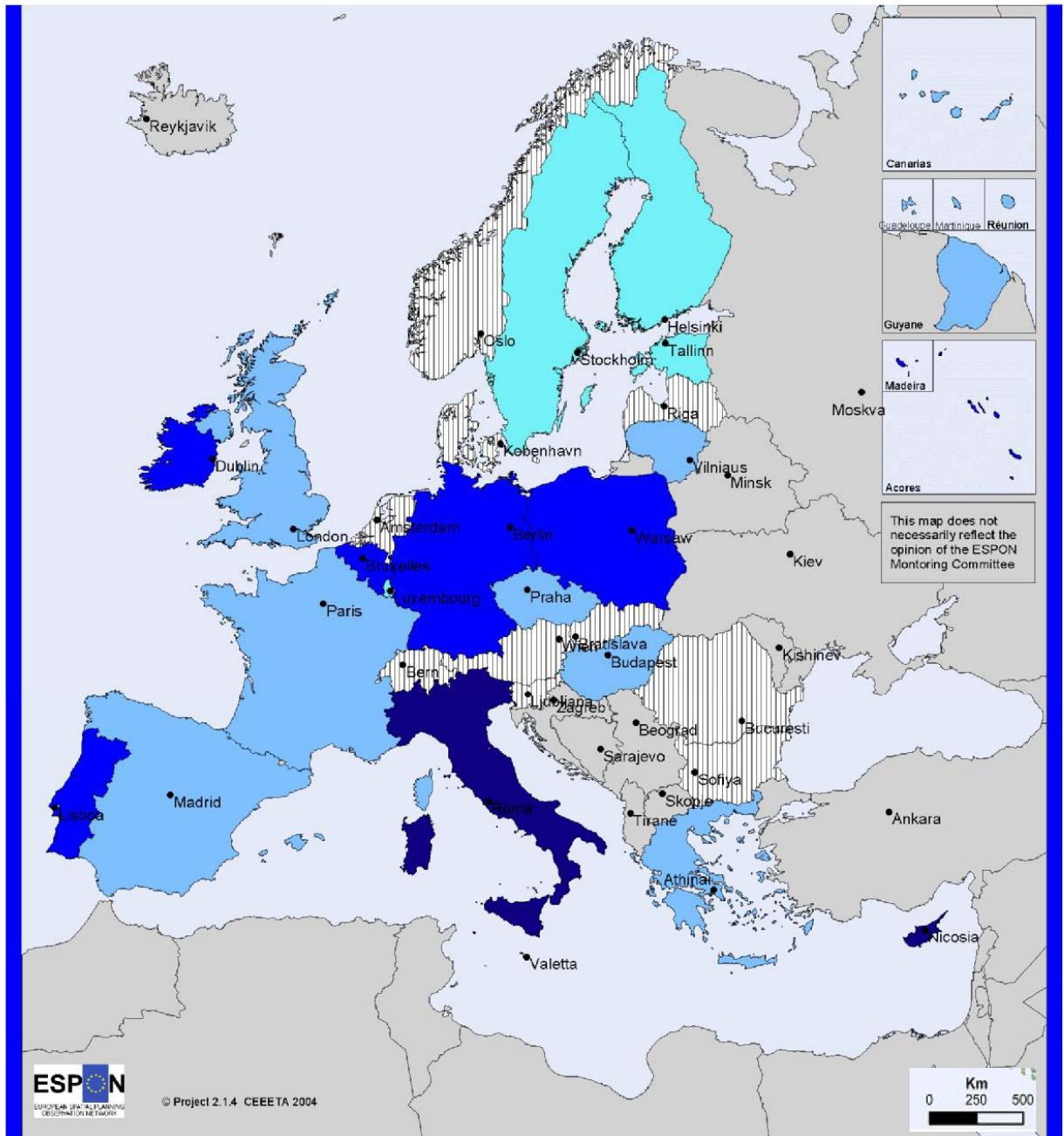
The greatest decrease in electricity price for industry was in Germany, the largest consumer country, and for that reason it was chosen as reference in the price indices (see the analysis of competitive energy markets - indicators C in section *Energy in Europe: themes and issues*).

**Figure 12 Electricity Prices for Industry (excise taxes included) between 1995 and 2002**








Source: DGET and Eurostat.

**Map 7 Electricity prices for industry (Excise taxes included) at NUTS 0 in 2002  
 (Current prices in € per 100 kWh)**



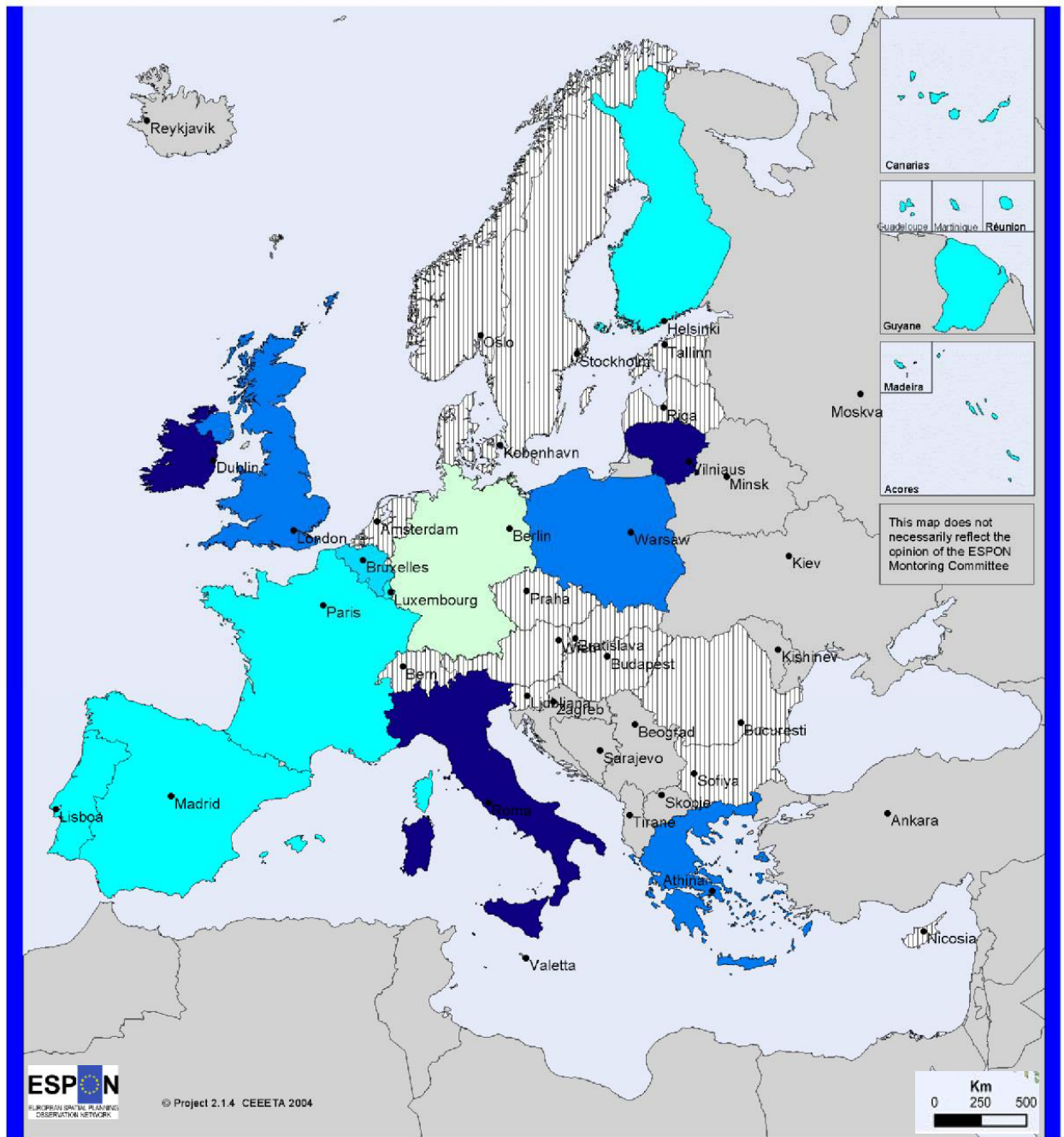
**Electricity Prices for Industry in 2002**

-  No Data
-  0 - 4.08
-  4.08 - 5.24
-  5.24 - 6.48
-  6.48 - 8.37







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Source: DGET, Eurostat

**Map 8 Growth rate of electricity prices for industry at NUTS 0 level between 1995 and 2002 (%)**



**Growth rate of electricity prices for industry 1995-2002 (%)**

-  No Data
-  -30
-  -30 - -8
-  -7.9 - 0
-  0 - 18
-  18 - 68

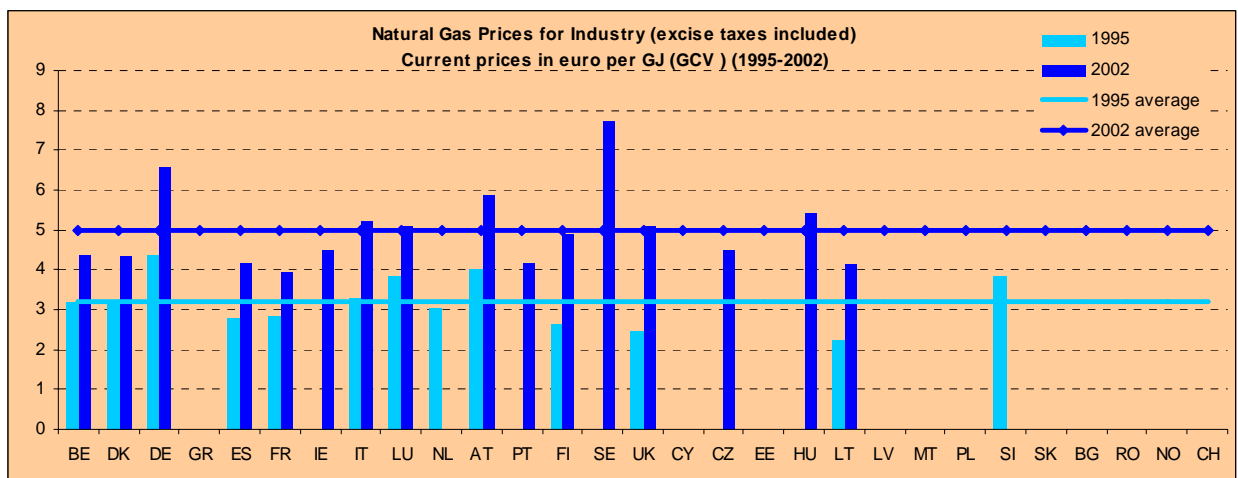
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Source: DGET, Eurostat

As it can be seen, price evolution varies significantly among European countries.

In the same period the natural gas prices for industry rose by 56% for the countries for which data is available. It is important to note that natural gas prices are directly influenced by the international oil prices. Some countries may benefit from the strategic location in the middle of a natural gas transport network.

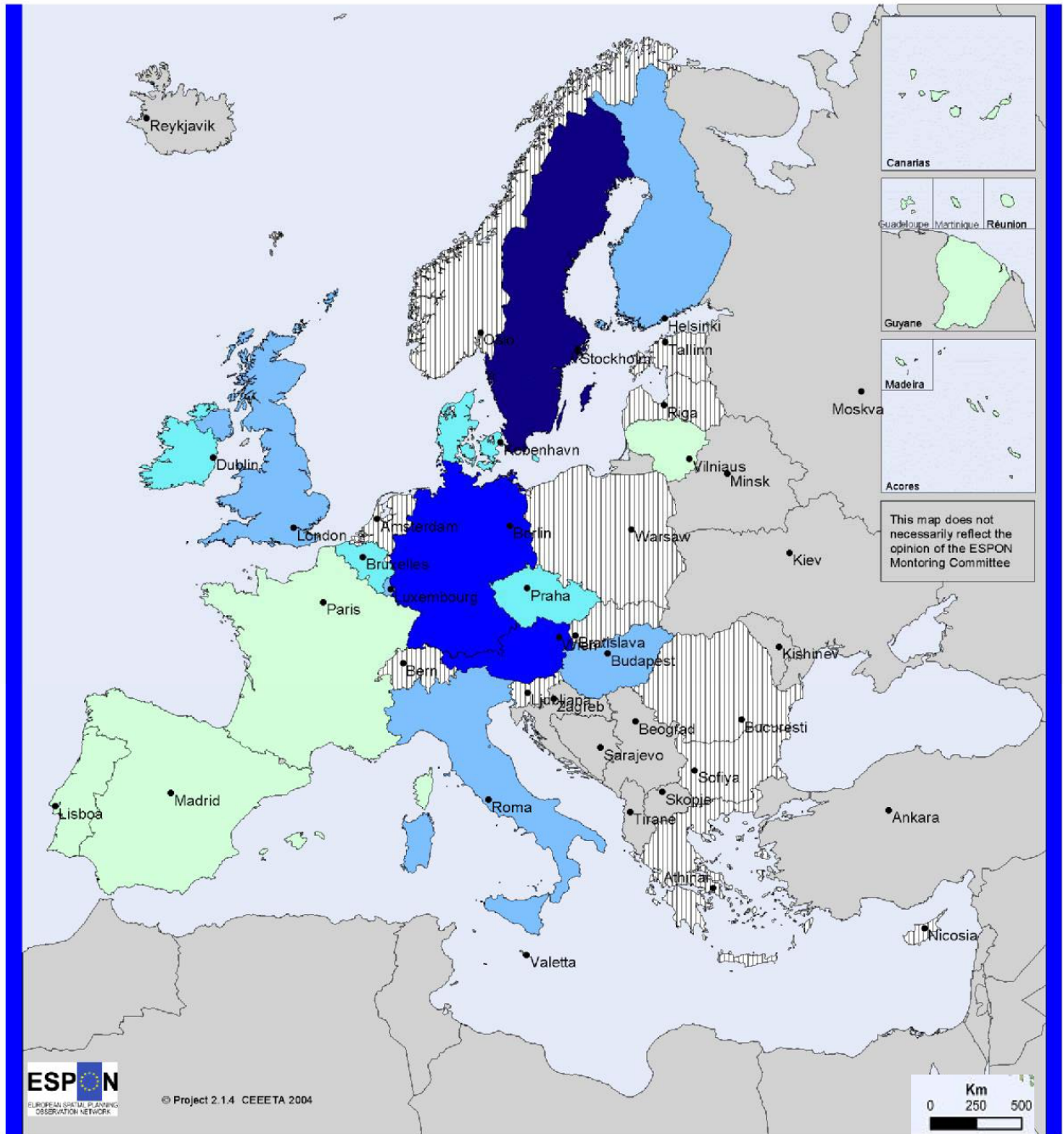
**Figure 13 Natural Gas Prices for Industry (excise taxes included) between 1995 and 2002**



Source: DGET and Eurostat.



**Map 9 Natural gas prices for industry at NUTS 0 level in 2002 (excise taxes included) Current prices in euro per GJ (GCV)**



**Natural Gas prices for industry in 2002**

- 3.9 - 4.2
- 4.2 - 4.5
- 4.5 - 5.4
- 5.4 - 6.6
- 6.6 - 7.7
- No Data

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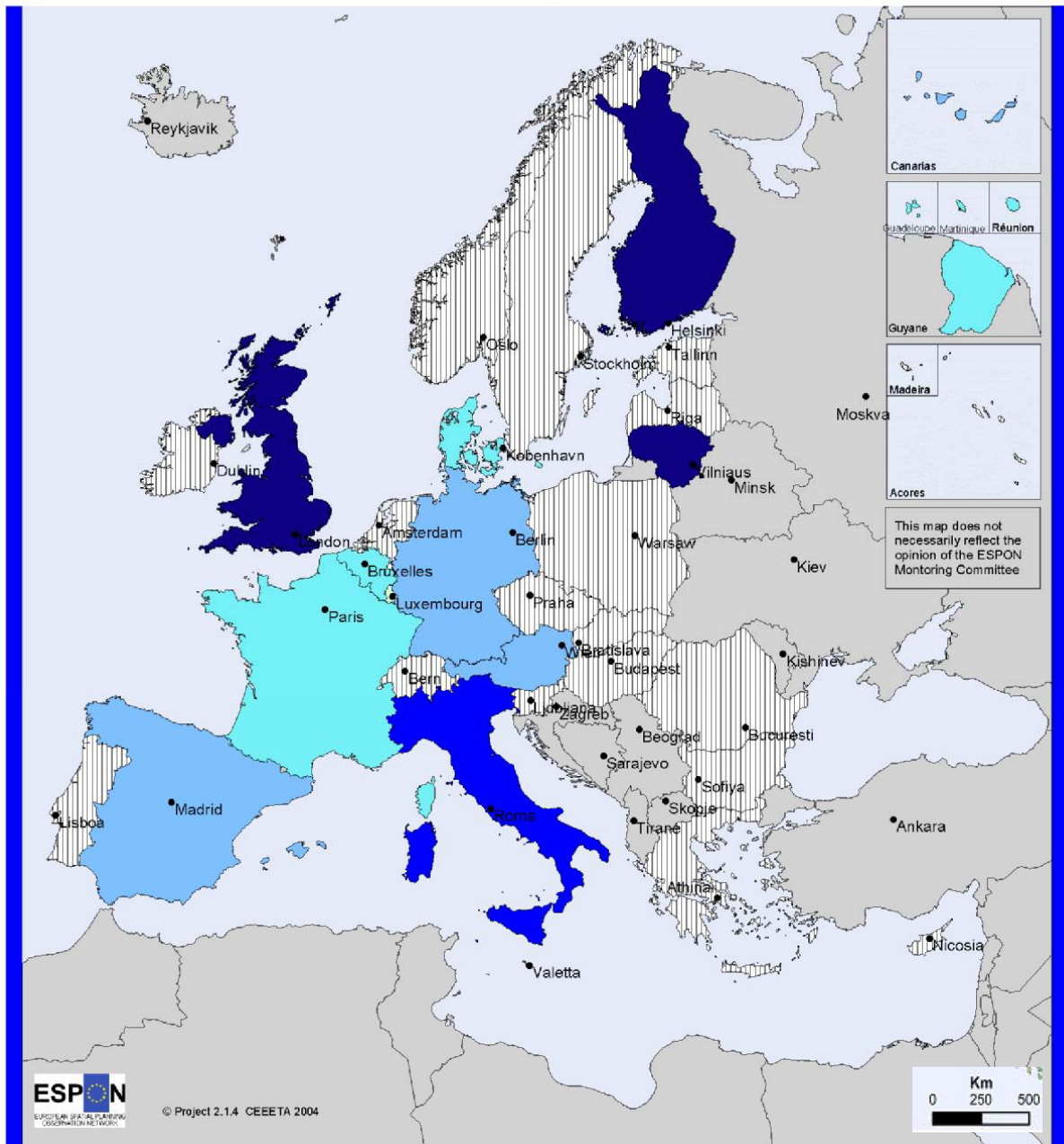
Source: DGET, Eurostat



Whilst for electricity we have seen that prices diverge (some growing, some being reduced), in the case of natural gas, the prices have been raised in all the countries, although at different rates.

The divergent pattern of behaviour of electricity and natural gas prices is important to retain, since this may be a paradox in a framework where less pollutant forms of energy use are at stake for industries in Europe.

**Map 10 Growth rate of natural gas prices for industry at NUTS 0 level between 1995 and 2002 (%)**



Growth rate of natural gas prices for industry

- 33
- 33 - 38
- 38 - 50
- 50 - 59
- 59 - 106
- No Data

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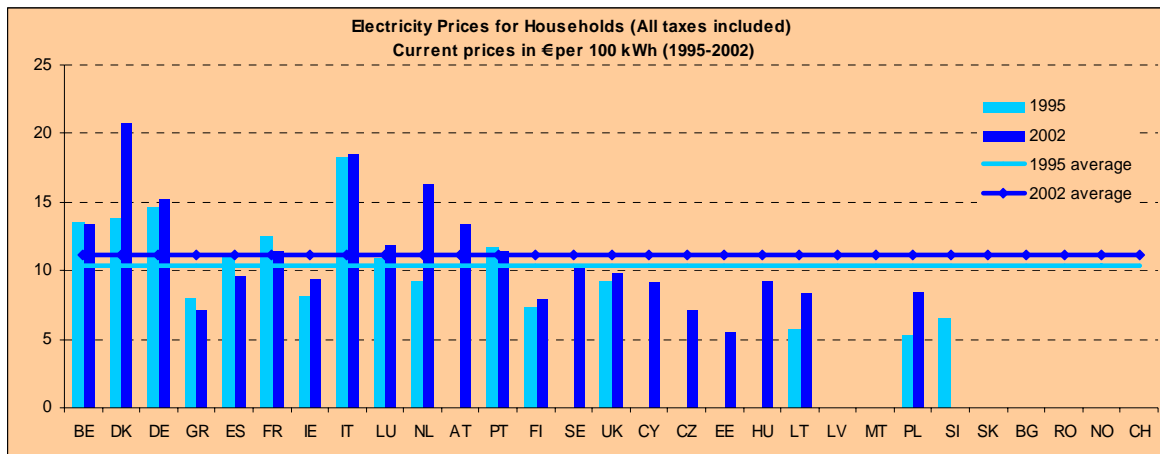
Source: DGET, Eurostat

### 1.2.4.2 Households and services sectors

Unlike industrial electricity prices, household electricity prices are affected by weather conditions with extreme temperatures pushing up or down demand and prices.

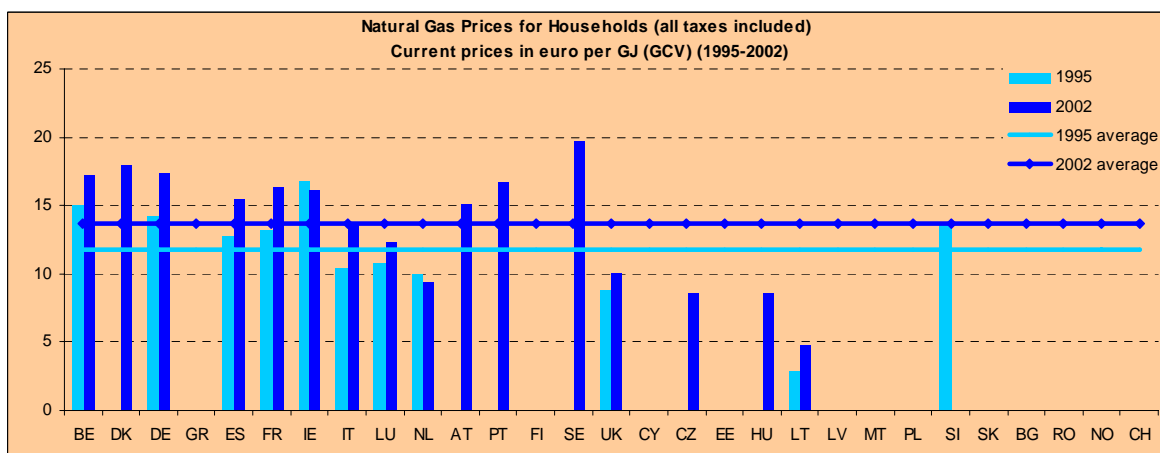
Over the observation period (1995-2002), domestic electricity price increased 7% for the countries with data available. On the other hand, natural gas experienced 17% increase in the same period.

**Figure 14 Electricity Prices for households (all taxes included) between 1995 and 2002**



Source: DGET and Eurostat

**Figure 15 Natural Gas Prices for households (all taxes included) between 1995 and 2002**



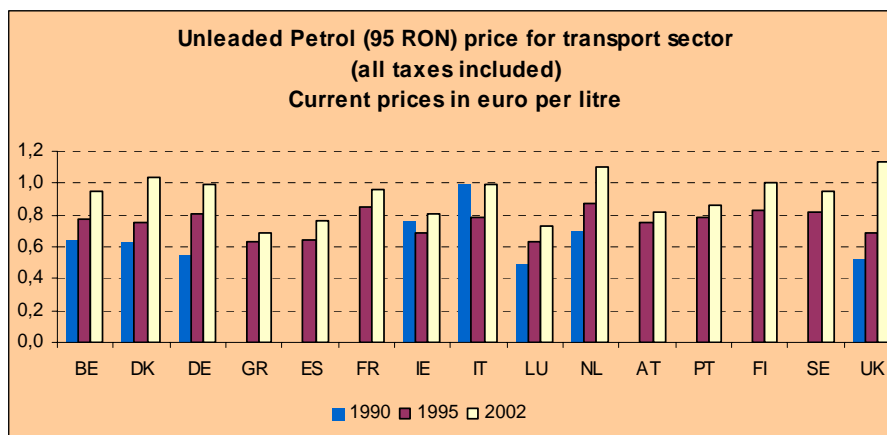
Source: DGET and Eurostat

So, if electricity for industry has suffered a mild reduction, for the households the prices have been pushed up in almost every country for which we have available information.

### 1.2.4.3 Transport sector

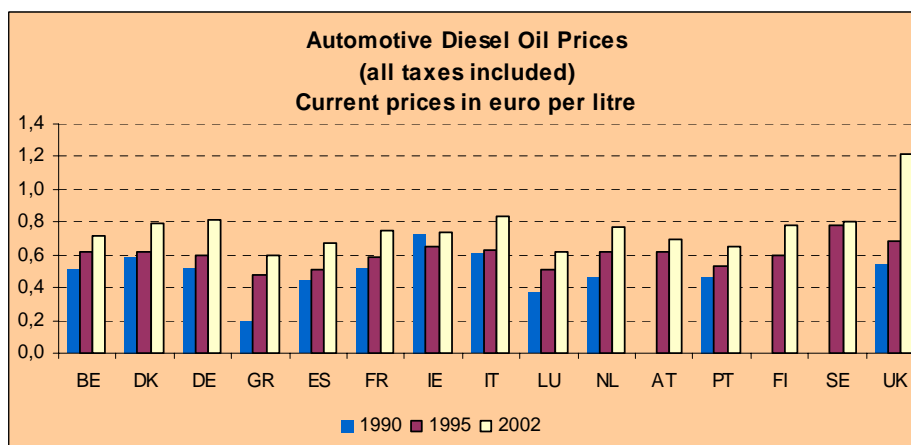
At current prices, during the period 1995-2002 unleaded petrol price for transport sector (tax inclusive) rose by 22% while automotive diesel oil prices increased by 27%. Both types of fuel exhibited related trends with similar volatility reflecting global oil market price developments. However on average diesel oil remained cheaper than unleaded petrol.

**Figure 16 Unleaded Petrol Price for Transport Sector between 1990 and 2002**



Source: DGET and Eurostat

**Figure 17 Automotive Diesel Retail Prices (tax-Inclusive) for Transport Sector (1995-2002)**



Source: DGET and Eurostat

Being responsible for a growing part of the European energy consumption, it seems evident that an upward trend in prices of transport fuels is a trait of Europe energy sector. The impact of the tax policy is considerable, as already mentioned.

### 1.3 Energy in Europe: themes and issues

The indicators used in our research have been grouped into 4 domains covering different aspects of the energy sector and were calculated when possible for the 29 countries of the study.

- ❖ Economy, society and energy (*indicators A*)
- ❖ Reliable supplies of energy (*indicators B*)
- ❖ Competitive energy markets (*indicators C*)
- ❖ Environmental objectives (*indicators D*)

#### 1.3.1 Economy, society and energy (*indicators A*)

Total energy supply is the first measure we must take in order to characterize the energy sector. In fact this indicator displays the total amount of energy made available to the economy and the society for its different uses. As a whole, it reflects the size of the economy, but it also reflects the efficiency in the transformation and in the transport (thus the quality of the grids and networks).

In a second moment we will look at the Final Energy Consumption, representing the demand that is met by the supply above mentioned.

The shape and characteristics of the Energy sector are dependent on the supply determinants (natural energy resources endowments of each country and energy policy determining what path has been followed in the past in terms of energy sources), the demand determinants (well being of the

population and industrial fabric) and the distribution grid and networks available (either in quantity and coverage and in terms of quality of those).

Thus four main types of comparison indicators can be obtained: sources of energy, nature of consuming sectors, uses per inhabitant and uses per unit of the GNP.

There is not a single way of looking for this. We should take into account the energy production (how much energy potential is produced) but also how much of this is actually consumed (Final Energy Consumption) since not all of the energy produced is consumed.

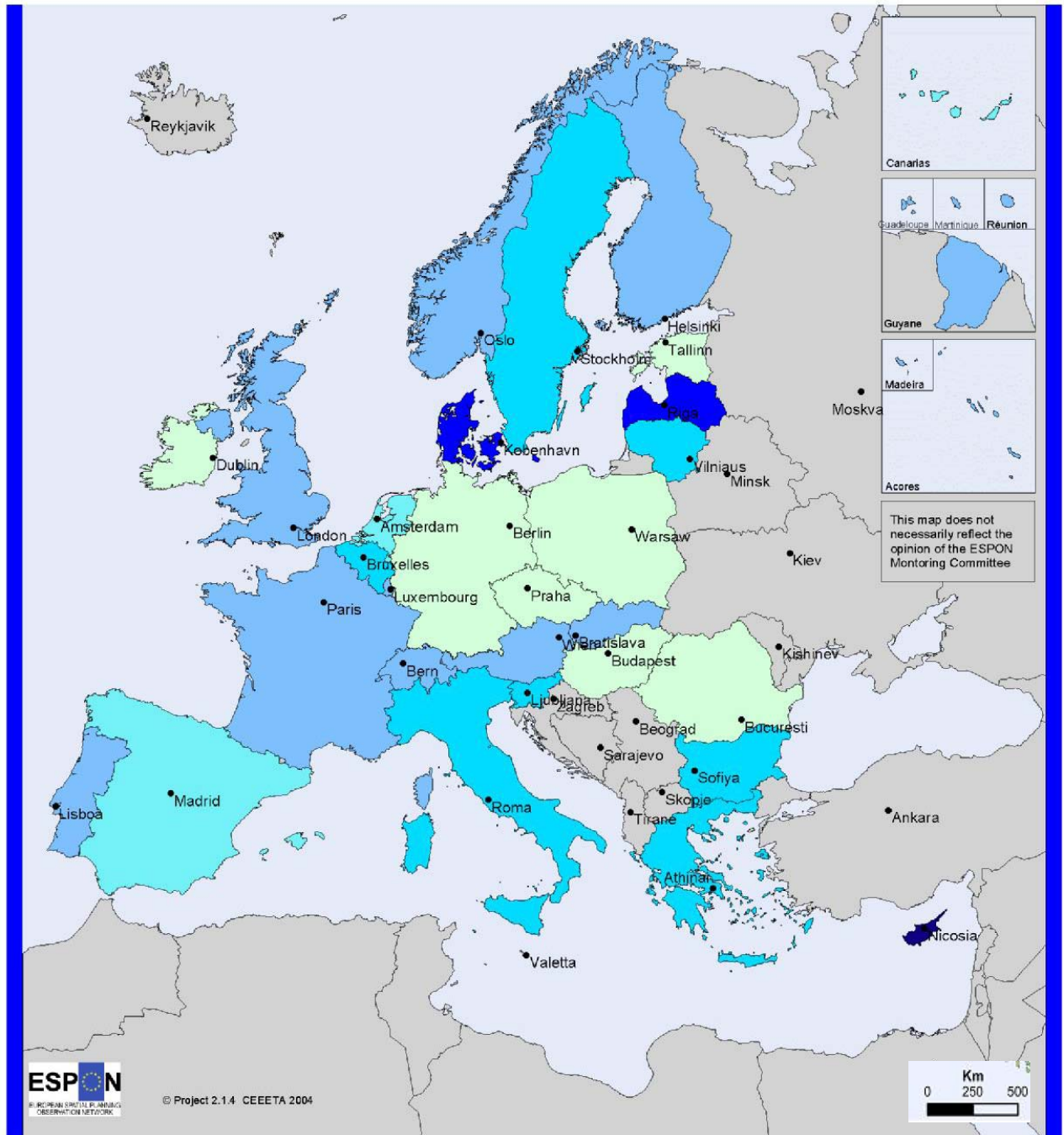
Energy production and consumption reflects the size and the characteristics of the economy and the society: level of well being and industrial activities present, but also how efficient the use of energy is.

#### 1.3.1.1 Primary energy production

Primary energy products are forms of energy obtained directly from nature, including non-renewable fuels such as coal, natural gas and crude oil, and renewable fuels such as wood, hydro-electricity and solar energy. In Europe there are few countries self sufficient in primary energy production and most countries are highly dependent on fossil fuels, especially imported oil.

In 2002, United Kingdom was the most important producer of primary energy in our country sample, followed by Norway. In average primary energy production in EU15 increased 7% between 1990 and 2002, and decreased 17% in N10.

**Map 11 Variation of Primary Energy Production at NUTS 0 level in 1990 and 2002 (%)**



Primary energy production in (1990-2002) (%)

Light Green	-57 - -19
Light Blue	-19 - 0
Medium Blue	0 - 17
Dark Blue	17 - 94
Very Dark Blue	94 - 328
Dark Purple	328 - 697
White with border	No Data

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Source: DGET, Eurostat

Looking at the evolution of Primary energy production in Europe, very different situations can be observed in the countries subject to this analysis.

In fact whilst some countries experienced remarkable growth in their production capacity with domestic resources some others show large diminution on their use of natural endogenous resources to produce energy.

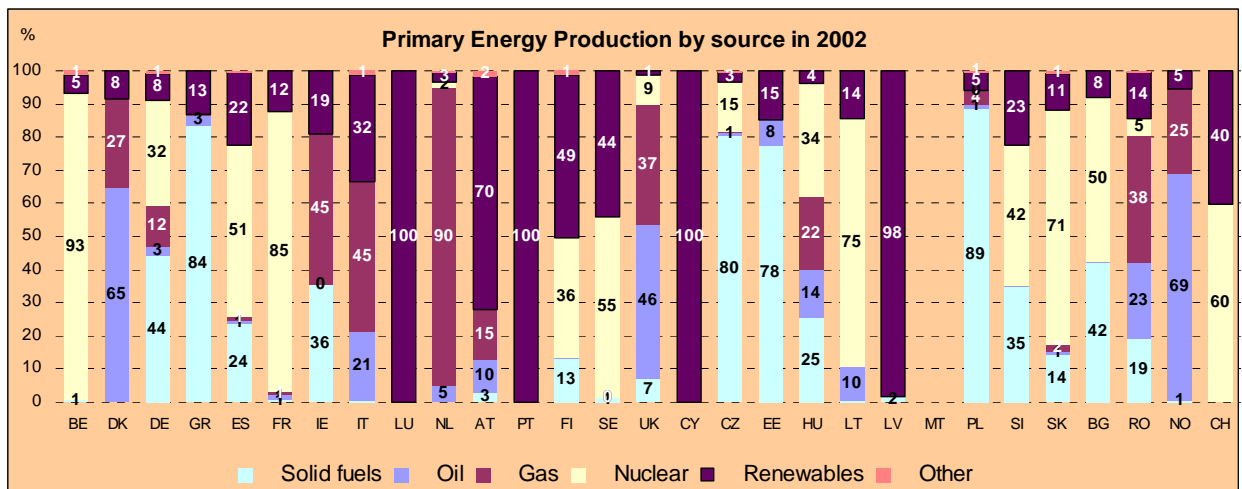
The reasons for that are very different in most countries, but most striking cases are marginal changes in small productions. Replacement of coal and development of renewables are responsible for most of the changes. A note must be left for France that has enlarged its nuclear production.

Primary energy production depends on the natural resources available in a country, which means great disparities between our country sample. But energy supply also considers the energy produced from imported sources.

For example, in 2002 the proportion of nuclear energy on primary energy production is dominating in Belgium, France and in Lithuania, with 93%, 85% and 75% respectively. In the Netherlands the production of natural gas is very important (90% of the primary energy production). The proportion of hydro energy is rather low in the countries referred. Although the hydropower energy potential is highly exploited for example in Belgium, it remains negligible due to the topography.

In general, European energy production is based on gas and petroleum deposits in the North Sea, which belong to the UK and Netherlands, while German potential is based on coal deposits and France on its nuclear production.

**Figure 18 Primary Energy Production by source in 2002**

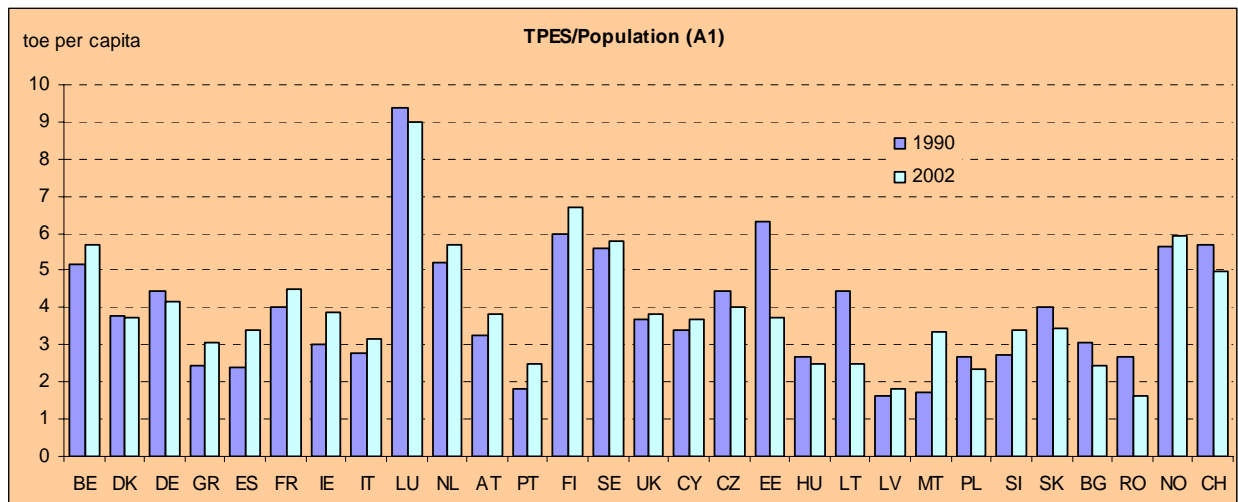


Source: DGET and Eurostat



The indicator *Total primary energy supply per capita (A1)* can translate differences in welfare of population, but also is very dependent in climate conditions and industrial structures.

**Figure 19 (A1) Total Primary Energy Supply<sup>2</sup> per capita in 1990 and 2002**



Source: DGET and Eurostat

In 2002 the EU15 average energy supply per inhabitant was 4.59 toe. Countries such as Luxembourg, Netherlands, Finland, Sweden and Belgium are way above that average, due mainly to their small population (especially Luxembourg) and their harsh climatic conditions. Countries like Spain, Greece, Portugal and Italy have a level of consumption that is relatively lower than the average, which is directly determined by the more favourable climate conditions, which significantly reduce the amount of energy consumed.

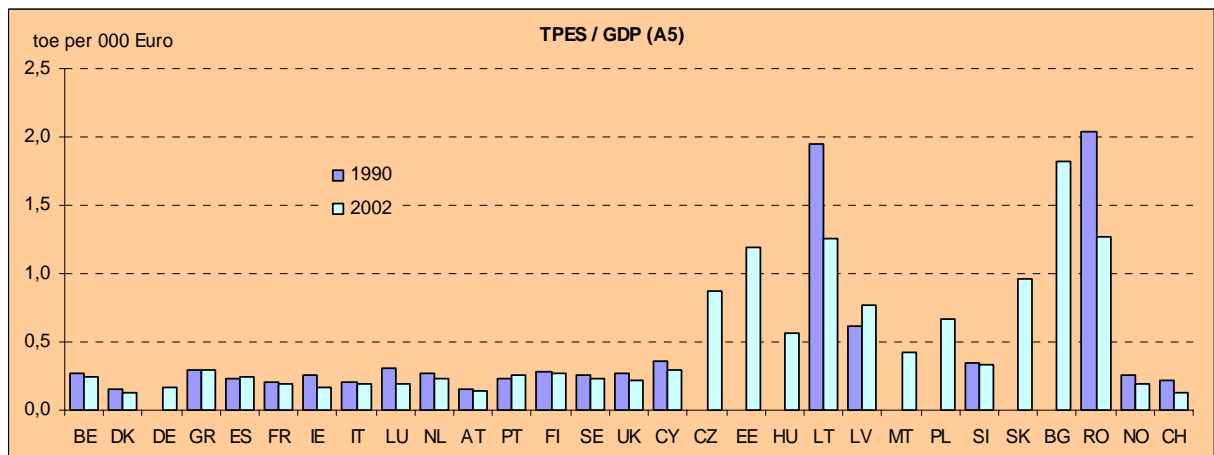
Analysing the evolution of this indicator over 1990 to 2002, it is important to refer that total primary energy supply per capita increased by 1.17% in N10 and 13,6% in EU15. In our sample this indicator decreased in that period in twelve countries (Denmark, Germany, Luxembourg, Czech Republic, Estonia, Hungary, Latvia, Poland, Bulgaria, Romania and Switzerland).

<sup>2</sup> Total Primary Energy Supply (TPES) is the energy content of different energy sources as they are offered by nature before they are transformed for use. TPES is made up of domestic production plus imports and minus exports, international marine bunkers, and stock changes.

The ratio TPES/GDP, *Total primary energy supply per thousand Euro of GDP (A5)* gives an idea of the energy intensity. Figure below shows considerable differences where most of N10 countries have a higher level in comparison to EU15.

In average this ratio has been reduced by 11% in EU15 and 8% in N10 in the period 1990-2002 (exceptions are Spain, Greece, Portugal and Latvia).

**Figure 20 (A5) Total primary energy supply per thousand Euro of GDP in 1990 and 2002**



Source: DGET and Eurostat

What lies behind the data is a very different efficiency in the use of energy as a production factor and a consumable product.

**Whereas in average each citizen of the UE15 uses 50% more energy than an N10 citizen, it requires about 30% of the energy in EU15 to produce an Euro of GDP than in N10 (weighted averages).**

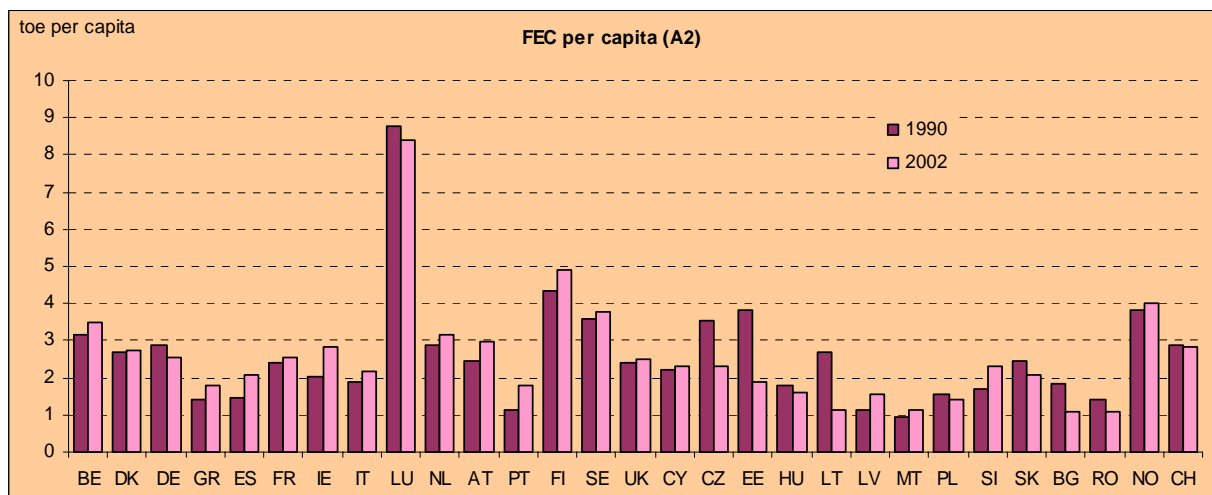
Given that countries exhibit a range of climate, industrial structures, geographical features and economic development, changes in the aggregate energy intensity ratio are an inadequate basis for measuring and comparing energy efficiency among countries. Using only the ratio of energy use to GDP as an energy performance indicator for cross-country comparison would be misleading. However, aggregate energy intensity can be broken down to identify the factors which have contributed to the net aggregate effect. These factors may be due to the level of economic activity (the production effect); the sectoral composition of the economy (the structural effect); and energy intensities of activity within the various energy-using sectors (the real intensity effect).

### 1.3.1.2 Final energy consumption

Considering that *Final energy consumption per capita (A2)* reflects the structure of the economy and the energetic efficiency of the industrial equipment and buildings, in 2002 the Scandinavian countries, as well as Luxembourg, had the highest per capita energy consumptions on our country sample, as can be seen in the figure below.

Total final energy consumption per capita in the more developed countries is about twice as high as in the New Member States, which is mainly due to higher consumption in the industry and transport sectors. It is important to note that between 1990 and 2002, Portugal, Spain, Ireland and Cyprus were the countries with more significant growth in this indicator.

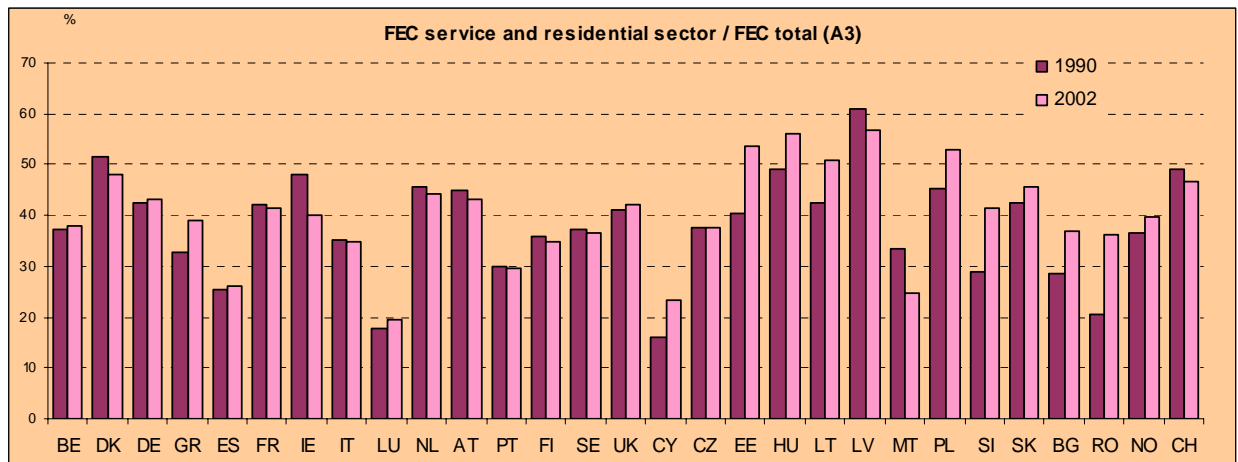
**Figure 21 (A2) Final Energy Consumption per capita in 1990 and 2002**



Source: DGET and Eurostat.

Observing the importance of *final energy consumption in service and residential sector (A3)* in total energy consumption, we see a more significant weight in N10 countries (see analysis of core indicator 2).

**Figure 22 (A3) Final energy consumption of service and residential sectors in final energy consumption in 1990 and 2002**



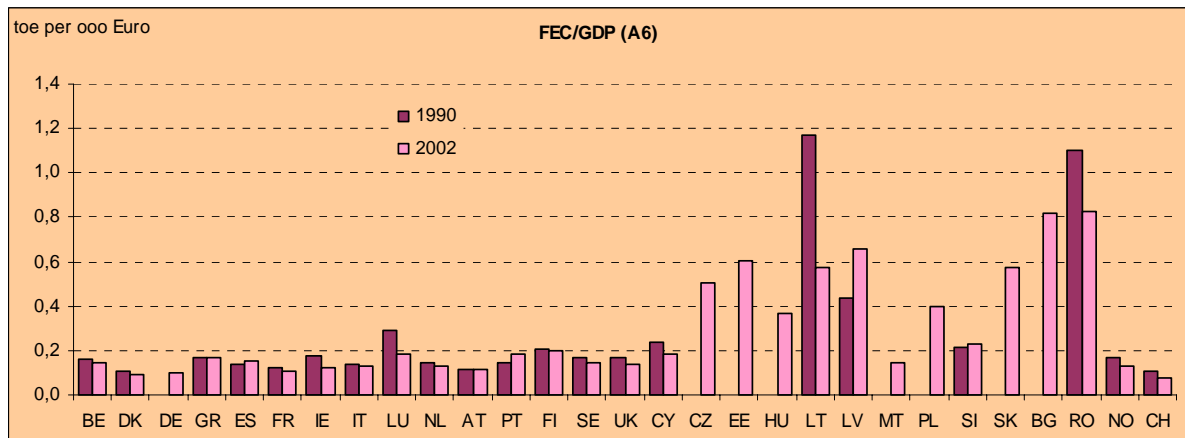
Source: DGET and Eurostat.

In 2002, the average of final energy consumption is around 0,13 toe per thousand Euros in EU15 and 0,42 toe per thousand Euros in the N10 (indicator A6).

Large differences exist between countries ranging from 0,09 toe per thousand Euros in Denmark to 0,9 toe per thousand Euro in Romania. Besides economic inequality between countries, the difference in this indicator may also reflect differences in energy consumption patterns as well as inefficiency in energy transformation.

In the period 1990-2002 energy intensity decreased with a particularly pronounced way in N10 countries. In EU15 energy intensity decreased also except in Spain and Portugal, which showed a higher increase than the average of their economic activity.

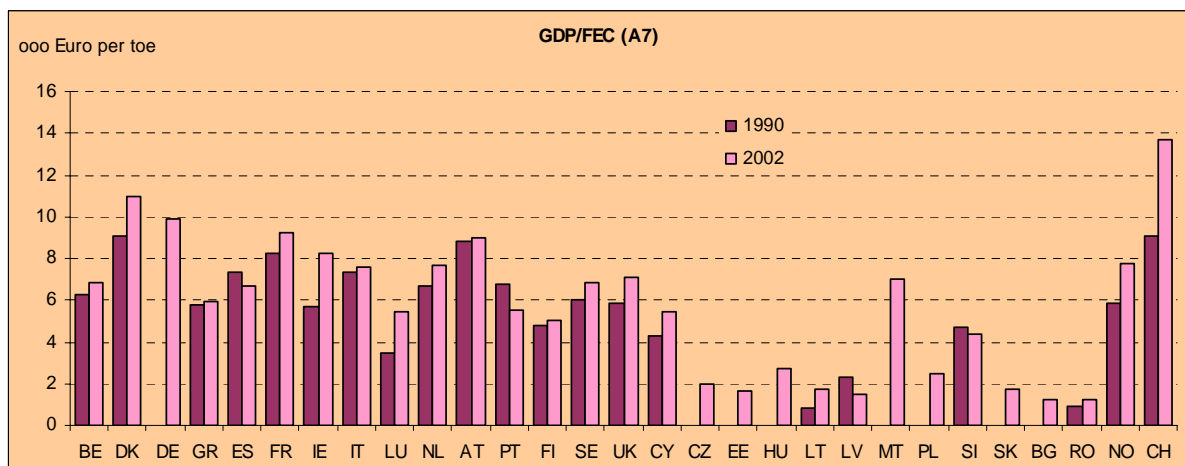
**Figure 23 (A6) Final Energy Consumption per thousand Euro of GDP in 1990 and 2002**



Source: DGET and Eurostat.

The inverse of this indicator, *GDP/FEC (A7)*, gives the energy productivity in terms of value added. This indicator measures each country progress in terms of obtaining more economic activity per unit of energy consumed. The N10 countries are more dependent of final energy in the productive process. Only in Spain and Portugal this indicator decreased between 1990 and 2002. We must bear in mind that the indicator are influenced by the relative weight of the economic sectors.

**Figure 24 (A7) GDP / FEC in 1990 and 2002**



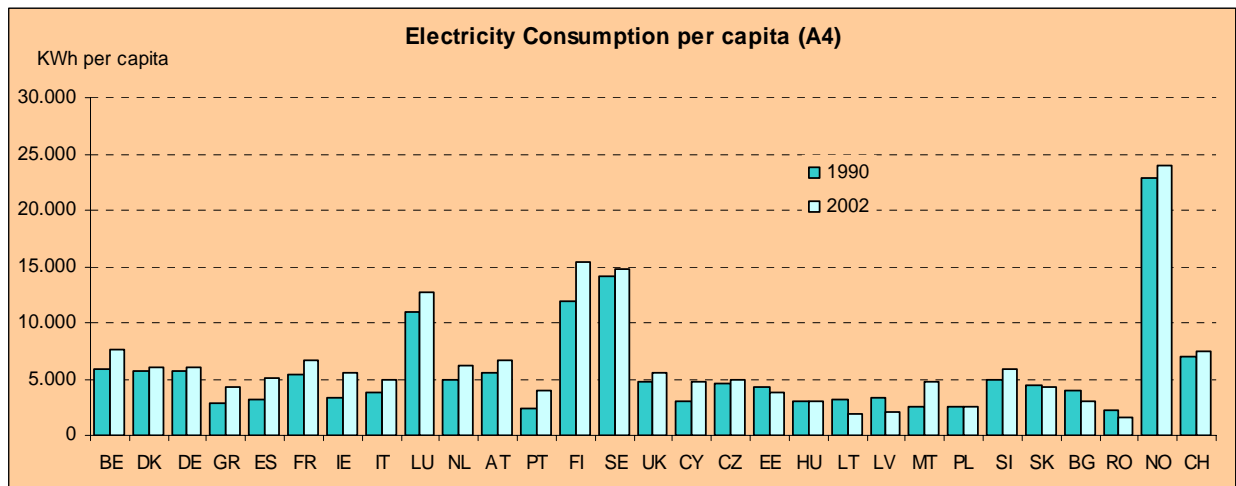
Source: DGET and Eurostat.

In terms of the electricity sector, it is necessary to use indicators such as electricity consumption per capita (indicator A4) and average consumption in terms of GDP (indicator A8).

In the figure below we can see the evolution of *electricity consumption per capita (A4)* with a general trend of growth in the period 1995 to 2000, with exception of Lithuania, Bulgaria, Romania, Estonia and Latvia.

There are great differences between countries. Although the European average is 5.895 kWh per person, the Nordic countries exceed largely that value. Luxembourg also have high values because of its very small population and because much of its industry is electricity intensive.

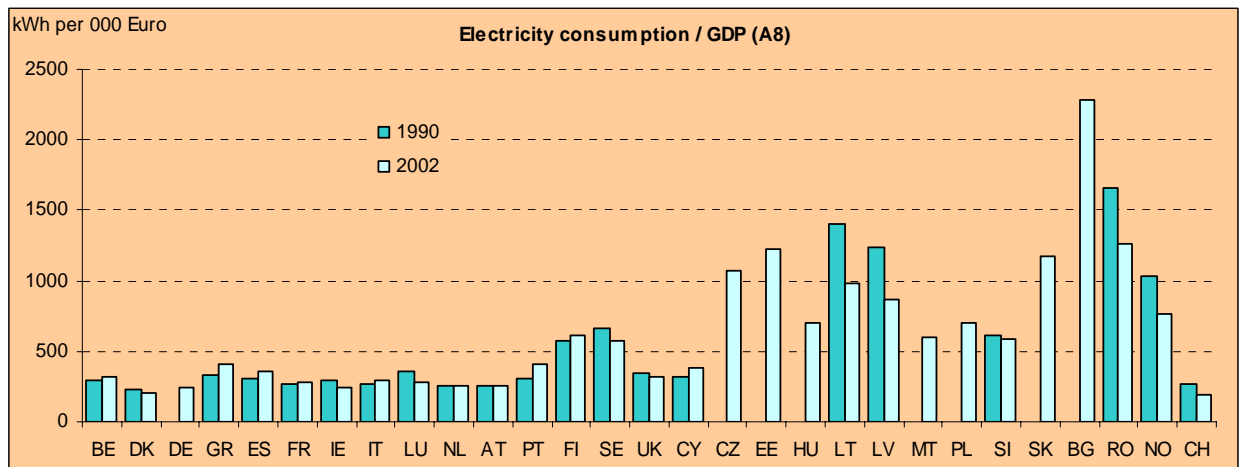
**Figure 25 (A4) Electricity Consumption per capita in 1990 and 2002**



Source: DGET and Eurostat.

Differences between E15 and N10 are also evident regarding *electricity consumption per thousand Euro of GDP (A8)*. The biggest consumers of electricity, in terms of GDP consumption, in 2002, are the Nordic countries in EU15 and Slovakia and Estonia in N10. Although great part of New Member States and candidate countries have a higher degree of dependence of economies from electricity, the trend is reducing this dependence to European average.

**Figure 26 (A8) Electricity consumption per thousand Euro of GDP in 1990 and 2002**



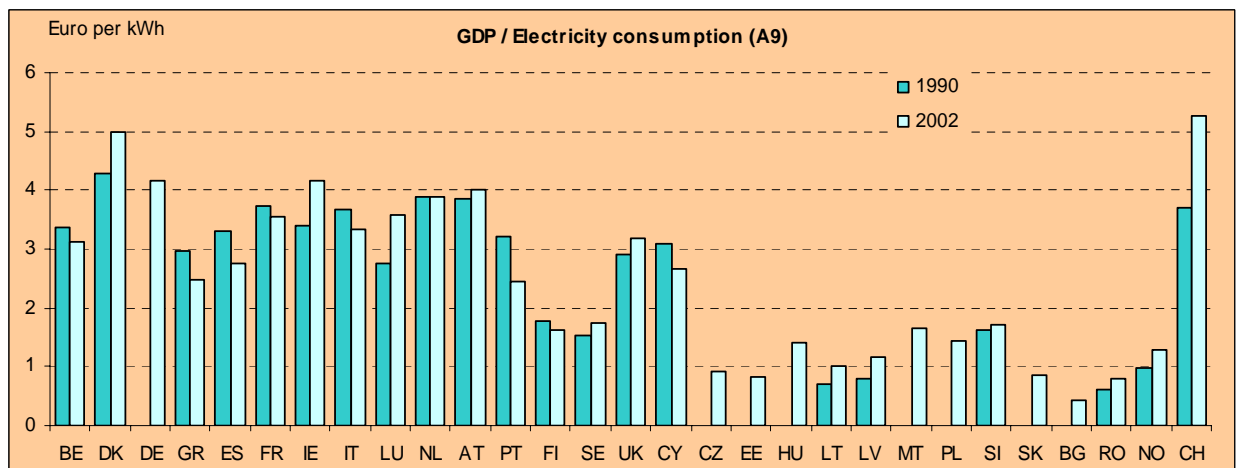
Source: DGET and Eurostat.

In cases of high electricity consumption in relation to GDP and low electricity consumption per capita, the explanation lies partly in electricity intensive industries, plus a lower GDP and a level of energy efficiency of industries which is below the other European countries.

We must notice the influence of certain key factors, which affect, to a greater or lesser degree, the level of consumption of electricity: factors such as climatic conditions, the economic structure of the country, energy consumption habits with regard to certain energy sources, plus efficiency in the use of energy.

The inverse of this indicator is GDP/electricity consumption (A9) which measures the relative efficiency in using electricity.

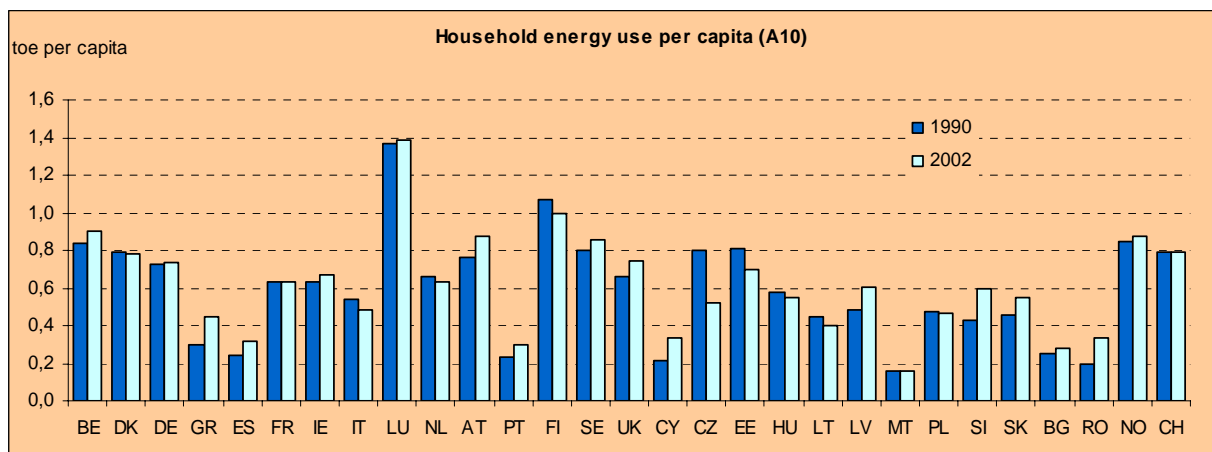
**Figure 27 (A9) Electricity productivity in terms of GDP in 1990 and 2002**



Source: DGET and Eurostat.

Analysing the amount of *household energy use (A10)* there are great differences between countries. This variation is a combination of many factors, such as climate, comfort levels, energy efficiency and energy prices. Within the EU15, northern countries generally have higher levels of household energy use per capita than southern countries, reflecting the fact that much household energy is used for heating. The countries with the lowest levels in EU15 are Greece, Portugal and Spain, and in the rest of the countries are Cyprus, Malta, Bulgaria and Romania.

**Figure 28 (A10) Household Energy use per capita in 1990 and 2002**



Source: DGET and Eurostat.

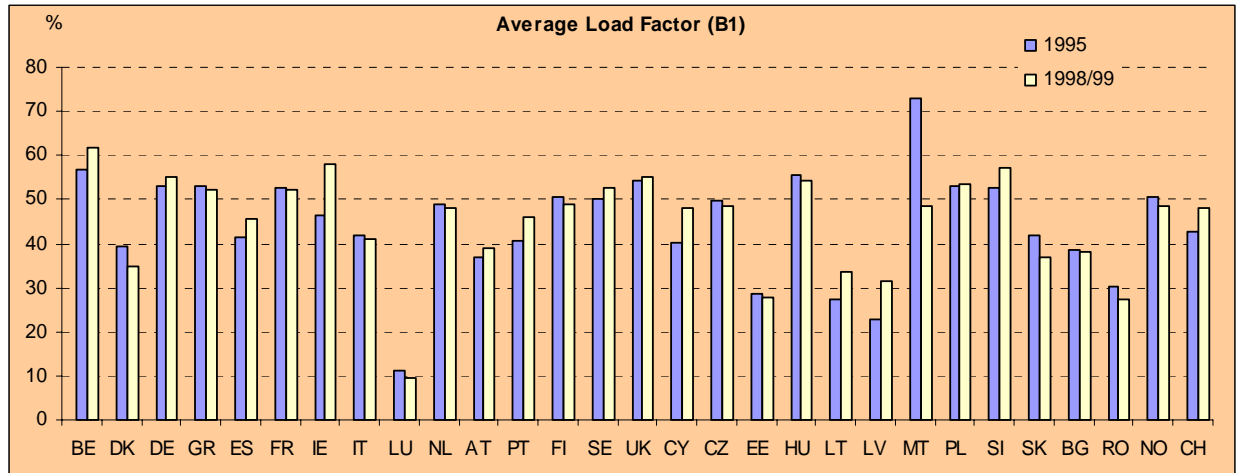
### 1.3.2 Reliable supplies of energy (*indicators B*)

Rely on secure supplies of energy is fundamental to the economy as a whole and to sustainable development, which requires the right infrastructure and liberalised energy markets in Europe.

The average percentage of generating capacity used, reflected in *average load factor (B1)*, is quite different among countries, as well the respective evolutions in the period 1995-1999 in the case of EU15 and 1995-1998 in the rest of the countries. Luxembourg is an exceptional case with a low value for this indicator.



**Figure 29 (B1) Average load factor in 1995 and 1999**

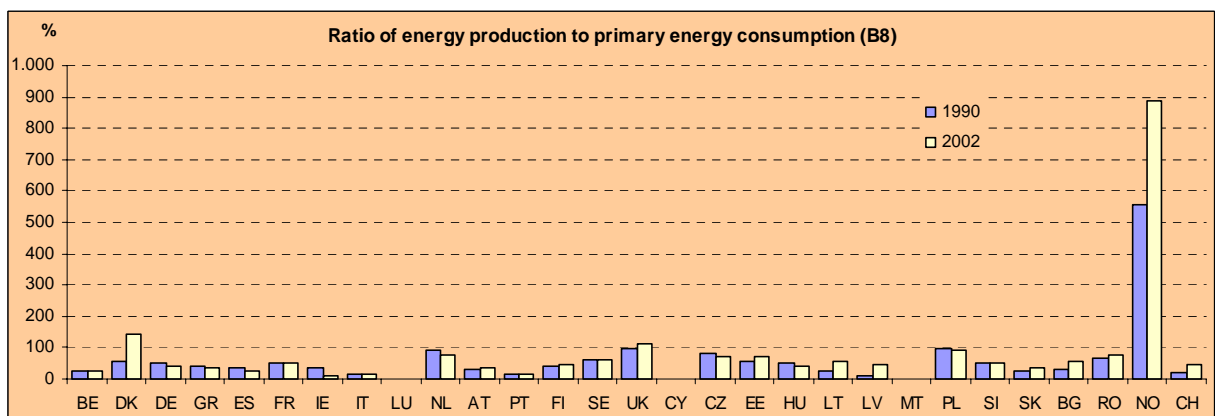


Source: "2001 - Annual Energy Review", 1998 data for New Member States, Bulgaria and Romania

To measure the primary energy self sufficiency we use indicator B8, giving the picture of security of supply in terms of primary energy consumption. In the next figure it is possible to see that Norway's position is exceptional in producing around 9 times as much energy as it consumes in 2002. Besides Norway only two countries, United Kingdom and Denmark had a surplus of energy over their own requirements.

It is important to refer that N10 countries have a high level of self-sufficiency. Poland is the most outstanding case, with around 90%, due mainly to its important coal deposits, while the Czech Republic has reached 74%.

**Figure 30 (B8) Ratio of energy production to primary energy consumption in 1990 and 2002**



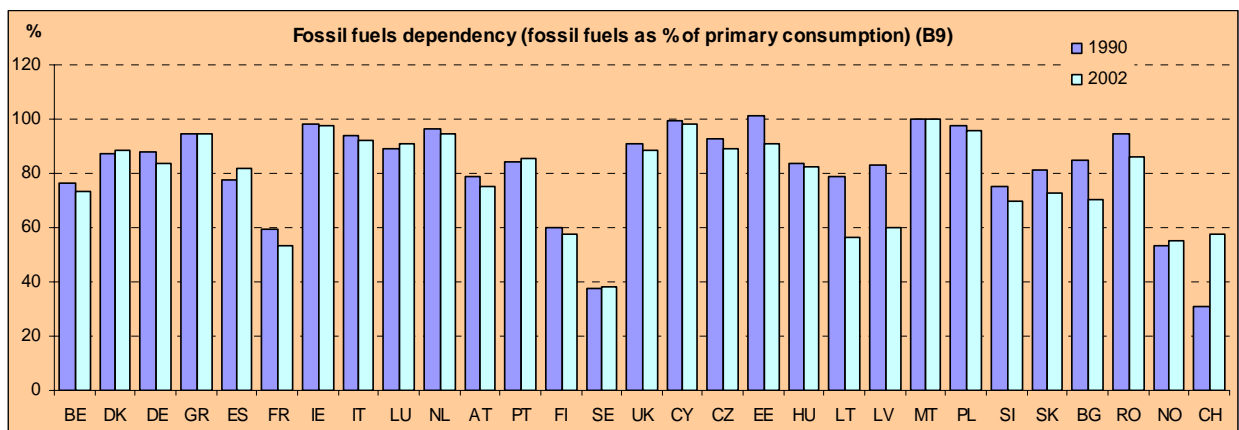
Source: DGET and Eurostat.

Between 1990-2002 energy dependency was reduced in average. A lower result of this indicator means high dependence from energy imports. The proportion of primary energy consumption met by coal, oil and gas gives a measure of a country's *dependence on fossil fuels (B9)*. In 2002, the countries least dependent on fossil fuels, such as Sweden, Norway, or France, have well developed sources of nuclear or hydro electricity.

Most countries have reduced their dependence on fossil fuels since 1990 by developing alternative sources. In average EU15 reduced by 1,4% and N10 reduced by 8,9%.

The development of renewables, mainly wind electricity, is taking place in almost all the countries. Spain and Germany are the leading countries in terms of wind investment.

**Figure 31 (B9) Fossil Fuels Dependency in 1990 and 2002**



Source: DGET and Eurostat.

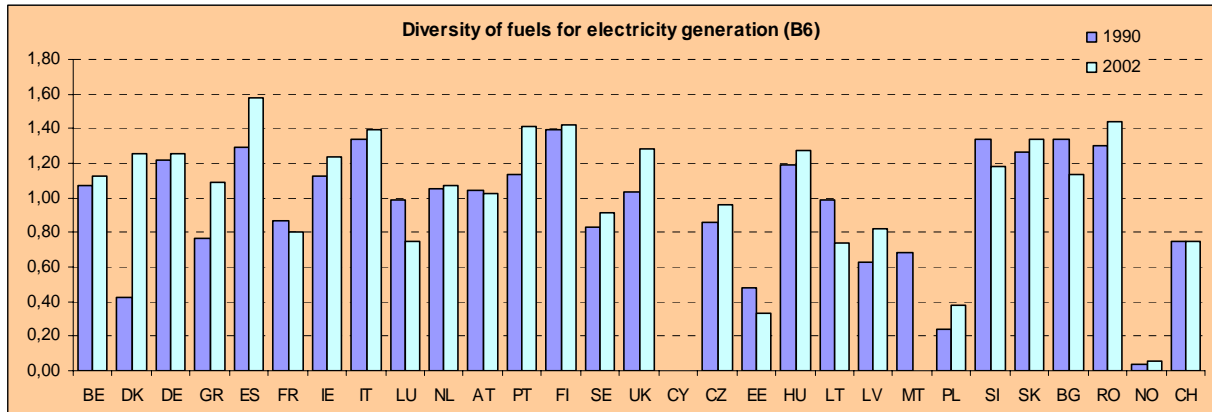
Energy investments are costly, risky and require long-term commitments. For that reason energy security policies should emphasize the expansion and diversification of energy supplies. The mix of primary fuels consumed for energy purposes has become increasingly diverse in the last years.

Diversification contributes to security of supply carrying out benefits for individual consumers and for the national economy. Security of supply is one of the major objectives of national energy policies, thereby contributing to reduce the dependence on one source of energy and seeking to increase the level of self-supply through the use of one's own resources in order to lessen the vulnerability of energy and the level of dependence on outside sources.

In the case of fuels used for electricity generation, *diversity of supply (B6)*, the Shannon-Weiner measure of diversity (described in the detailed analysis in Annex 1) increased between 1990 and 2002 for a great part of the 29

countries (exceptions were Austria, France, Luxembourg, Estonia, Lithuania, Bulgaria and Slovenia).

**Figure 32 (B6) Diversity of fuels used for electricity generation in 1990 and 2002**

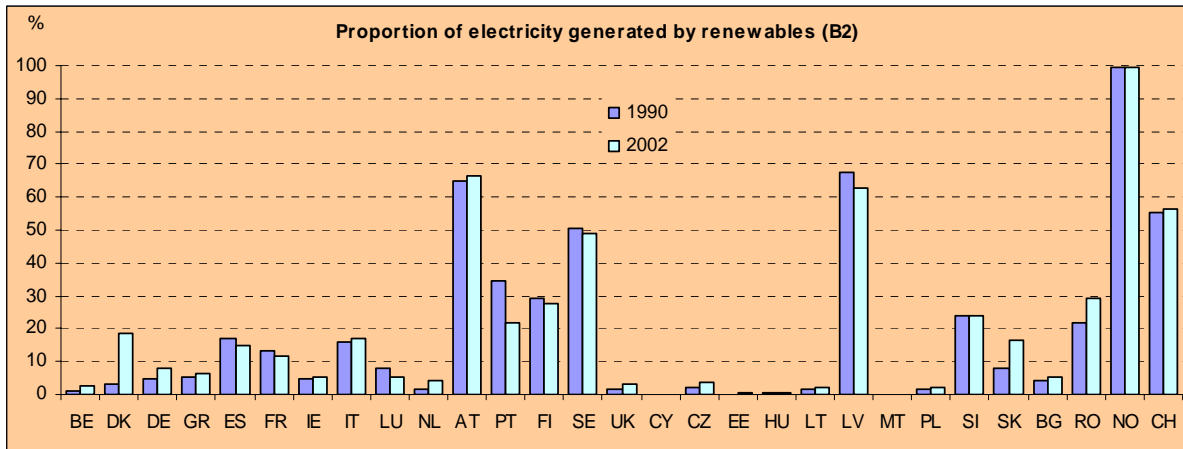


Source: DGET and Eurostat

In 2002 countries such as Spain, Italy, Portugal, Finland and Romania, with higher values of the Shannon-Weiner measure, have energy systems less dependent of a reduced number of fuels.

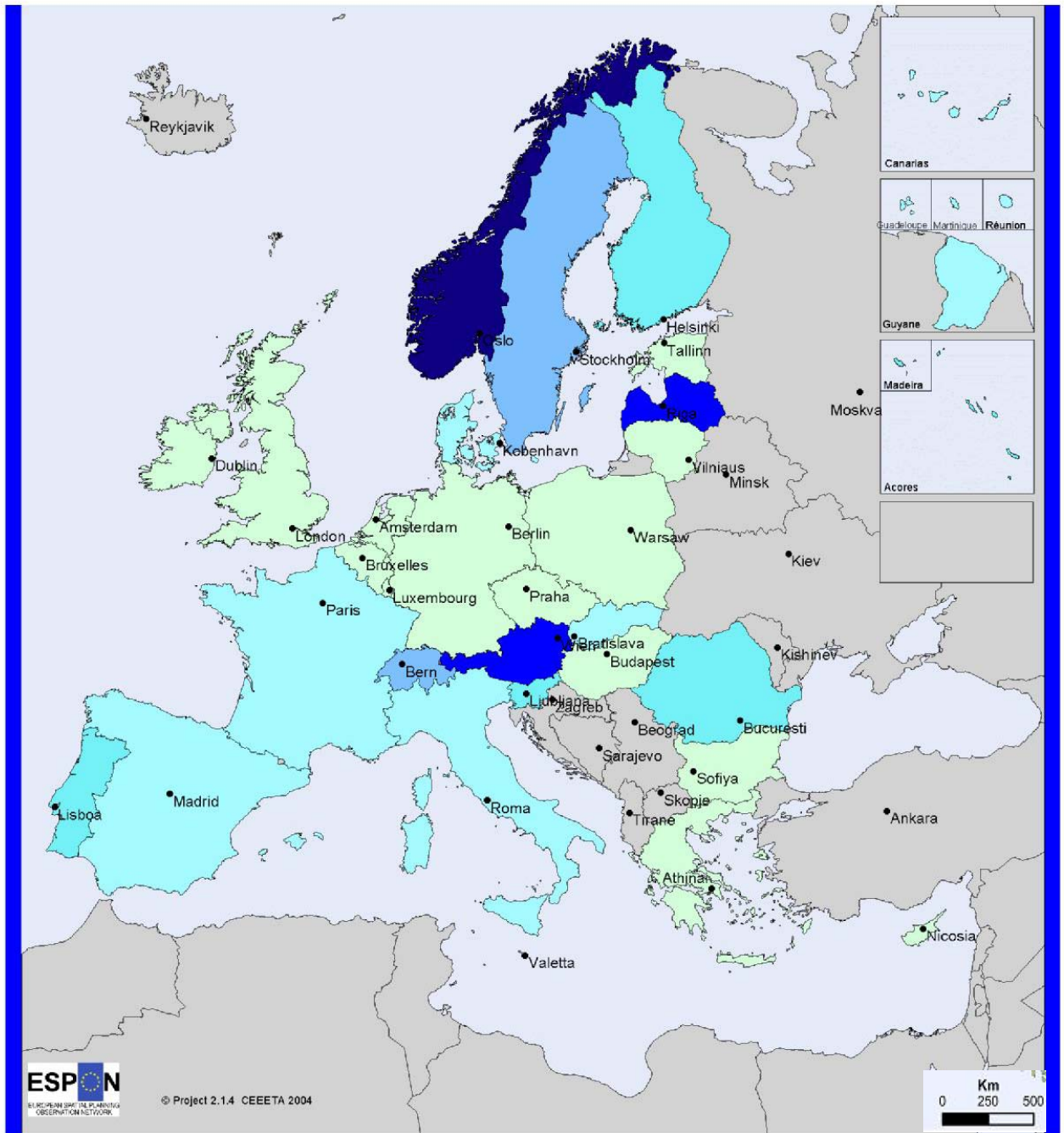
For the same year, the *proportion of electricity generated by renewables (B2)* is significant in countries such as Norway and Austria for example, although it must be understood that the nature of renewable energy in this context is very different among countries. It must be stressed when conducting comparisons between different years that some renewables are dependent on weather conditions. That is why a reduction in penetration between years must be carefully analysed.

**Figure 33 (B2) Proportion of electricity generated by renewable in 1990 and 2002**



Source: DGET and Eurostat

Map 12 Proportion of electricity generated by renewables in 2002 (%)



Proportion of electricity generated by renewables 2002

- 0 - 10
- 10 - 20
- 20 - 40
- 40 - 60
- 60 - 79
- 79 - 99

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Source: DGET, EUROSTAT

Evolution of proportions of electricity generated by liquid and solid fossil fuels, as well as natural gas in each country can be seen through indicators B3, B4 and B5 in the Annex 8.

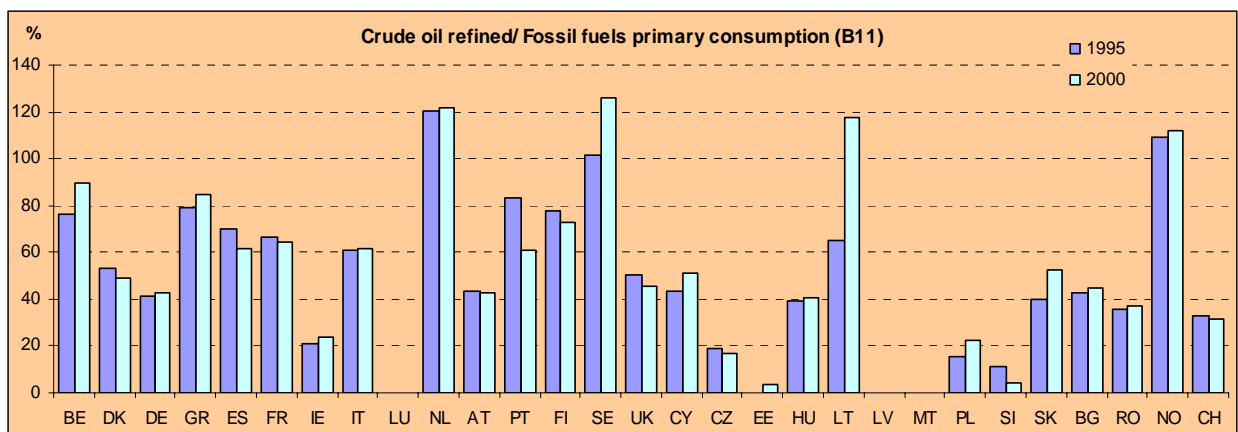
For indicators like Gas Capacity (B7), and Grid density high and medium voltage (B12) it was not possible to collect consistent data besides the maps presented in Annex 8.

For the construction of the indicator crude oil refined / fossil fuels primary consumption (B11) we collected data for output of refined petroleum products from EIA for the years 1995 and 2000.

In the figure below we can see that the proportion is higher than EU15 average in countries like Belgium, Greece, Netherlands, Sweden, Lithuania and Norway in 2000.

This indicator is of great value to measure to what extent fossil fuels other than crude oil are penetrating in the economy. The decrease observed for Portugal and Spain, for example, reflects the higher penetration of natural gas in the economy.

**Figure 34 (B11) Proportion of Crude Oil refined in Fossil Fuels Primary Consumption in 1995 and 2000**



Source: EIA and DGET and Eurostat  
 Note: Crude Oil refined refers to Output of Refined Petroleum Products.

### 1.3.3 Competitive energy markets (*indicators C*)

In energy markets competition does not guarantee lower prices and may be based on other factors such as quality of service. Prices paid by final consumers are influenced by several factors including: international prices of

key raw materials such as crude oil; the balance of supply and demand; taxes; and the costs of extracting, transforming, transporting, distribution and marketing individual fuels.

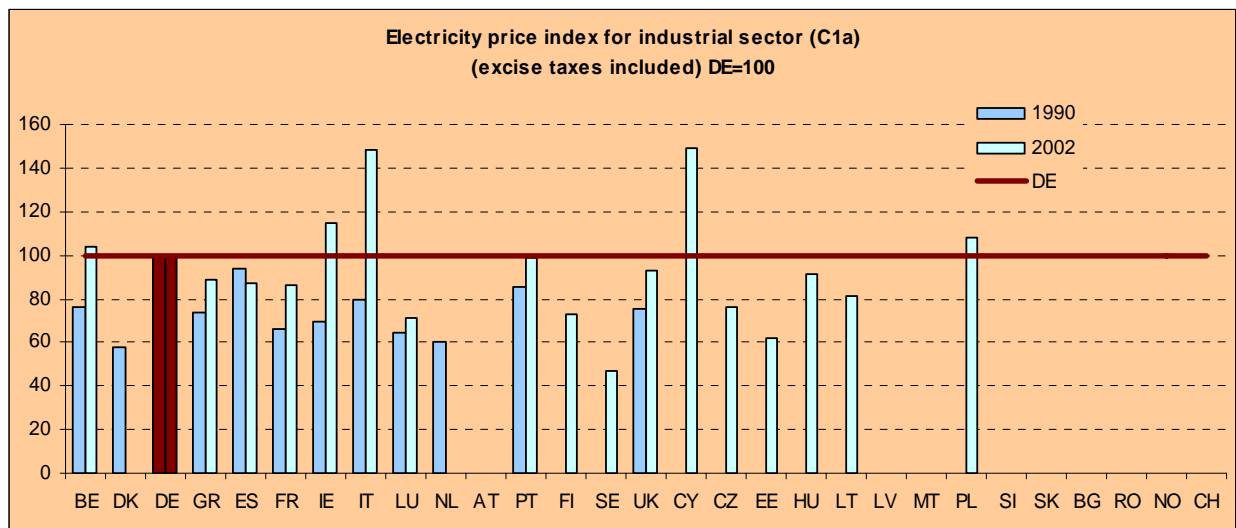
In an exercise of assessing the relative competitiveness among countries it should be underlined that comparing prices across countries involves many questions such as the relative levels of inflation and exchange rates, taxes and individual market structures.

Therefore, we analyse the evolution of relative price indices of electricity and natural gas prices used by industry sector (C1a and C1b). These indicators shows the trends in electricity and natural gas prices indexed to Germany prices (considered the largest consumer country in this study).

With Germany electricity prices as basis for comparison and considering that those prices decreased there much more then anywhere else (see core indicator 3), we realize that EU15 haven't been able to follow up this trend, improving their competitiveness.

As we can see in the figure below the situation in 2002 is quite different from 1990, reflecting a trend of larger disparities between electricity prices for industry.

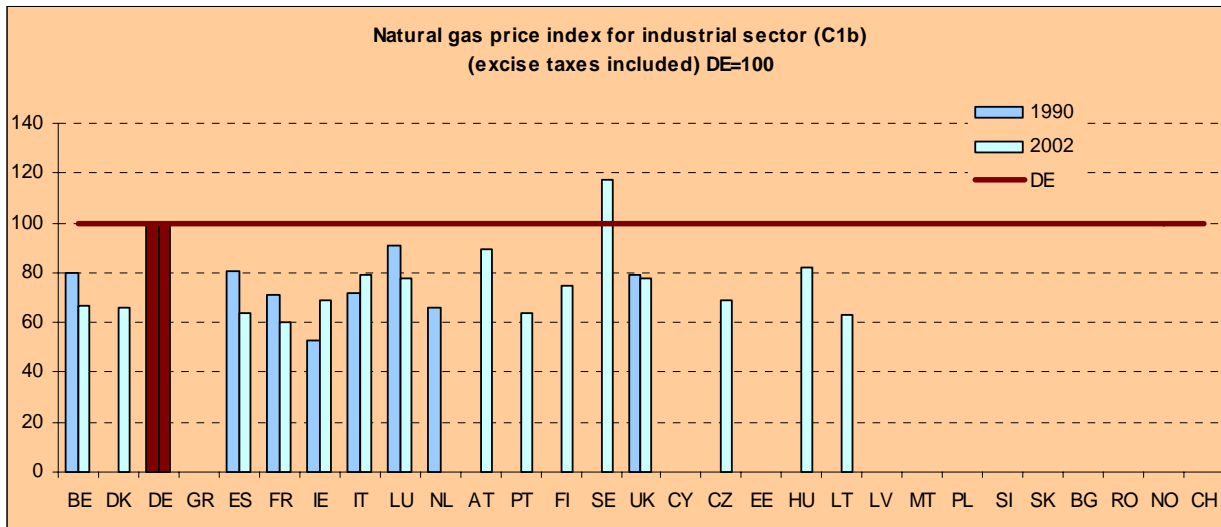
**Figure 35 (C1a) Electricity Prices Indices for industrial sector in 1990 and 2002 (Germany=100)**



Source: DGET and Eurostat

Regarding natural gas prices trend for industry, after a period of some instability, in 2002 the situation became similar to the year of 1990.

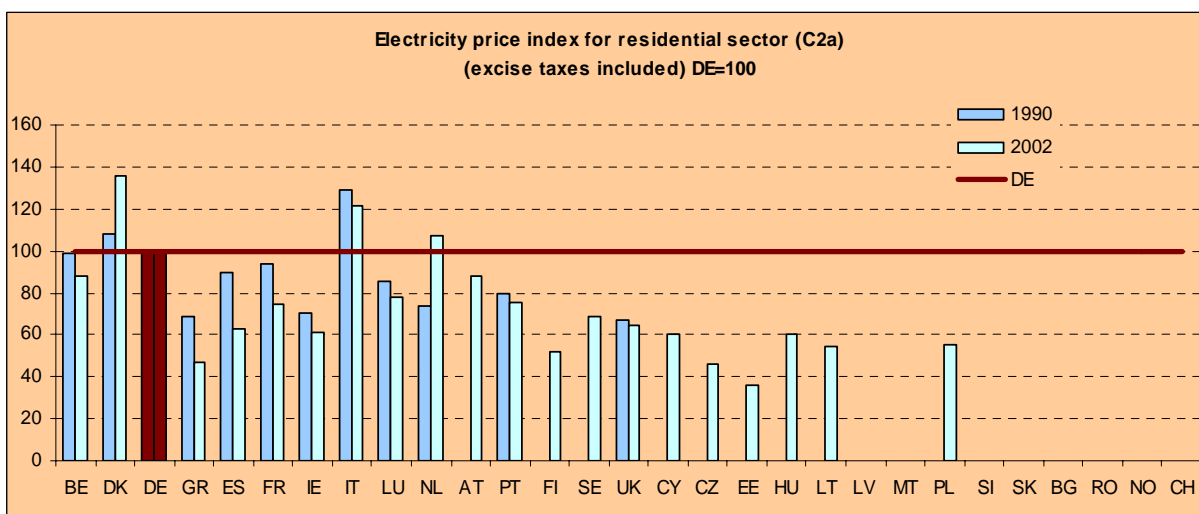
**Figure 36 (C1b) Natural Gas Prices Indices for industrial sector in 1990 and 2002 (Germany=100)**



Source: DGET and Eurostat

For price indices of electricity and natural gas prices used by the household sector (C2a and C2b) the disparities among countries are larger when comparing to Germany prices. Comparing the situation in 1990 to 2002 the differences are not significant.

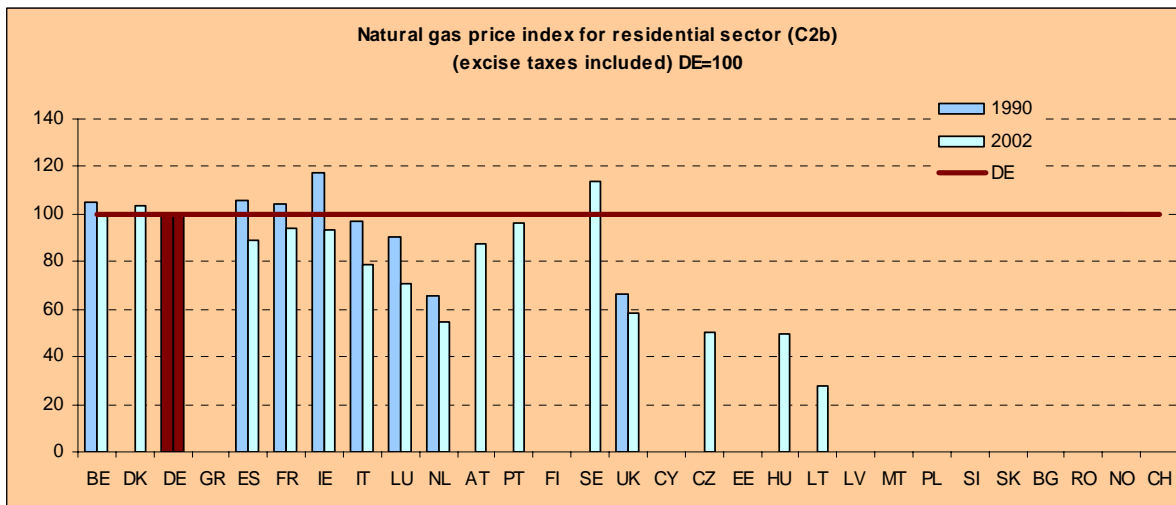
**Figure 37 (C2a) Electricity Prices Indices for residential sector in 1990 and 2002 (Germany=100)**



Source: DGET and Eurostat



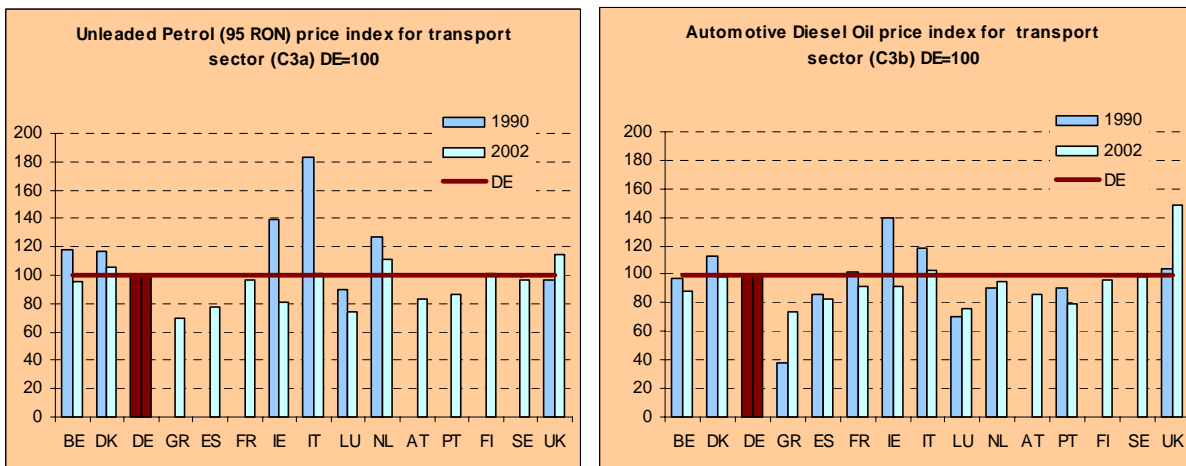
**Figure 38 (C2b) Natural Gas Prices Indices for residential sector in 1990 and 2002 (Germany=100)**



Source: DGET and Eurostat

Observing the price indices of fuel prices used by the transport sector (C3a and C3b) the disparities among countries are smaller when comparing to Germany prices.

**Figure 39 (C3a and C3b) Fuel price indices for the transport sector in 1990 and 2002 (Germany=100)**



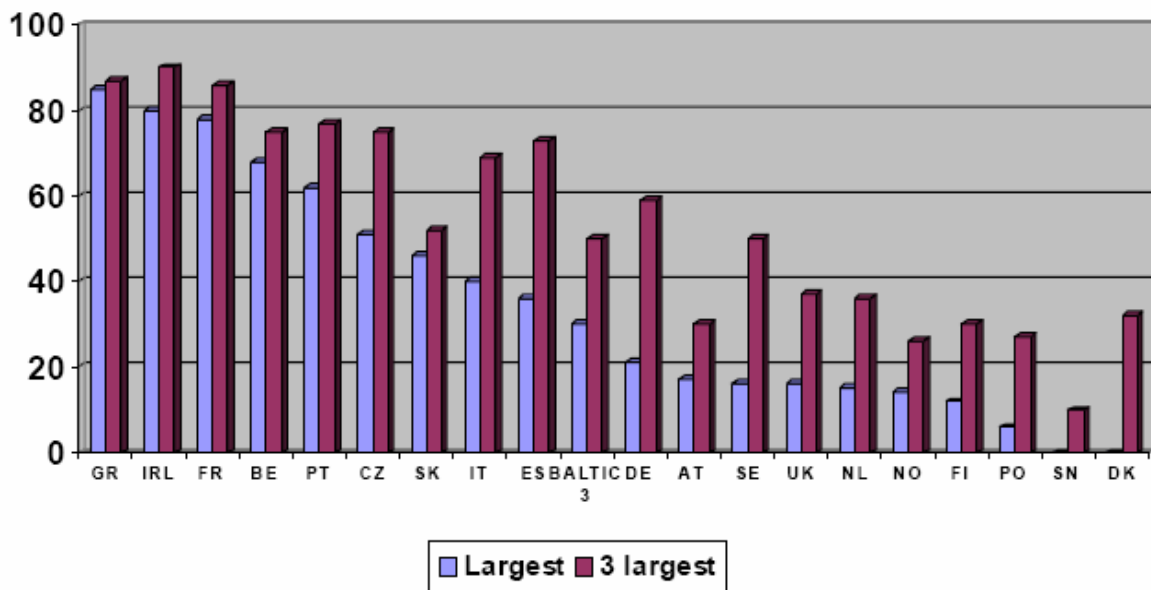
Source: DGET and Eurostat.

To measure the degree of concentration in the electricity generation market using the indicator *competition in electricity generation (C4)* (Herfindahl-Herschmann measure) was a difficult task because of availability of data. Therefore we opted to use the data presented in the European Commission

Communication about the degree of concentration in each generation market, in terms of the share of the largest, and the three largest companies.

The graph below has been adjusted (i.e. lowered) by taking into account the amount of import capacity, recognising that this is also a source of competition.

**Figure 40 Concentration of largest companies in electricity generation market**



Source: “Energy Infrastructure and security of supply”, COM(2003) 743 final, December 2003  
 ([http://europa.eu.int/comm/energy/electricity/infrastructure/doc/2003/com\\_2003\\_743\\_en.pdf](http://europa.eu.int/comm/energy/electricity/infrastructure/doc/2003/com_2003_743_en.pdf))

In that document it is referred an unsatisfactory position in a number of the 25 Member States with the following striking examples:

- Greece, where the “Public Power Company” (PPC) controls the domestic generation market and connection with Balkan neighbours is not well developed,
- Ireland, where Electricity Supply Board’s (ESB) position continues to be isolated from potential competitive pressures and where there is insufficient interconnection with Northern Ireland and the wider EU market
- France, where Electricité de France’s (EDF) position can only be challenged to a limited extent through imports,

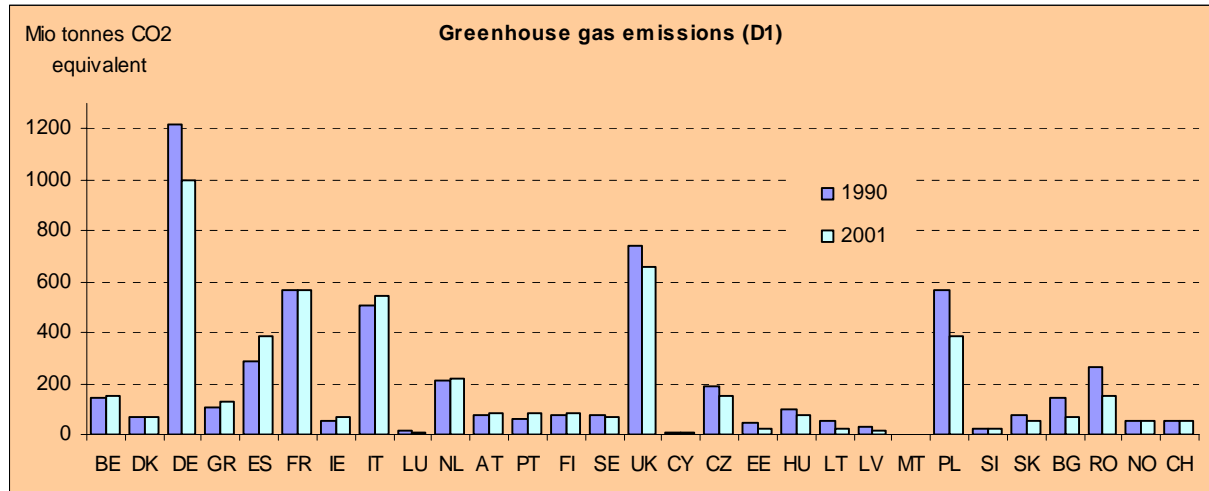
- Belgium, where the dominant position of Electrabel is compounded by insufficient import capacity,
- A number of the new Member States (e.g. Czech Republic, Slovakia), where transmission grids need to be reinforced and/or further upgraded to allow competition between former incumbents,
- Austria, where reinforcement of the national network is needed to ensure sufficient cross border competition with the newly merged “Energie Austria”,
- Italy where reinforcement of connections with neighbouring countries, especially, Austria and Slovenia would increase reliability and provide greater diversity,
- Finally, in Spain and Portugal, the slow progress in developing interconnectors and the completion of an integrated market still means that the largest companies retain a significant degree of control.

#### 1.3.4 Environmental objectives (*indicators D*)

The objective of energy efficiency activities is to ensure rational use of energy resources and reduce adverse environmental effects of energy use. Reducing greenhouse gas emissions is getting the main reason for efficient use of energy.

The following indicator shows a positive evolution on the reduction of amounts of CO<sub>2</sub> equivalent released to the atmosphere between 1990 and 2001. Emissions have declined substantially in all of the New Member States and candidate countries (except Cyprus and Malta) mainly due to the introduction of market economies and the consequent restructuring or closure of heavily polluting and energy-intensive industries. In EU15 only Germany, Luxembourg, Sweden and United Kingdom reduced the values in the same period.

**Figure 41 (D1) Greenhouse gas emissions in 1990 and 2001**

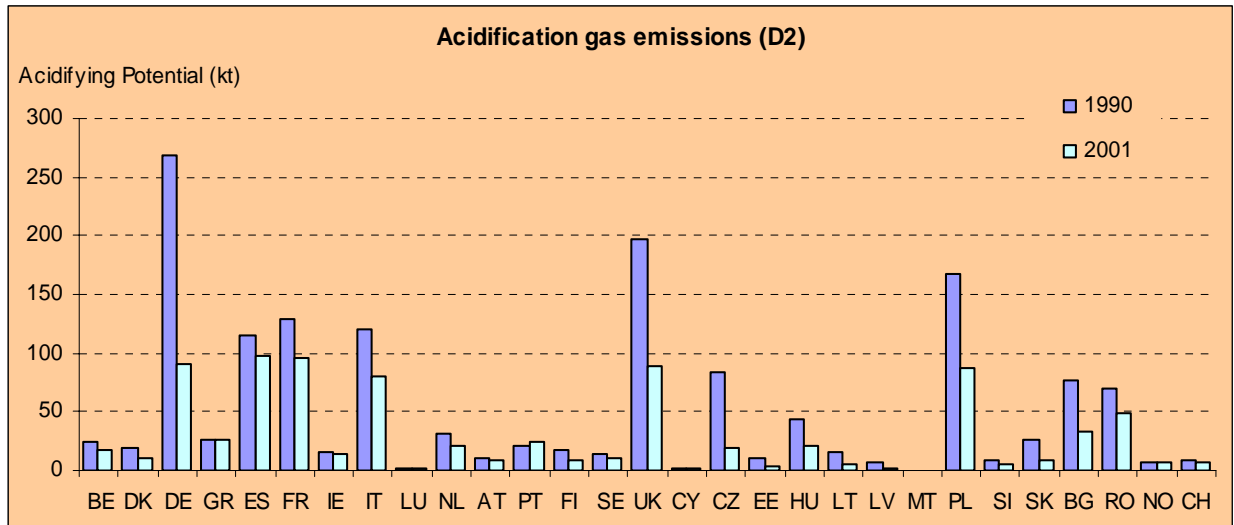


Source: "Energy, transport and environment indicators 1991-2001", Eurostat

The reduction in energy intensity (see indicator A5) in the period 1990-2002 in almost EU29 countries is a positive factor for controlling overall GHG emissions. For example in the United Kingdom the reduction of greenhouse gas emissions was partly a result of the liberalisation of the energy market and subsequent changes in the choice of fuel used in electricity production from oil and coal to gas.

Regarding the *emissions of acidifying substances (D2)* in the EU15 they have decreased by 41% between 1990 and 2001, and by 58% in the 10 new Member States. In EU15 the biggest reductions have been in Germany and United Kingdom, in N10 was in Czech Republic and Latvia.

**Figure 42 (D2) Acidification gas emissions in 1990 and 2001**



Source: "Energy, transport and environment indicators 1991-2001", Eurostat. No available data for Malta.

Note: The acidifying substances considered in this publication are sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) and ammonia (NH<sub>3</sub>). Emissions of these gases are associated with the formation of acid rain.

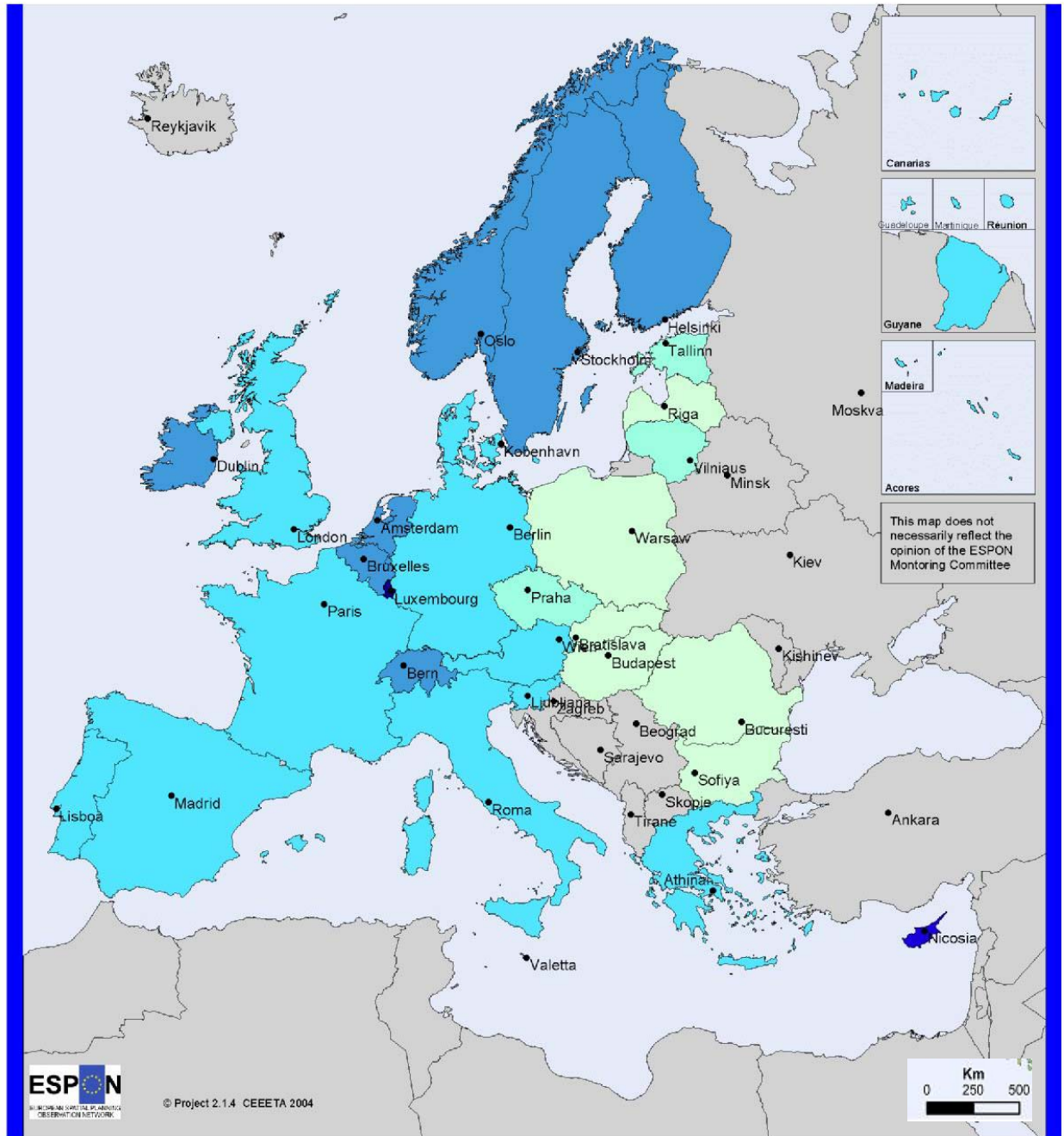
## 1.4 Renewable energy potential

The development of renewable energy sources are of the most important challenges and objectives of EU energy policy based either on environmental concerns, but also on security of supply and reduction of energy dependence.

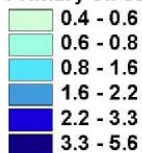
### 1.4.1 The present: how important oil is?

We have seen before that oil is the most important energy source in Europe. And per capita consumption of oil is dual, setting EU15 apart from N10 for two main reasons: the absolute level of energy consumption; and the importance of coal in primary energy production structure.

**Map 13 Primary oil consumption per capita at NUTS 0 in 2002 (ktoe per person)**



Primary oil consumption per capita in 2002 (ktoe)



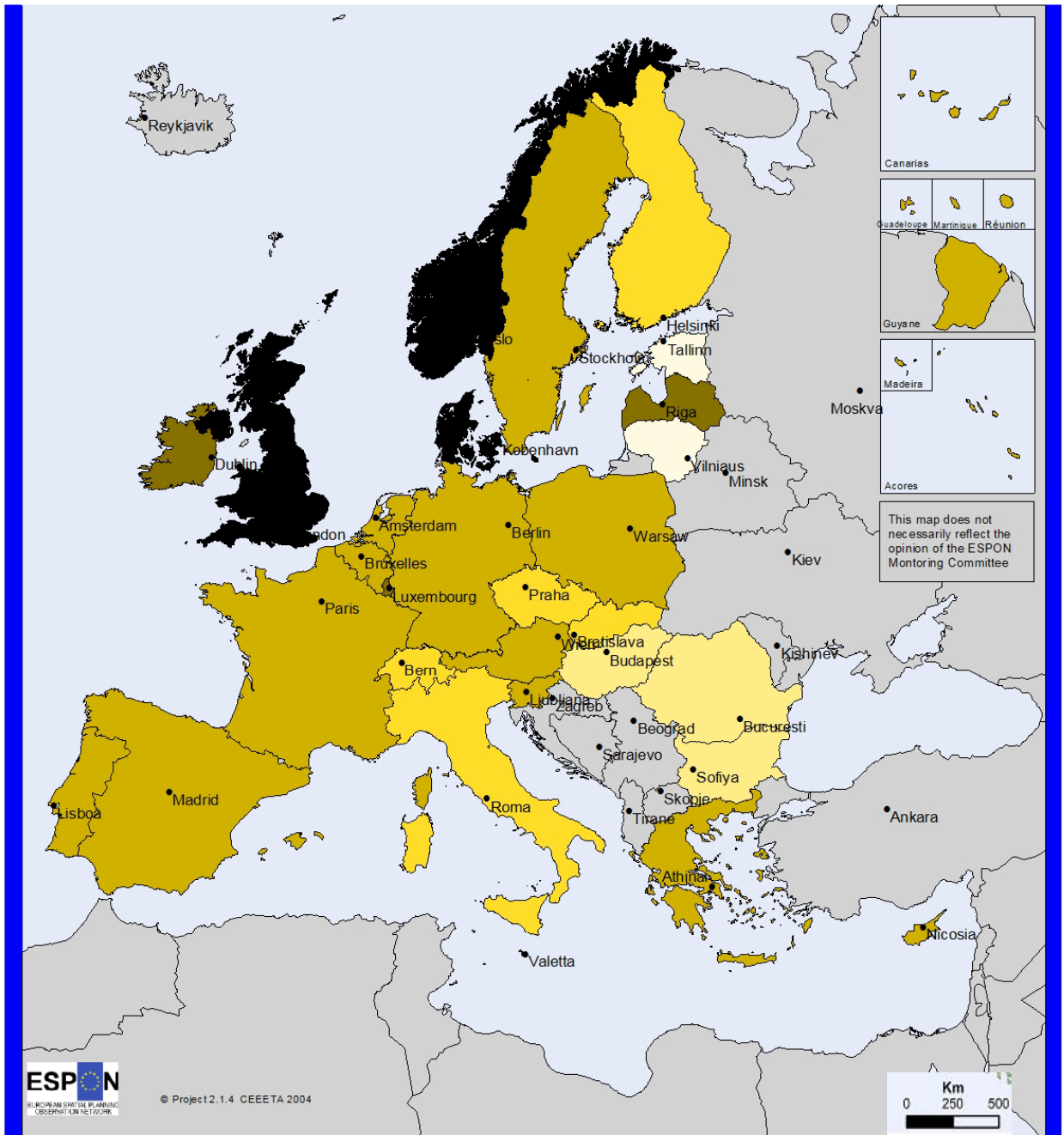
© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat

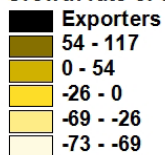
As we can see in the next map, the largest share of countries show a diminishing trend on oil imports.

But a number of countries (Spain, Greece, Ireland, Latvia, Luxembourg and Malta) have experienced growth in oil imports above 50% between 1990 and 2002. And this growth rate has been reflected in their structure of energy consumption.

Map 14 Growth rate of oil net imports at NUTS 0 in 1990-2002 (%)



Growth rate of oil net imports 1990-2002 (%)

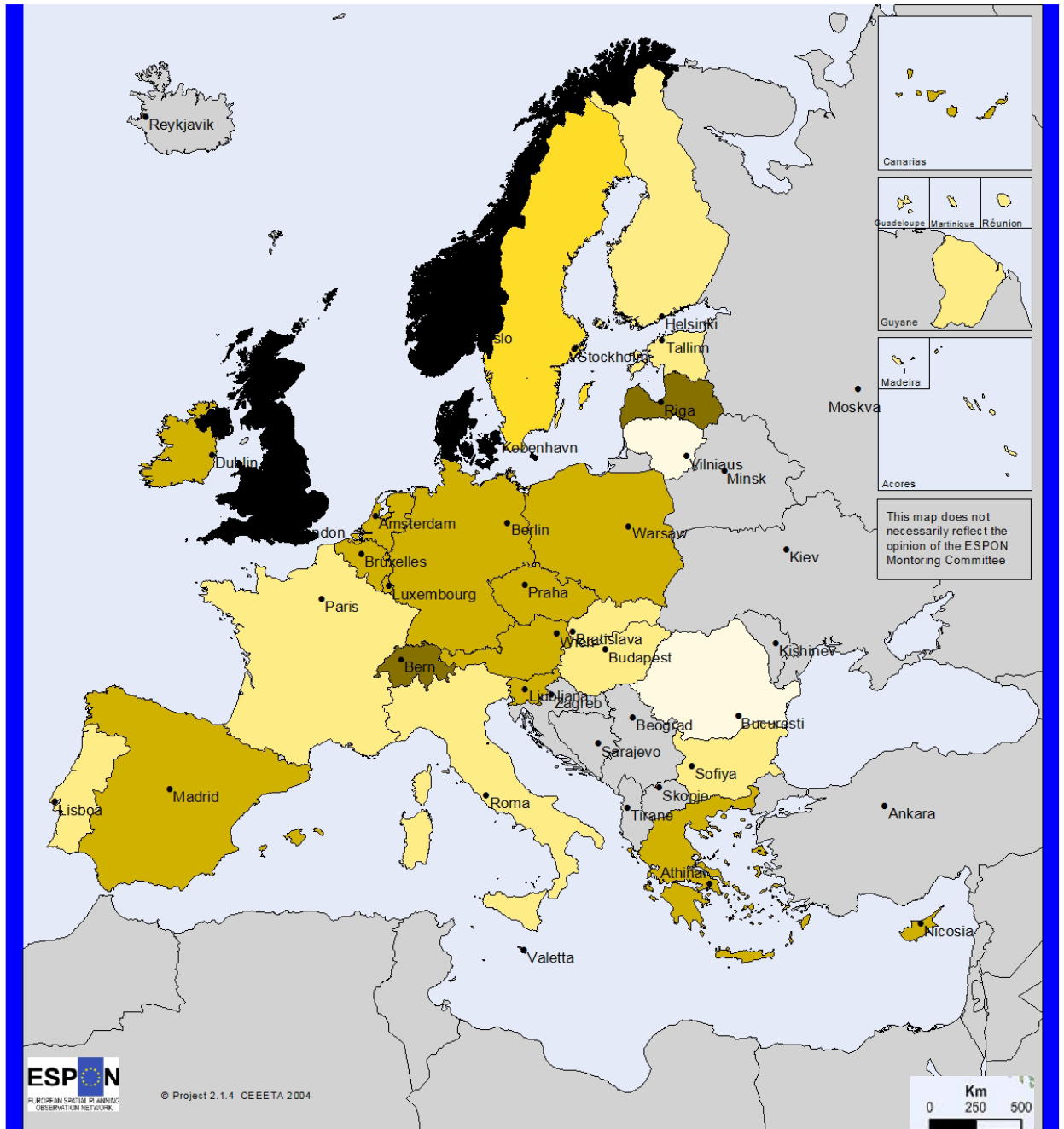


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Source: DGET, EUROSTAT.



**Map 15 Growth rate of oil net imports in primary energy consumption at NUTS 0 in 1990-2002 (%)**



**Growth rate of oil net imports in primary energy consumption 1990-2002 (%)**

Black	Exporters
Dark Yellow	53 - 103
Yellow	0 - 53
Light Yellow	-7 - 0
Very Light Yellow	-44 - -7
White	-49 - -44

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Source: DGET, EUROSTAT.

## 1.4.2 The future: renewable energy sources potential

### 1.4.2.1 Potential for Solar and Wind energy production

When searching data for solar and wind energy production in Europe in geographic terms we resorted to Meteotest<sup>3</sup>. Due to technical problems we couldn't transpose the data that we acquired to ESPON map template. The data constraints couldn't be solved in sufficient time minimizing the costs involved.

In the case of wind, we were informed that the available wind map for Europe was the one from WASP ([www.wasp.dk](http://www.wasp.dk)) but with some remarks related to its quality. We could have ordered specialized services in order to supply data with the adequate format, but the costs were very high.

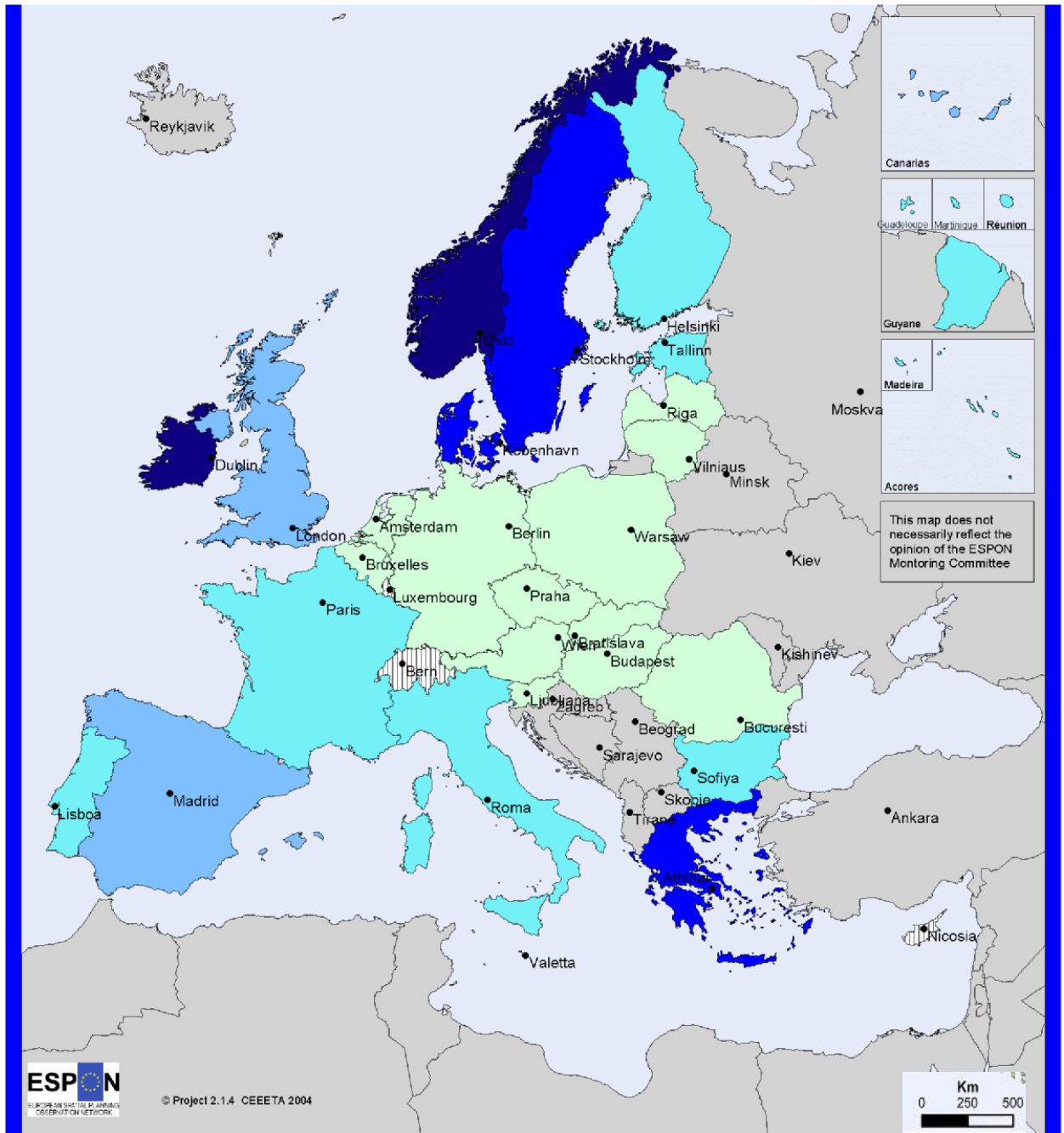
With this scenario we decided to present only the maps at NUTS 0 level regarding the information about wind technical potential using data from European Wind Energy Association (EWEA). The following Map presents the potential for wind electricity production at European level.

Potential is especially relevant for Norway and Ireland, but it is also important for Greece, Sweden, Spain and UK.

---

<sup>3</sup> solar database (Meteonorm)

**Map 16 Wind technical potential per capita at NUTS 0 in 2002/2001 (TWh/year by million persons)**



Wind technical potential per capita (TWh/year/million persons)

- 0.13 - 0.6
- 0.6 - 1.45
- 1.45 - 2.11
- 2.11 - 5.4
- 5.4 - 16.8
- No Data

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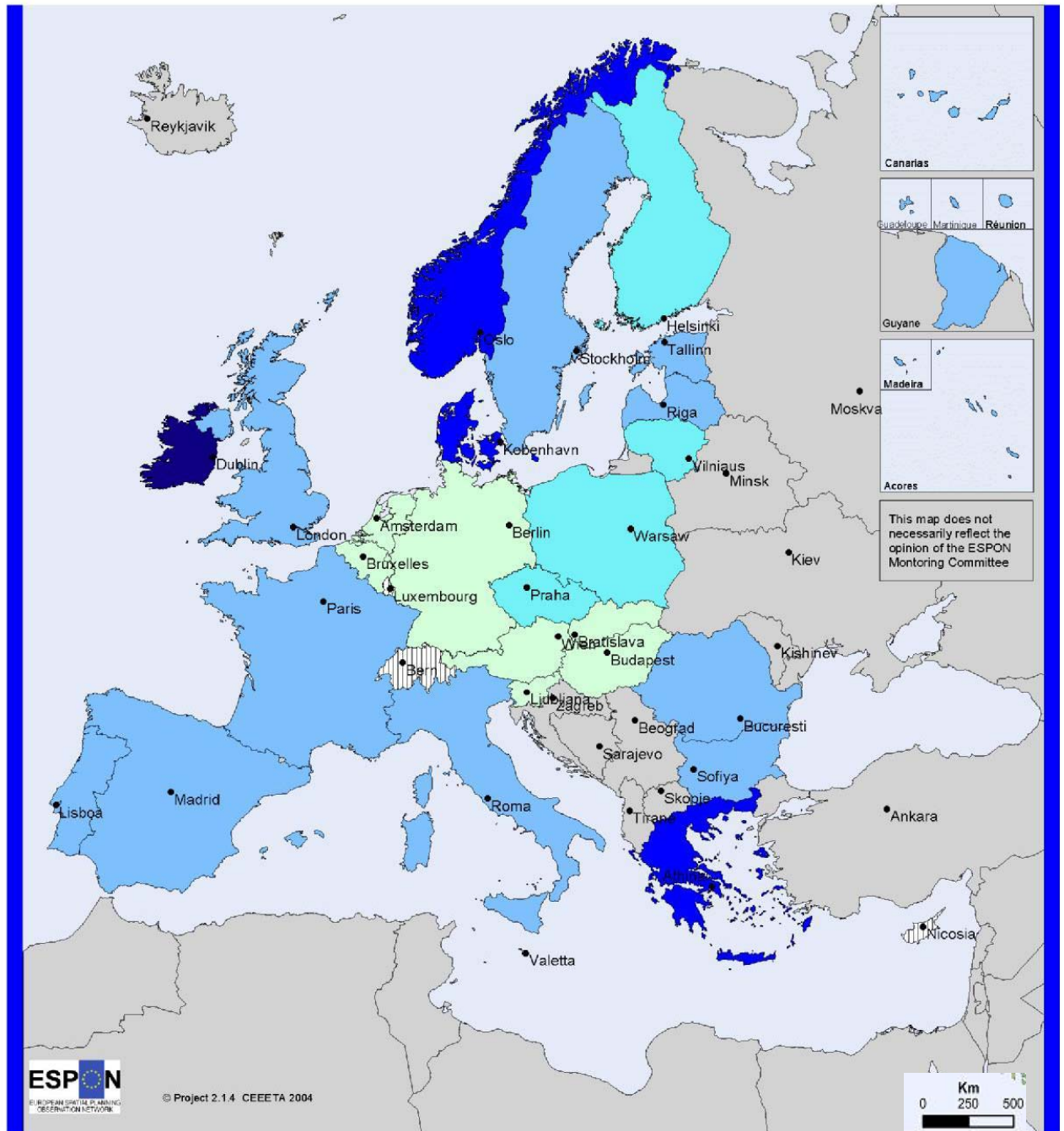
Source: EWEA

But the most important information can be obtained by the indicator considered in the next Map: the weight of wind potential in final electricity consumption at NUTS 0 level.

It is remarkable that wind energy can provide a non negligible contribution for energy production and in some cases the potential goes close to the total amount of electricity consumed (Norway and Greece) or is able to provide half or more of the total electricity consumption (the case of Ireland). In the majority of the cases the potential is up to 3/5 of total electricity needs.

It can be, thus, concluded that wind energy is an important reserve of European energy endogenous resources that could be used to promote less dependency and more environmental friendly energy structures. However the variability of the resource has to be considered because of the costs of extra reserve capacity. The proportion of wind in the electricity supply sources deserves a careful attention and additional R&D for optimizing the electric system in terms of total costs and emissions of GHG. This problem is also very relevant or the closed systems in the islands where important wind resources exist.

Map 17 Wind potential in final electricity consumption at NUTS 0 in 2002 (%)



Wind potential in final electricity consumption

- No Data
- 0 - 7
- 7 - 19
- 19 - 42
- 42 - 95
- 95 - 202

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Source: EWEA

#### 1.4.2.2 Potential for Biomass energy production

Biomass is also an important energy resource that is abundant in Europe.

Biomass, along with other renewable energy sources (solar and wind) can provide important supply potential to help reduce the overall dependency from oil as the major source of electricity supply.

Although there are very important variations among countries, forests can be a very valuable source of energy, providing not only energy but also income and employment sources in less developed areas, based on the forest resources.

But energy obtained from forests is also decentralized power supply sources that can provide for an improvement in the security of supply.

For the calculations we use data from a recent study<sup>4</sup> about biomass available energy potential from different sources: agriculture, forestry, industry, waste, parks and gardens, for 24 countries in Europe (exceptions are Switzerland, Norway, Cyprus, Malta and Luxembourg).

Relating this potential with population as can be seen in the next map, almost half of the countries have low biomass potential per capita (less than 9,5 PJ/year per million persons, like Italy, Poland, United Kingdom and Belgium).

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<sup>4</sup> Biomass availability in Europe, 2003, DGET.

**Map 18 Biomass - available energy potential per capita at NUTS 0 in 2000 (PJ/year by million persons)**



**Biomass potential 2000 (PJ/year/million persons)**

- 4 - 9.55
- 9.55 - 15.46
- 15.46 - 25.17
- 25.17 - 37.27
- 37.27 - 70.99
- No Data

© EuroGeographics Association for the administrative boundaries  
 Source: European Commission  
 "Biomass availability in Europe"  
 2003

The overall picture of biomass potential is quite changed if we take not the total potential but the potential per square Km. In fact, Central Europe become much well endowed in this relative measure, than it was in the absolute measurement provided by the first map.

Like in the analysis of wind potential we relate biomass potential to final electricity consumption<sup>5</sup>. The following map shows that there is a dual scenario, with a great part of the countries with low weight of biomass potential in final electricity consumption and a few countries with considering contribution estimated (more than 70% of total electricity consumption).

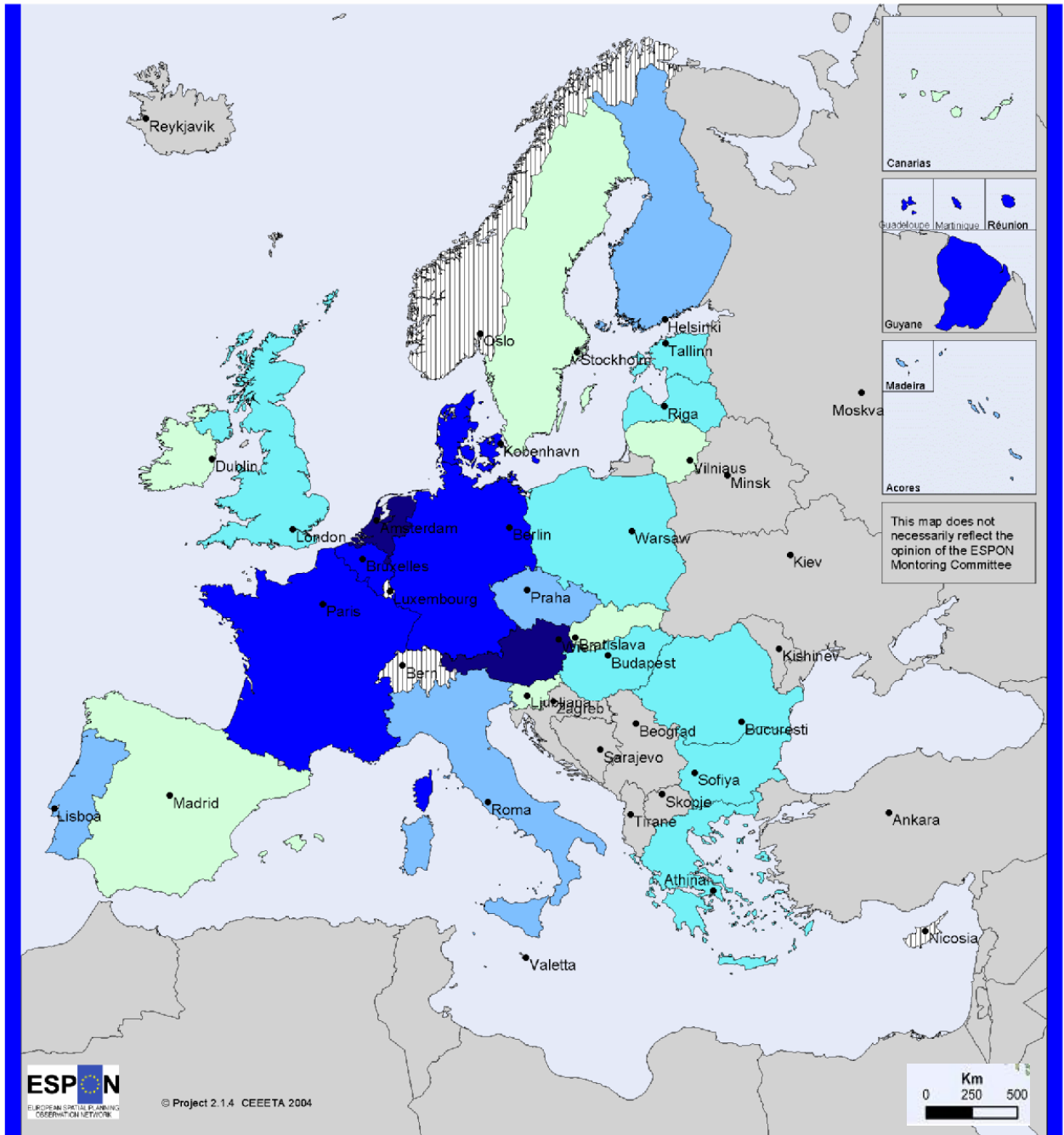
At least in those countries the proportion of biomass in the electricity supply sources deserves a careful attention and additional R&D for optimizing the electric system in terms of total costs and emissions of GHG.

---

<sup>5</sup> In this estimative we considered that a third of biomass available potential can be transformed in electricity.



Map 19 Biomass available energy potential at NUTS 0 in 2000 (GJ/km<sup>2</sup>)

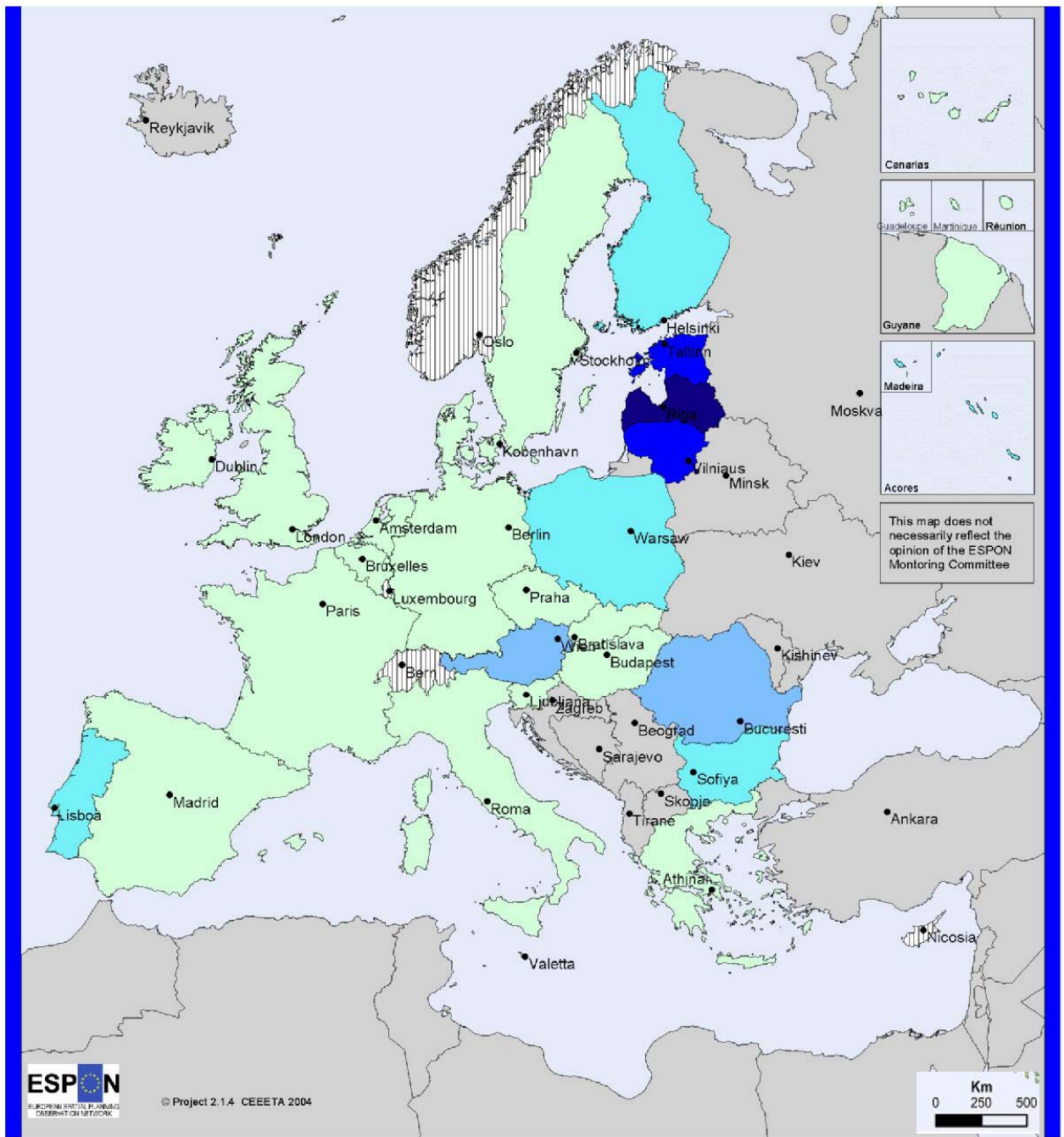


**Biomass potential 2000 (GJ/Km<sup>2</sup>)**

- 0.6 - 0.85
- 0.85 - 1.14
- 1.14 - 1.6
- 1.6 - 2.79
- 2.79 - 3.57
- No Data

© EuroGeographics Association for the administrative boundaries  
 Source: European Commission  
 "Biomass availability in Europe"  
 2003

**Map 20 Biomass Potential in Final Electricity Consumption at NUTS 0 in 2002 (%)**



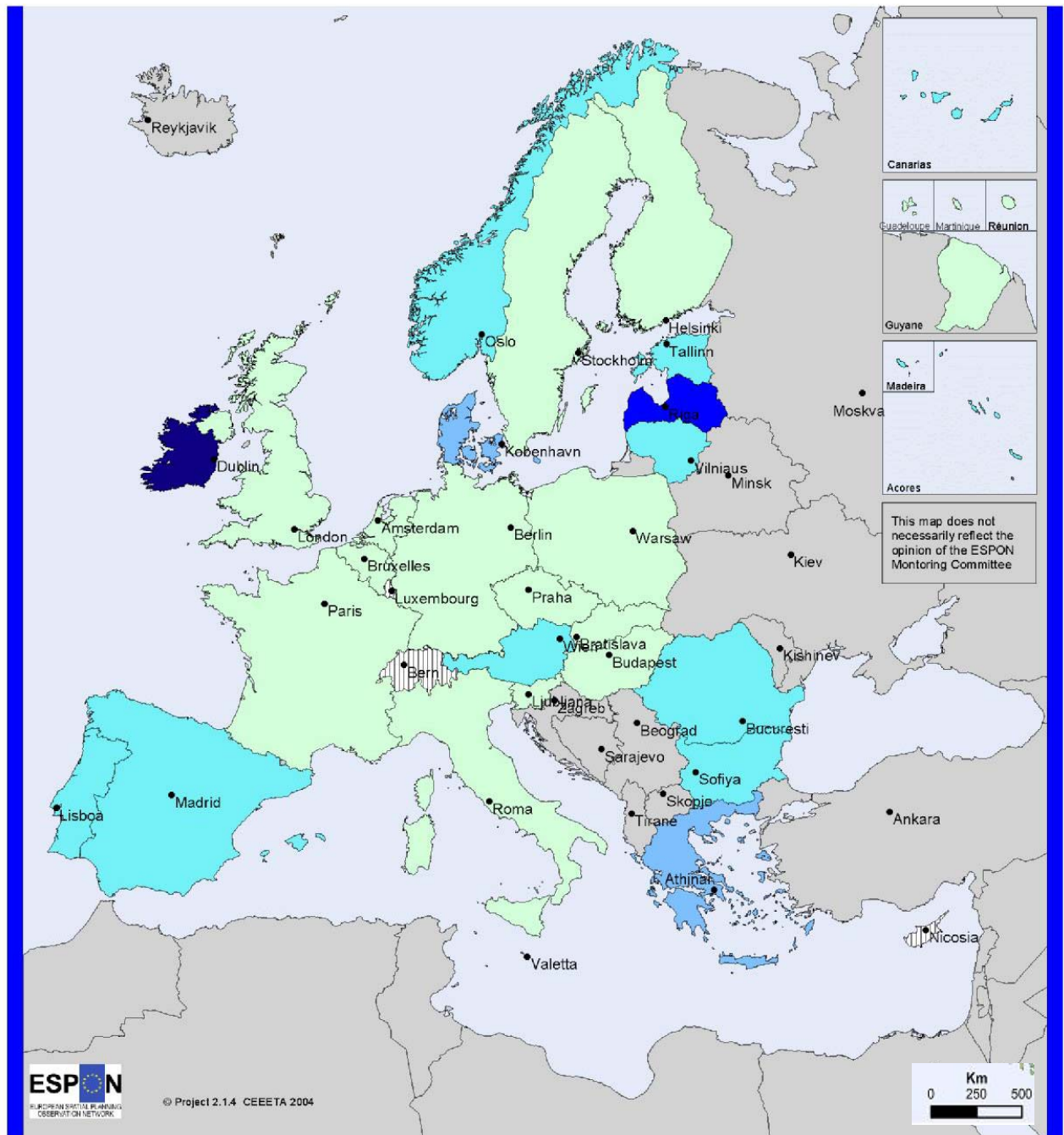
**Biomass Potential / Final electricity consumption in 2002 (%)**

- 7 - 28
- 28 - 49
- 49 - 70
- 70 - 91
- 91 - 113
- No Data

© EuroGeographics Association for the administrative boundaries  
 Source: DGET, EUROSTAT.  
 "Biomass availability in Europe" 2003

Considering the biomass potential together with wind potential and related both with final electricity consumption, we can see in the next map some exceptions of countries with a considering potential, like Ireland and Latvia.

**Map 21 Wind & Biomass potential in final electricity consumption at NUTS 0 in 2002 (%)**



Wind & Biomass Potential / Final electricity consumption in 2002 (%)

- 15 - 56
- 56 - 97
- 97 - 138
- 138 - 179
- 179 - 219
- No Data

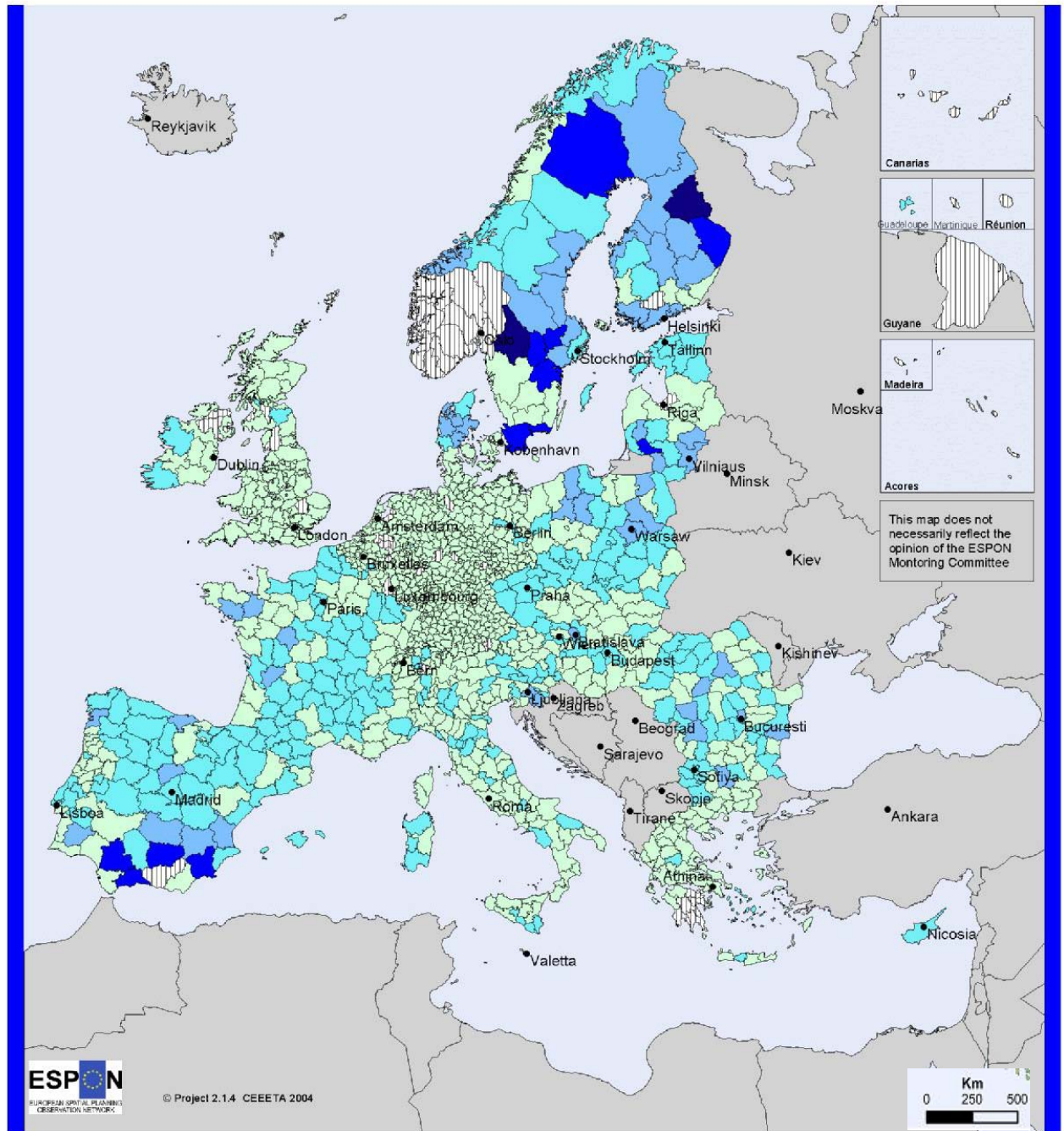
© EuroGeographics Association for the administrative boundaries

Source: DGET, EUROSTAT.  
 "Biomass availability in Europe" 2003,  
 EWEA

At NUTS 3 level we used data from ESPON database (Corine landcover) transforming the potential of forest area into energy (GJ). We can easily see that the picture is very different across regions, thus providing an opportunity for local development policies based on the exploitation of biomass.



Map 22 Biomass potential at NUTS 3 in 2002 (GJ)



Biomass potential 2002 (GJ)



© EuroGeographics Association for the administrative boundaries

Source: EEA - Corine Landcover

## 1.5 Energy networks and infrastructures

Besides demand and supply of energy and the price system, energy networks are another trait of energy structures that require detailed attention when trying to outline the situation in Europe.

For the high voltage electricity networks, natural gas supply infrastructures and power plants it was possible to have a regional representation for all the countries studied.

Additional maps can be seen in Annex 8. Some remarks have to be made concerning the map designing:

- For mapping high voltage electricity networks and hydro and thermal power plants location we used the UCTE<sup>6</sup> map of 2003. It should be underlined that for Northern parts of Finland, Sweden and Norway the 2000 Nordregio map was used. For Malta we use the 2004 map of Enemalta Corporation and for Cyprus we considered as the main source the 2004 map of Electricity Authority of Cyprus.
- For mapping the location of nuclear power plants we considered the 2003 data of Nuke database system<sup>7</sup> used by 1.3.1 ESPON project.
- For mapping European natural gas network we used the GTE<sup>8</sup> map for 2004.
- For mapping the refineries and oil pipelines we used 2002 map of Europa/Concawe covering the EU29 countries of our study.

---

<sup>6</sup> (UCTE) Union for the Co-ordination of Transmission of Electricity is an association of transmission system operators in continental Europe.

<sup>7</sup> NUKE database system covers nuclear power plants all over the world and was created by Nuclear Training Centre in Ljubljana (Slovenia).

<sup>8</sup> (GTE) Gas Transmission Europe is an association representing the gas transmission companies in Europe.

### 1.5.1 Electricity Network

Six synchronous grids coexist in Europe. The most important is the UCTE grid (Union for the Coordination of Transmission of Electricity), which is divided in two areas, one for most EU and the other one for Romania, Bulgaria, the Balkans and Greece. Several AC connections are currently under construction to interconnect UCTE 1 and UCTE 2 grids. United Kingdom has a synchronous grid of its own, excluding Northern Ireland which is connected to the autonomous Irish grid. Norway, Sweden, Finland and the eastern part of Denmark form the Nordel grid. Baltic countries are connected to the Russian grid.

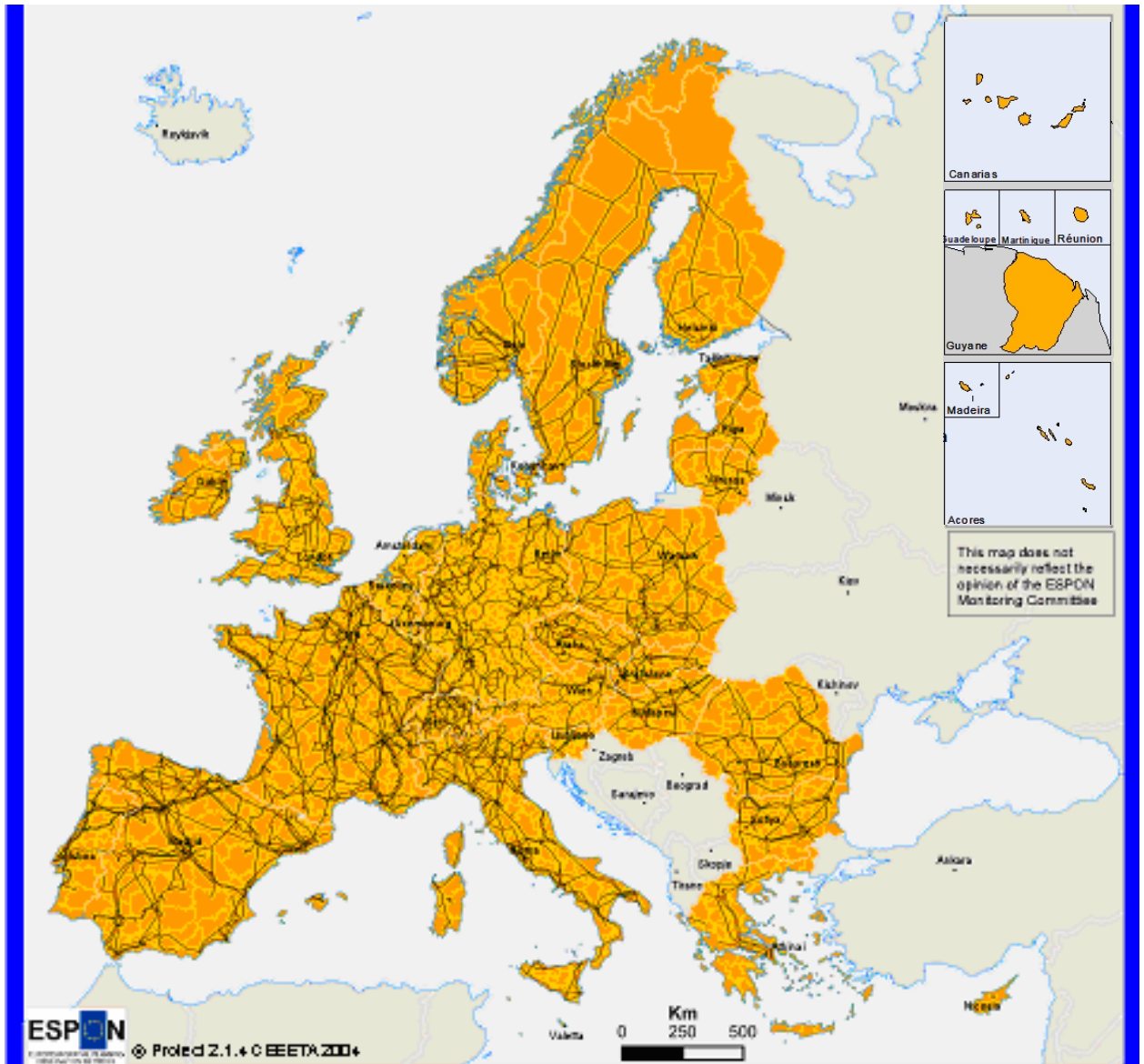
Due to the liberalisation of electricity markets, interconnections between the different areas and within a specific zone have taken crucial importance. Formerly, zones were nearly self balanced and ensured high system security but due to the heavy increase of cross border electricity flows, systems are operated more often very close to their limits.

It's technically difficult and economically not interesting to bury AC Very High Voltage lines. Hence for sea-cross interconnections it's mandatory to switch to DC lines. This mainly explains the existence of several synchronous grids in Europe. In liberalized electricity markets, some of these connections have taken high importance. Among them we can mention the DC connection between France and England, allowing the continental countries to sell electricity in the UK, the connections between Denmark, Germany and Poland with the Nordel, allowing trading with the Norpool and the connection between Greece and Italy, reinforcing the security of the Italian power system. A DC connection between Finland and Estonia is currently under construction.

It can also be mentioned that some of the former members of the Warsaw pact, namely Poland, Hungary, Romania and Bulgaria are connected to the Ukrainian nuclear power plants by Very High Voltage (750kV) lines.



**Map 23 High Voltage Transmission Networks**



— | **High Transmission Line**

© EuroGeographics Association for the administrative boundaries  
 Origin of the data: EU24 - UCTE Map, 2003  
 Finland, Sweden, Norway – Nordregio 2000

**Source: UCTE, Nordregio**

The European grids are mostly mature and most regions of Europe are connected to Very High Voltage. They will be reinforced within the next years (especially in Italy, Greece and the Iberian Peninsula) and interconnections will be multiplied in order to facilitate electricity exchanges

and hence reinforce the security of supply. However construction of new Very High Voltage lines, which are too expensive to hurry, is often very problematic due to public protest, as is faced now in south Italy.

### 1.5.2 Natural Gas Supply

Europe has diversified its gas supply in order to increase security. Consequently gas comes from different sources.

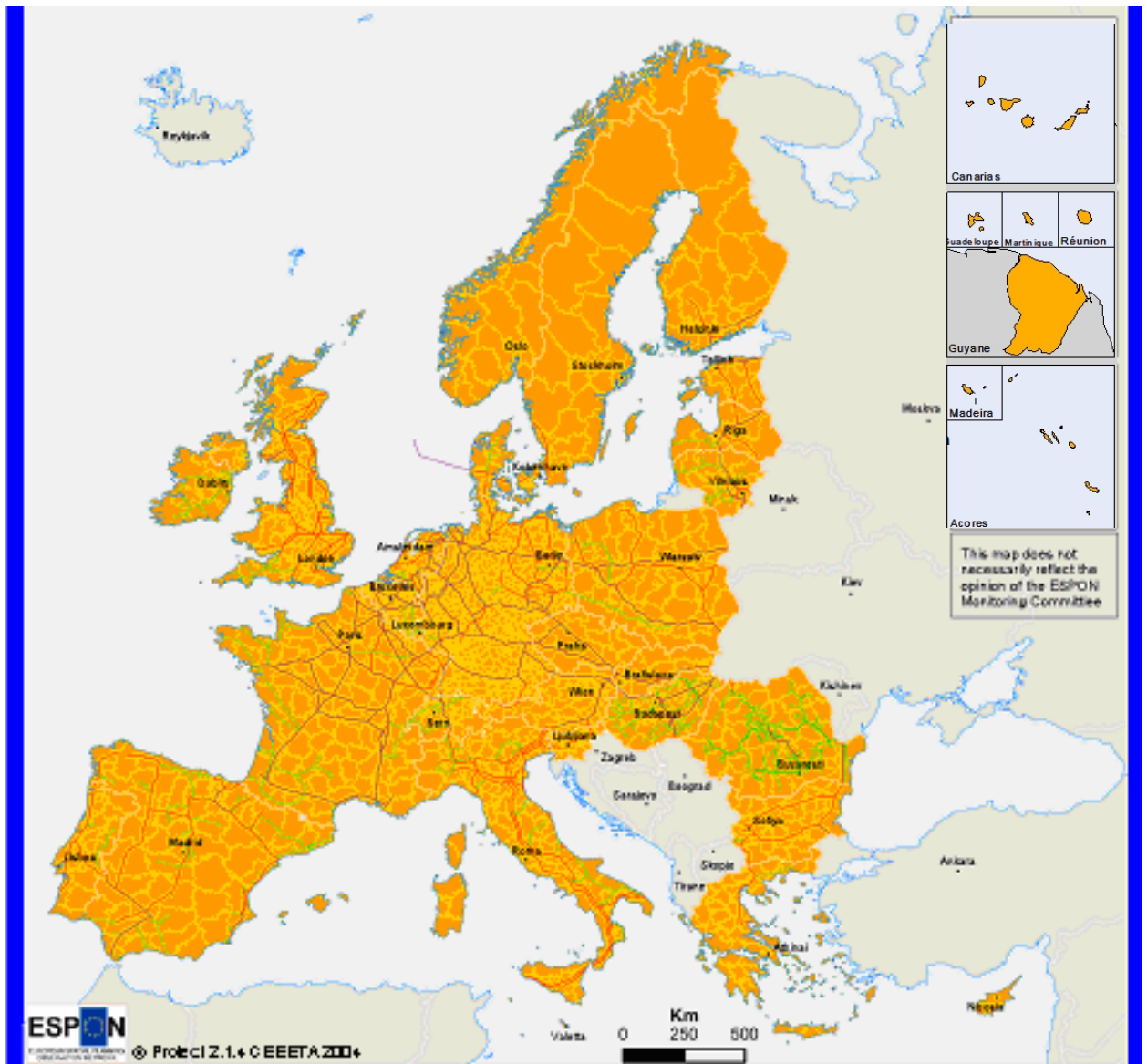
It is a local resource in the Netherlands and in the North Sea between Norway and Scotland. It is transported by gas pipeline mostly to Benelux countries, Germany and the UK. It's also a national resource in Poland, Hungary and Romania where the gas is more self-consumed than exported to the rest of Europe.

The main foreign supplier of gas for EU is Russia. Gas comes by pipelines. Due to the geography, the main routes are across Poland and between the Carpathian and the Tatra mountains in Slovakia and Hungary. This situation made the gas hubs of Baumgarten (Austria) and Poland of major importance in Europe (only 20% of the gas going through Austria is for national consumption). Large gas transport pipelines do not cross mountainous regions like the Alps and the Tatra.

The two major gas resources for Europe, the North Sea and Russia, interconnect in Germany and the Netherlands. In this zone, pipelines are of major size. This is also the zone where major interconnections are made. The gas transport pipelines are then going thinner when they reach the furthest regions of Europe.

One pipeline is going from Turkey through Bulgaria to Greece and Romania. It is connected to the gas resources of the Caspian Sea. While Romania has a good gas transport network using mostly national resources and Russian gas, Greece has quite a poor connection to gas. This could change when the large gas reserves of the Middle East will be more widely exploited, making the route through Turkey of major importance. The pipelines between Morocco and Spain and between Tunisia and Italy secure the gas supply from Algeria, though connection through the Pyrenees has to be reinforced.

Map 24 Gas transport by pipeline



- Gas pipeline under 24"
- Gas pipeline 24" to 36"
- Gas pipeline 36" and over

© EuroGeographics Association for the administrative boundaries  
 Origin of the data: The European Natural Gas Network Map, 2004

**Source: Gas Transmission Europe**

Another way of reinforcing connection to Algerian and other suppliers of gas resources is by developing LNG (Liquid Natural Gas) terminals. Portugal and Spain are not gas producers but have clearly decided to switch large part of its electricity production to gas. Apart from the pipeline going through the strait of Gibraltar, Spain already has 4 LNG terminals and plans to construct 2 more. Portugal also recently opened one LNG terminal at the deep water port of Sines. Those terminals are important as the Iberian Peninsula miss

gas storage capacities to modulate gas supply. Portugal is also investing in underground storage for natural gas using caverns excavated in salt.

Most gas storage capacities can be found in France, Northern Germany and in Central Europe.

### 1.5.3 Power Plants

#### General observations

The maps represent only large power stations and don't take into account small-scale distributed generation. Nor do they represent renewable energies apart from large hydro. The hypothesis of dominance among countries of large centralized power generation system is valid in almost all the countries studied. However it should be moderated in countries like the Netherlands, where distributed energy (mostly by cogeneration) represents more than a third of the electricity market and in countries like Denmark which produce 20% of its electricity from wind energy.

Independent to the technology employed, it can already be pointed out that power stations are in most cases near to high population density areas, especially country's capitals. In the cases of thermal or nuclear power plants, water in large quantity is needed for cooling the reactors. Hence, most power stations are also near to big rivers or by the sea.

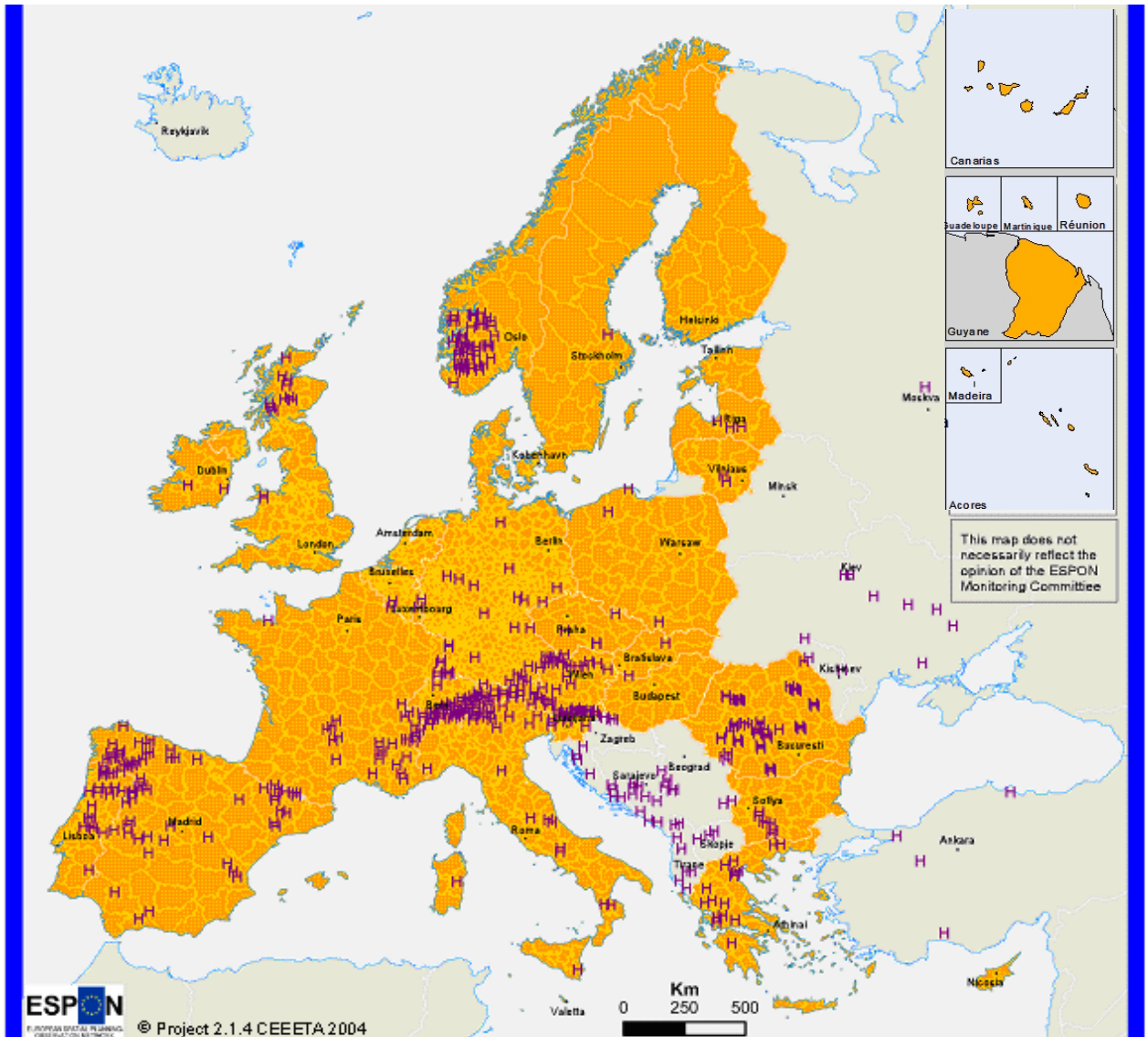
#### Hydro-electric Power Stations

There are two different ways of exploiting hydro potential for electricity production: by creating a retention pool in altitude and using the difference of potential energy of water hence created, or by using the flow debit of water along a river. Consequently large hydroelectric power plants are concentrated around mountainous areas and large rivers.

They are especially concentrated in regions around the Alps, where countries like Austria and Switzerland produce most of their electricity from hydro (70% for Austria, 60% for Switzerland). Regions with lower relief but high precipitation levels, like northern western Iberian Peninsula, Scotland and Norway also produce centralized hydro energy. Norway even produces 99% of its electricity needs from hydro. The potential in the Carpathian Mountains in Romania is largely exploited while there could possibly be more power stations in the Tatra Mountains between Slovakia and Poland. On the other hand, flat regions in the Netherlands, Belgium and Poland for example have

nearly no potential for large hydro. Large rivers like especially the Rhone, the Danube and to a smaller extent the Rhine are largely used for electricity generation.

**Map 25 Hydro-electric Power Stations**



**H** | **Hydro-electric Power Station**

© EuroGeographics Association for the administrative boundaries

Origin of the data: EU24 - UCTE map, 2003; Finland, Sweden, Norway - Nordregio, 2000

Source: UCTE, Nordregio

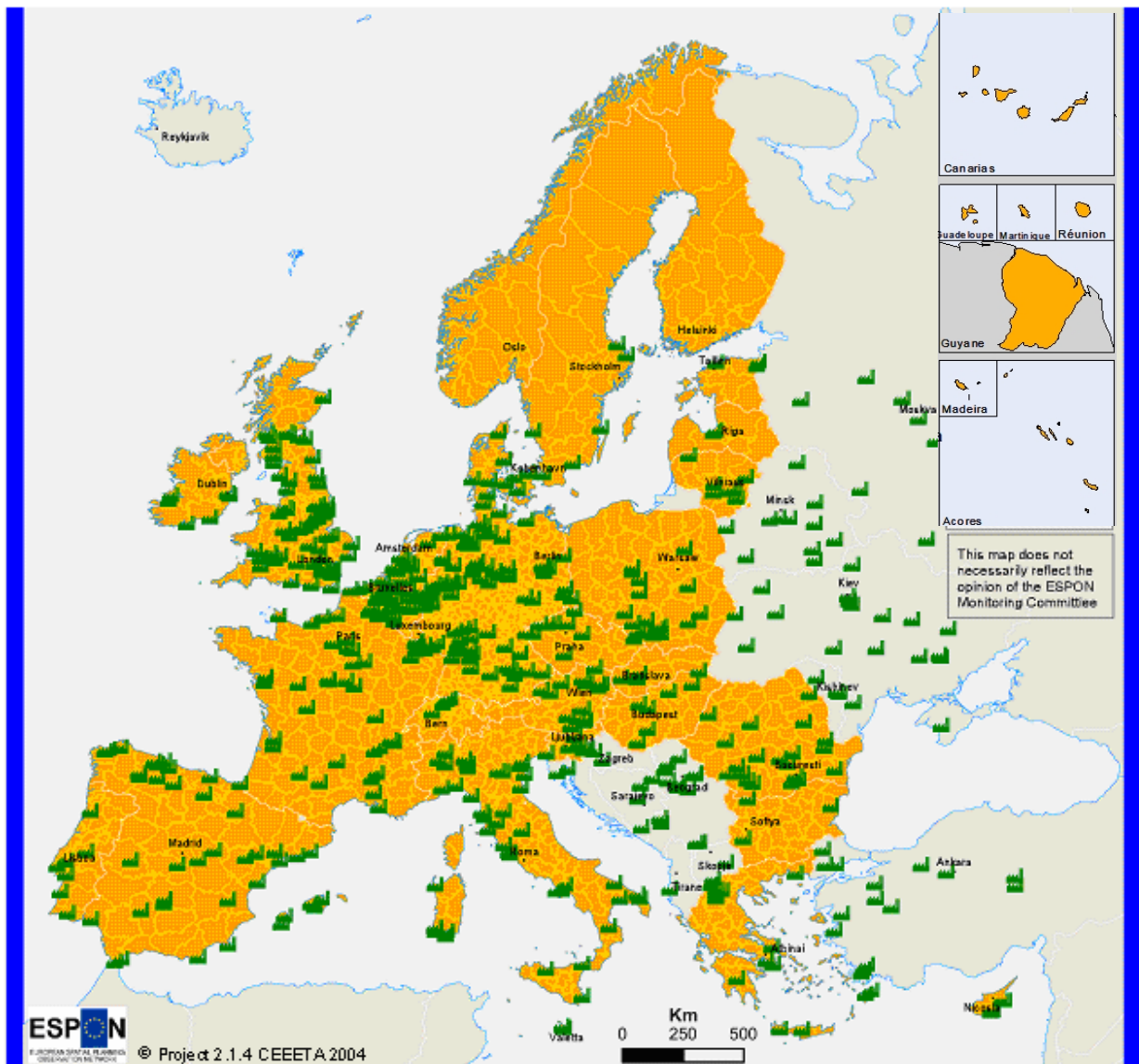
The maximum potential for large hydro-electric power stations is nearly reached, especially in western European countries, but there still exists a good potential for smaller hydro power plants along the rivers, which is much better distributed around Europe. Those small power stations are not represented on the map.



## Thermal Power Stations

The repartition of thermal power stations is quite homogeneous around Europe, though they are still near to high population density areas. Norway, which produces all of its electricity from hydro, is a notable exception with no thermal power plants installed.

**Map 26 Thermal Power Stations**



**Thermal Power Station**

© EuroGeographics Association for the administrative boundaries  
 Origin of the data: EU29 except Finland, Sweden, Norway, Malta and Cyprus - UCTE map, 2003;  
 Finland, Sweden, Norway - Nordregio 2000; Malta - Enemalta Corporation 2004; Cyprus -  
 Electricity Authority of Cyprus 2004  
 Source: UCTE, Nordregio, Enemalta, Electricity Authority of Cyprus

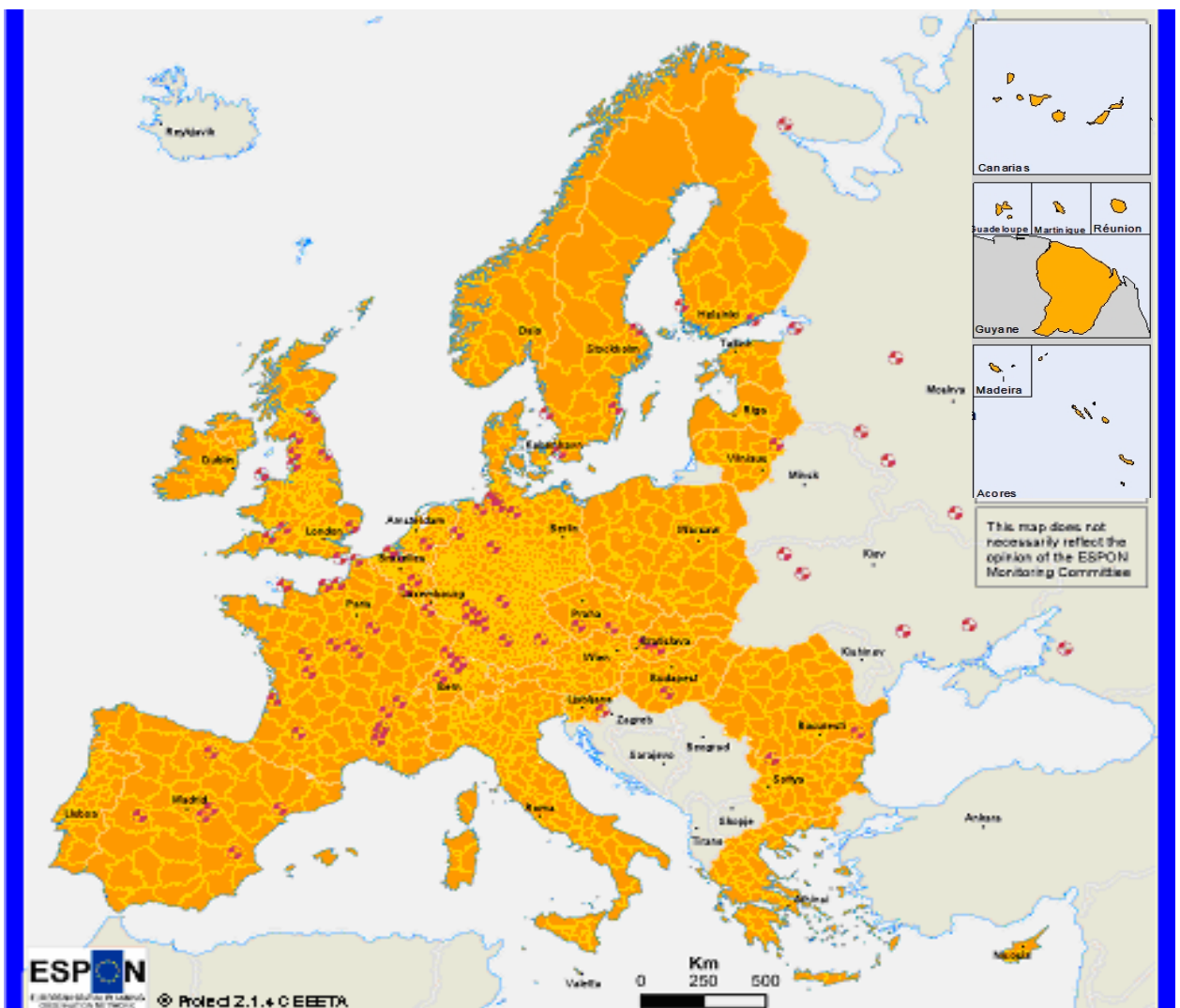
## Nuclear Power Stations

National policies regarding nuclear power generation are different among European countries, thus leading to disequilibrium in power capacity

distribution around Europe. While France produces 80% of its electricity from nuclear energy, Italy decided by referendum in 1987 to phase out its reactors.

Nuclear Power Capacities are mostly installed in western countries and especially in France (especially along the Loire, the Rhone and by the Northern Coast). In Eastern countries, nuclear power stations are installed near to the country's capitals. Though Poland is the more populated of EU new countries, Poland doesn't have nuclear power plants.

**Map 27 Nuclear Power Stations**



 **Nuclear Power Station**

© EuroGeographics Association for the administrative boundaries

Origin of the data: Nuke database system, 2003

Source: Nuke database

#### 1.5.4 Refineries

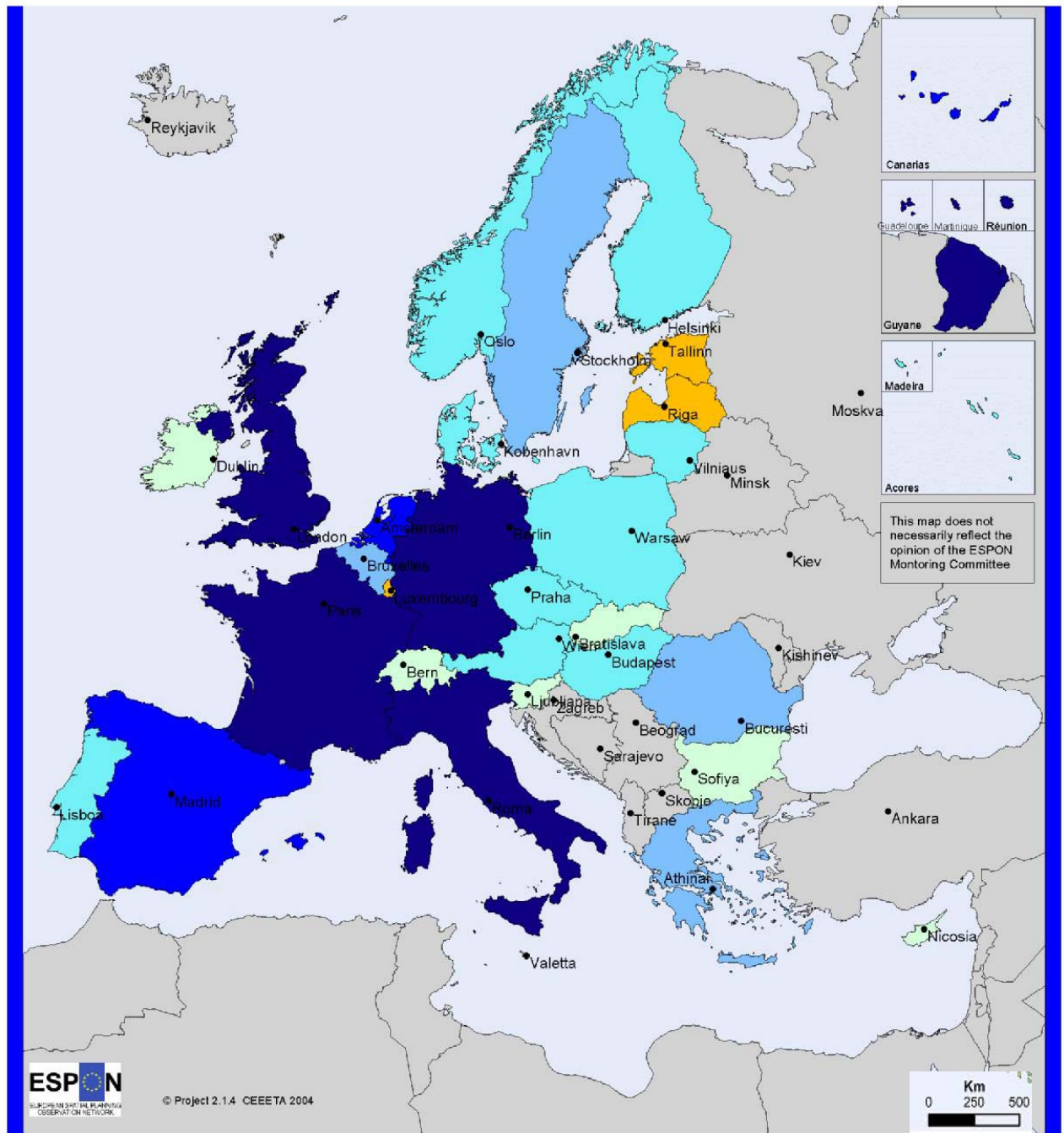
Approximately 54% of crude oil refining capacity in the EU29 was located in Germany, France, Italy and United Kingdom in 2003.

To assess the importance of refinery in fossil fuels primary consumption we use the proportion of crude oil refined in fossil fuels primary consumption (see analysis of indicator B11). For the analysis we used the total output of refined petroleum products in million tonnes to compare with fossil fuels primary consumption.

The Map 30 shows that Germany, France, Italy and United Kingdom represented 52% of total output of refined petroleum products in EU29 countries in 2001.



Map 28 Crude Oil Refining Capacity in 2003



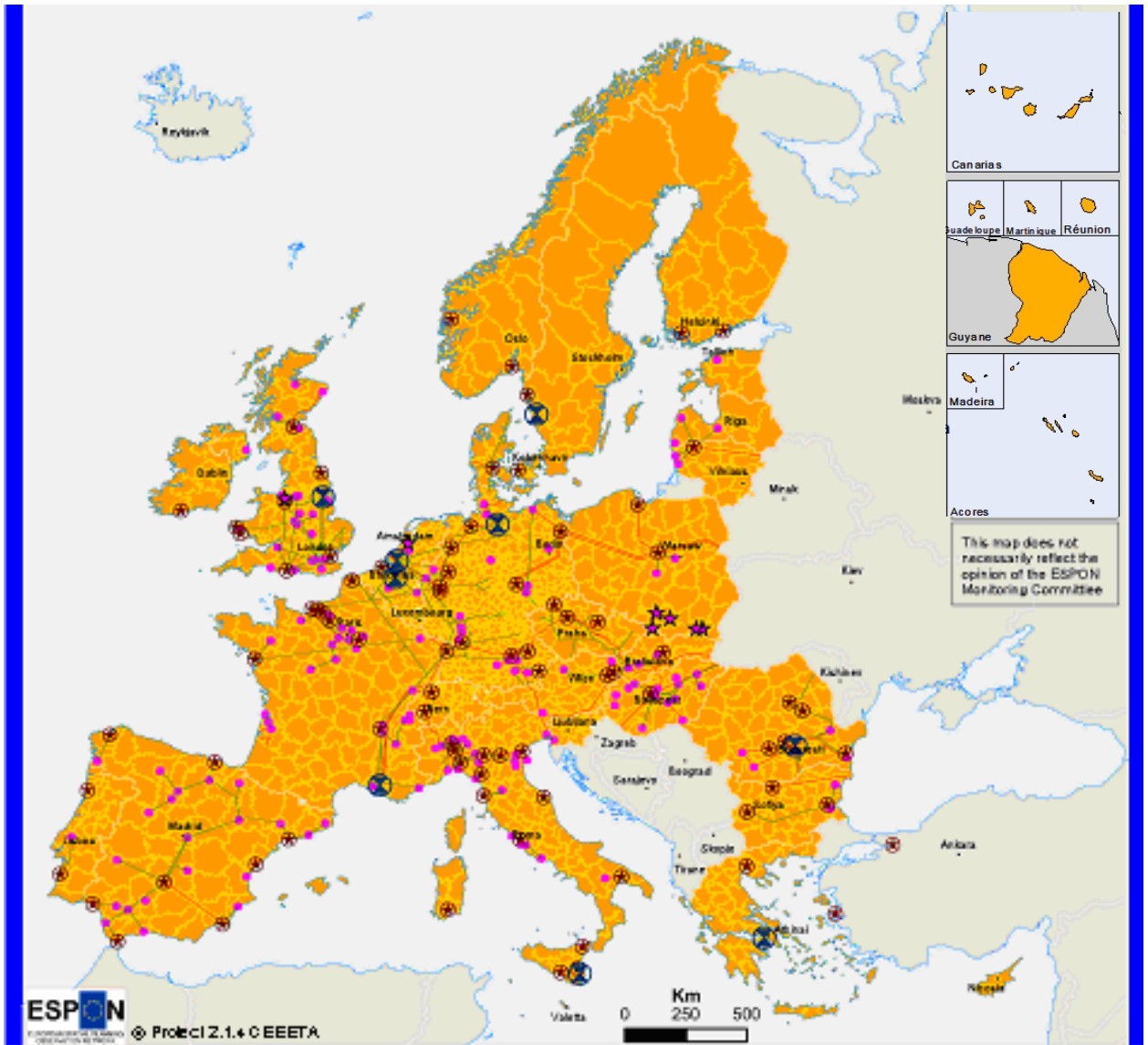
Crud oil refining capacity 2003 (thousand barrels/day)

- 0
- 1 - 180
- 180 - 435
- 435 - 1066.11
- 1066.11 - 1851.43
- 1851.43 - 3332

© EuroGeographics Association for the administrative boundaries

Source: EIA, International Energy Annual

Map 29 Refineries & Oil Pipelines (2002)



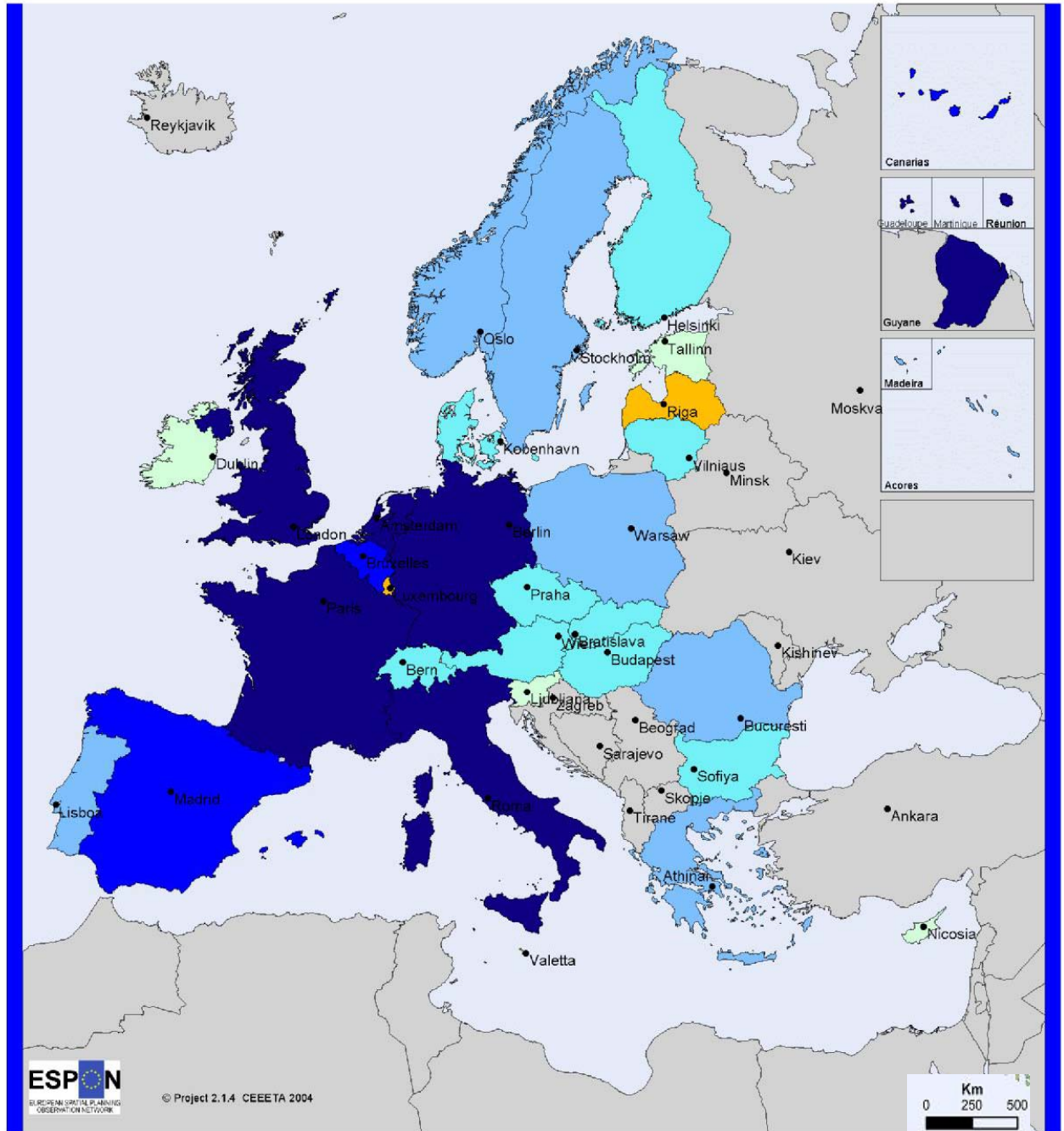
- Crude Oil
- Oil Products
- ★ Small Refinery
- ⊗ Refinery in Operation
- ⊗ Two or more Refineries in Operation
- Depots
- No data for outermost territories

© EuroGeographics Association for the administrative boundaries

Origin of the data: Refineries & Oil Pipelines in Europe 2002

Source: Europa/Concawe

Map 30 Total output of refined petroleum products in 2001



Total output of refined petroleum products in 2001 (thousands barrels/day)

- 0
- 1- 67
- 67 - 242
- 242 - 441
- 441 - 1197
- 1197 - 2422

© EuroGeographics Association for the administrative boundaries

Source: EIA

### 1.5.5 The spread of EU co-financed investment

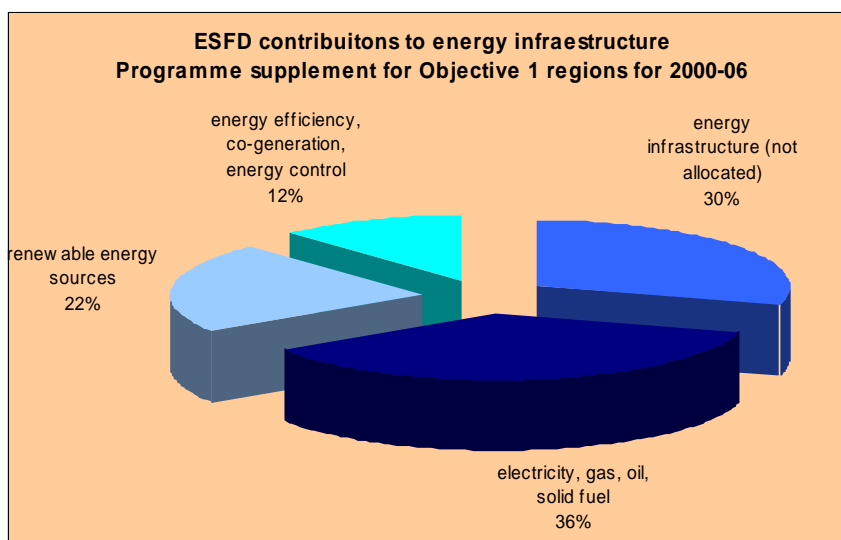
Accordingly to the preparatory study<sup>9</sup> for the second cohesion report a series of measures has been adopted by EU which includes:

- International co-operation
- Diversification of energy sources
- Energy saving
- Promotion of energy technology

European energy policy and financial support have a great bearing on social and economic cohesion, especially with regard to those aspects related to the creation of European networks and the saving and diversification of energy sources.

Based on the inventory of public aid granted to different energy source, the commitments already made, in March 2002, under measures in the field of **energy infrastructures**, included in the programme supplements for the Objective 1 regions for the period 2000-2006 are the following:

**Figure 43 EU contributions to energy infrastructure**



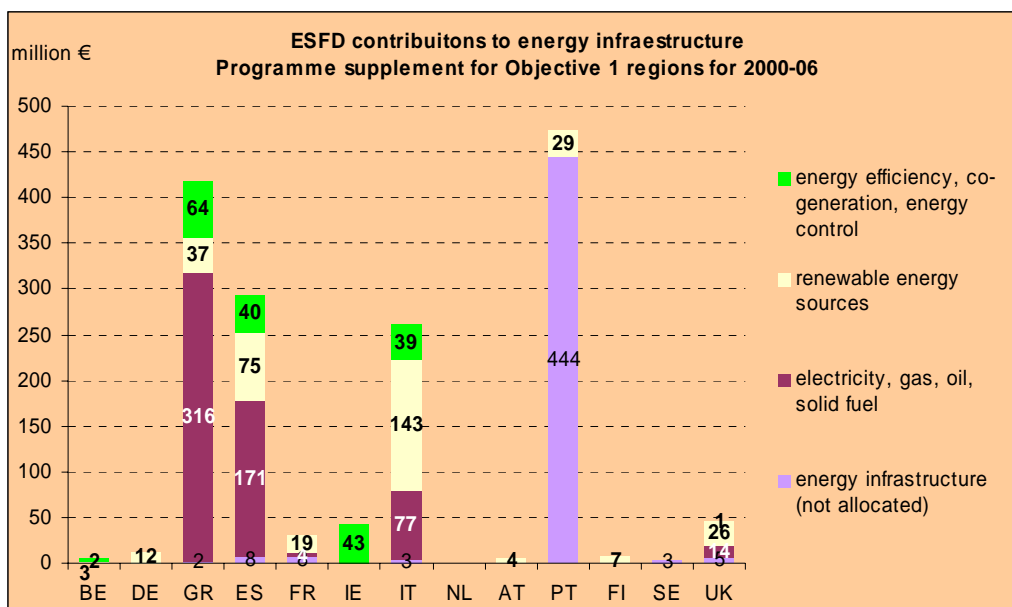
Source: Inventory of public aid granted to different energy source (2002), Commission Staff working paper

<sup>9</sup> Javier de Quinto, Yolanda Mezquita, Antonio Navarro, Santos Ruesga and Richard Watt, Second Rapport on Economic and Social Cohesion: The Role of Energy, Preparatory study for the second cohesion report, December 2000.

The ESFD (European Spatial Development Framework) contributions resources worth 1,599 million euros for energy infrastructure, mainly in European networks (gas and electricity) accounting for 36% of the total ESDF contributions to energy infrastructure.

Looking at country data, Greece, Spain and Portugal received most the contribution, accounting for 74% of the total allocated to energy to the period 2000-2006, although in each country the contributions are in different areas.

**Figure 44 EU contributions to energy infrastructures by country**



Source: Inventory of public aid granted to different energy source (2002), Commission Staff working paper

## 1.6 Quality of electricity supply

Electricity black outs remind us of the central importance of energy in our every day lives as well as the importance of a European energy policy.

In a recent study about quality of electricity supply in nine European countries the minutes of electricity supply disruption are measured through CML (customer minutes lost).

According to that study<sup>10</sup> the unplanned electricity interruptions for the period 1999-2001 observed the following trends:

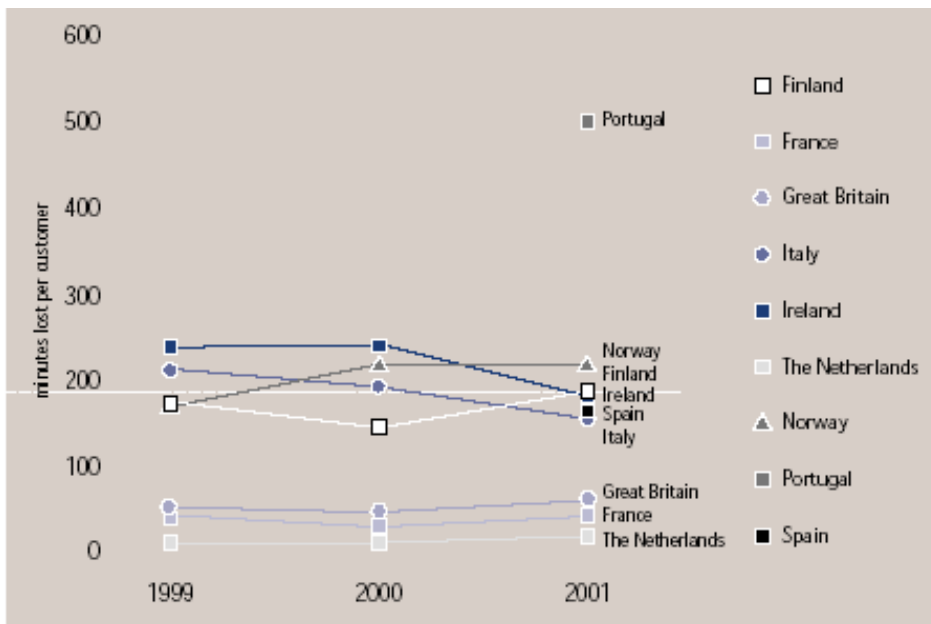
- Great Britain, France and the Netherlands, have an average annual CML consistently below 100 minutes lost per customer for each of the three years.
- Norway, Ireland, Italy and Finland have an average annual CML within a 161/256 minutes range for each of the three years. Spain also lies within this range for the year 2001, the only year for which it has available data.
- For the year 2001, Portugal report high national averages for minutes lost, of 531. Natural hazards like storms could explain this outlier behaviour, but in absence of data for other years the explanation can only be considered sufficient.

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<sup>10</sup> "Second Benchmarking report on quality of electricity supply", Council of European Energy Regulators, September 2003.



**Figure 45** Unplanned electricity interruptions minutes lost per customer per year (1999-2001)



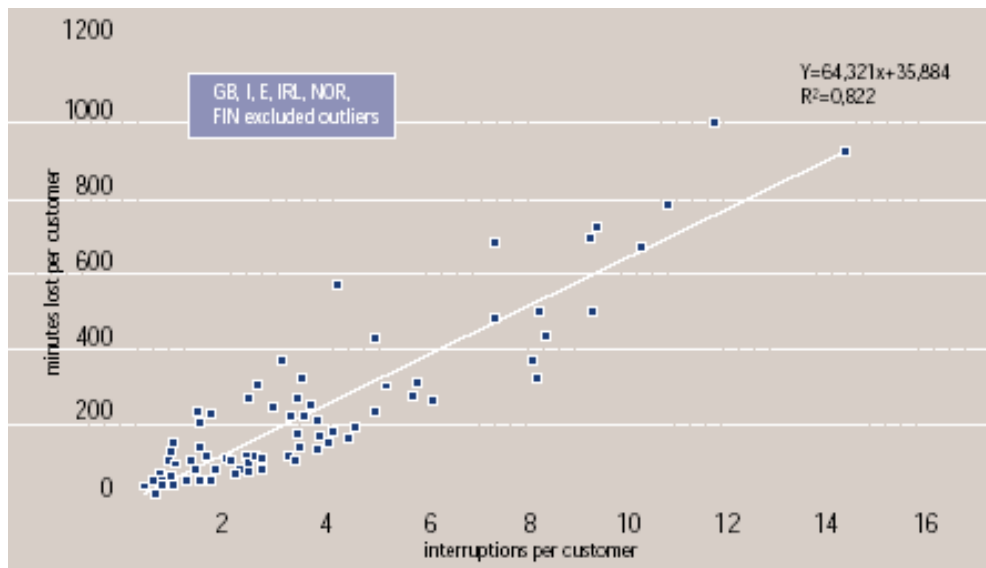
Source: "Second Benchmarking report on quality of electricity supply", Council of European Energy Regulators, September 2003.

In seven countries some data is available at a regional or district (province) level but the number of regions vary across countries (see Annex 8). The disaggregated data shows sharp differences among regions and among districts in all countries where it is available. In Italy and Spain the geographical classifications can help to explain differences which arise for geographical reasons.

Using regional data for 2001, it is possible to see a positive correlation between CMLs and number of interruptions<sup>11</sup>. The regression results show (with an  $R^2$  of 0.82) an intercept of 3.5 minutes (which is in keeping with the definition of long term interruptions) and a slope of 64.321 minutes.

<sup>11</sup> Customer Minutes Lost should equate to the multiple of the average duration of the interruption (minutes per interruption) times the number of interruptions per customer plus approximately 3 minutes per customer (for so-called long interruptions).

**Figure 46 Regression analysis of the duration and frequency of unplanned electricity interruption (2001)**



Source: "Second Benchmarking report on quality of electricity supply", Council of European Energy Regulators, September 2003.

Regarding planned electricity interruptions in 2001, five countries reported data for each of the three years, 1999-2001. Data for planned interruptions is not available for the Netherlands. Partial data is also available for a further three countries, Italy for the latter two years, and year 2001 data for Portugal and Spain. The following trends are observed:

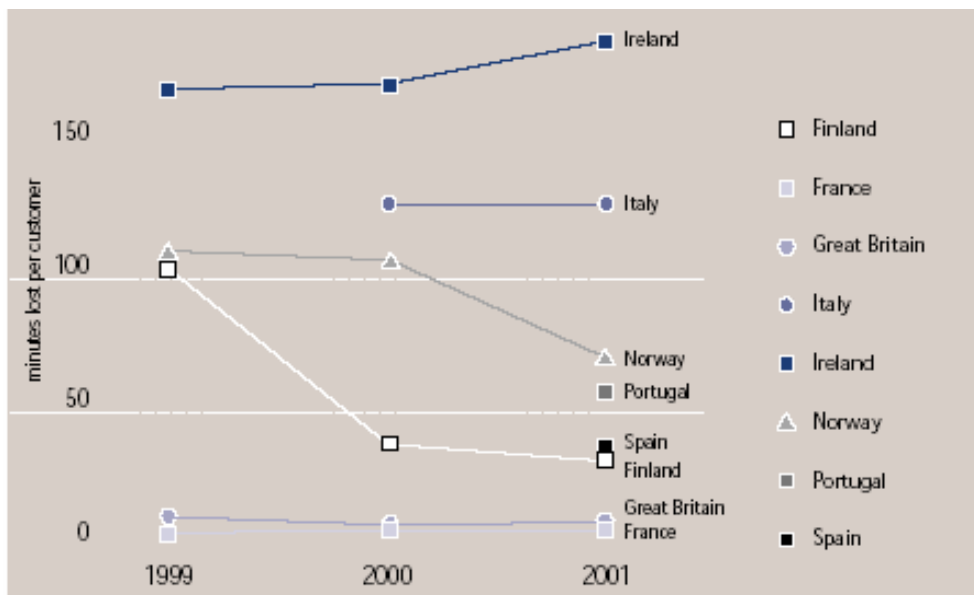
- France has an average CML of 6 minutes or less for each of the three years. Great Britain too has a relatively low and consistent level of annual average CML value (of between 8.12 and 10.95) for each of the three years.
- The data shows that Finland experienced a significant drop in the average number of customer minutes lost from a high of 103 minutes in 1999 to 38 in the year 2000. This levelled off to an average of 32 minutes in 2001, which is comparable to the average in Spain (in 2001) of 36.6 minutes lost.
- Norway also experienced a fall in planned interruptions, but with the fall occurring over the course of the latter two years (from 106 minutes lost in 2000 to 70 minutes lost in 2001). Portugal has a lower average CML of 57.37 minutes for 2001.
- Data for Italy is available for 2000 and 2001. Accordingly, Italy ranks relatively high both in terms of the average number of interruptions



(126.57 and 127.4 respectively) and the average customer minutes lost (0.83 and 0.79 respectively) for both of these years.

- In terms of the duration of outages, Ireland ranks highest for each of the three years, with average CML of 170 minutes in 1999 and 172 in year 2000 rising to 188 minutes lost on average per customer in 2001.

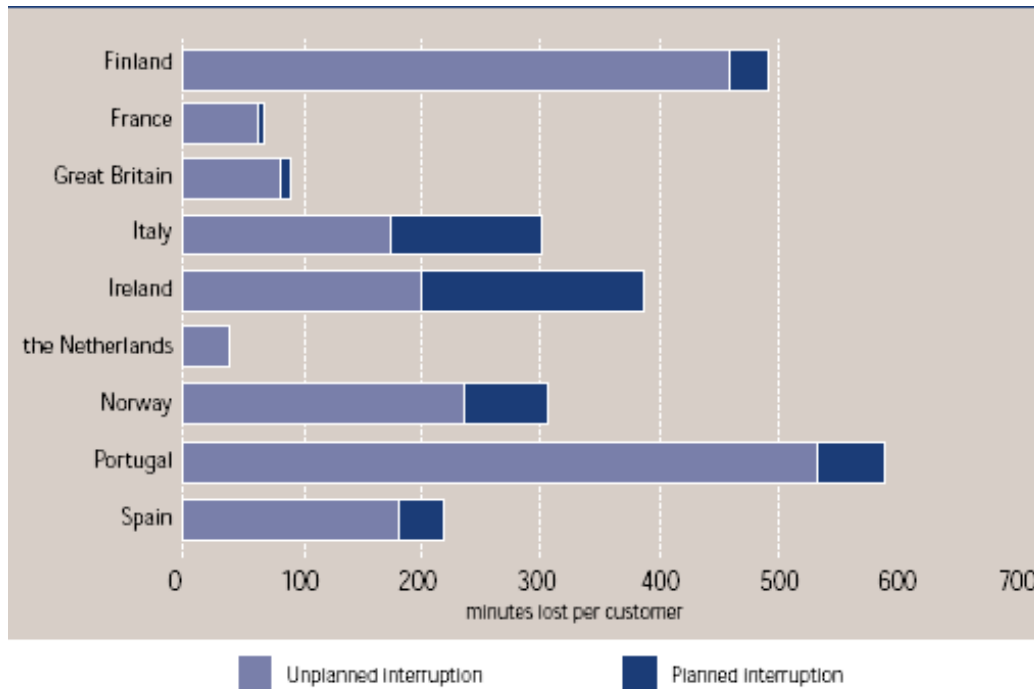
**Figure 47 Planned electricity interruptions minutes lost per customer (1999-2001)**



Source: "Second Benchmarking report on quality of electricity supply", Council of European Energy Regulators, September 2003.

For a global picture, the Figure below charts the total interruptions (planned and unplanned) in 2001 on the basis of Customer Minutes Lost for the nine countries.

**Figure 48** Unplanned and Planned electricity interruptions minutes lost per customer (2001)



Source: "Second Benchmarking report on quality of electricity supply", Council of European Energy Regulators, September 2003.

The following observations can be made:

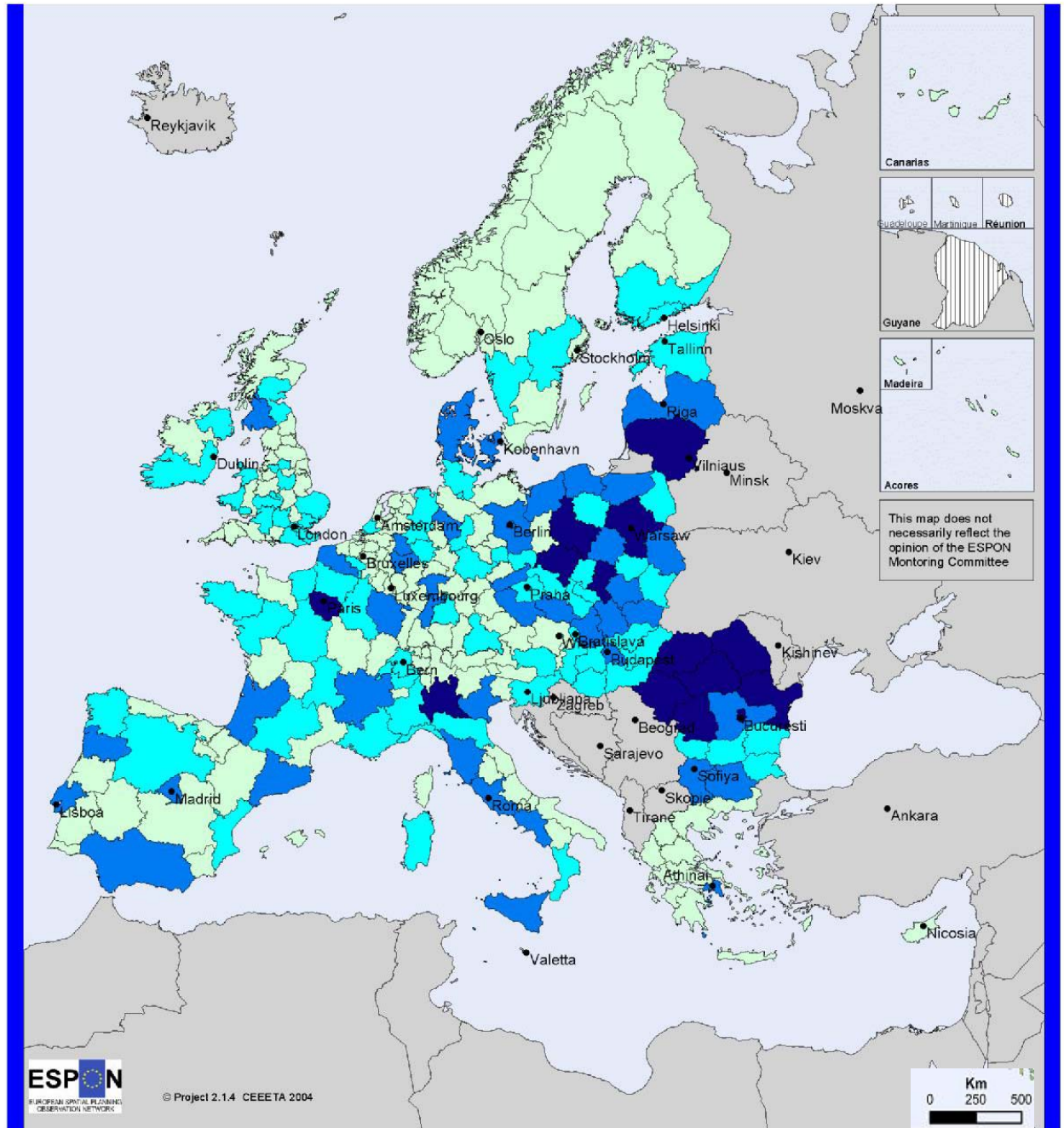
- All countries (except Ireland and Italy) show proportionately higher averages for unplanned than planned electricity interruptions.
- Significant differences are evident across countries.
- Countries can be grouped into three groups according to performance. The best performers, with the shortest average duration are Great Britain, France and the Netherlands. Second group is Portugal and Finland which show very high averages for unplanned interruptions in 2001. Finally, Spain, Norway, Ireland and Italy are on a par for the average duration of unplanned interruptions.
- For Ireland and Italy, the relatively high average duration for planned outages skews their averages for total duration of interruptions in 2001 upwards.

## 1.7 The relevance of employment in the energy sector

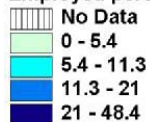
In 2001 around two million people were directly employed in the energy sector in the EU29 countries. About a quarter of the total employment in energy sector are in Germany (14%) and Poland (13%).

Once again the absolute size of the sector reflects the size of the countries. But if we take the weight of energy sector employment towards total industrial employment (see the map below) efficiency differences became evident.

Map 31 Employed persons in energy sector at NUTS 2 in 2001 (thousands)

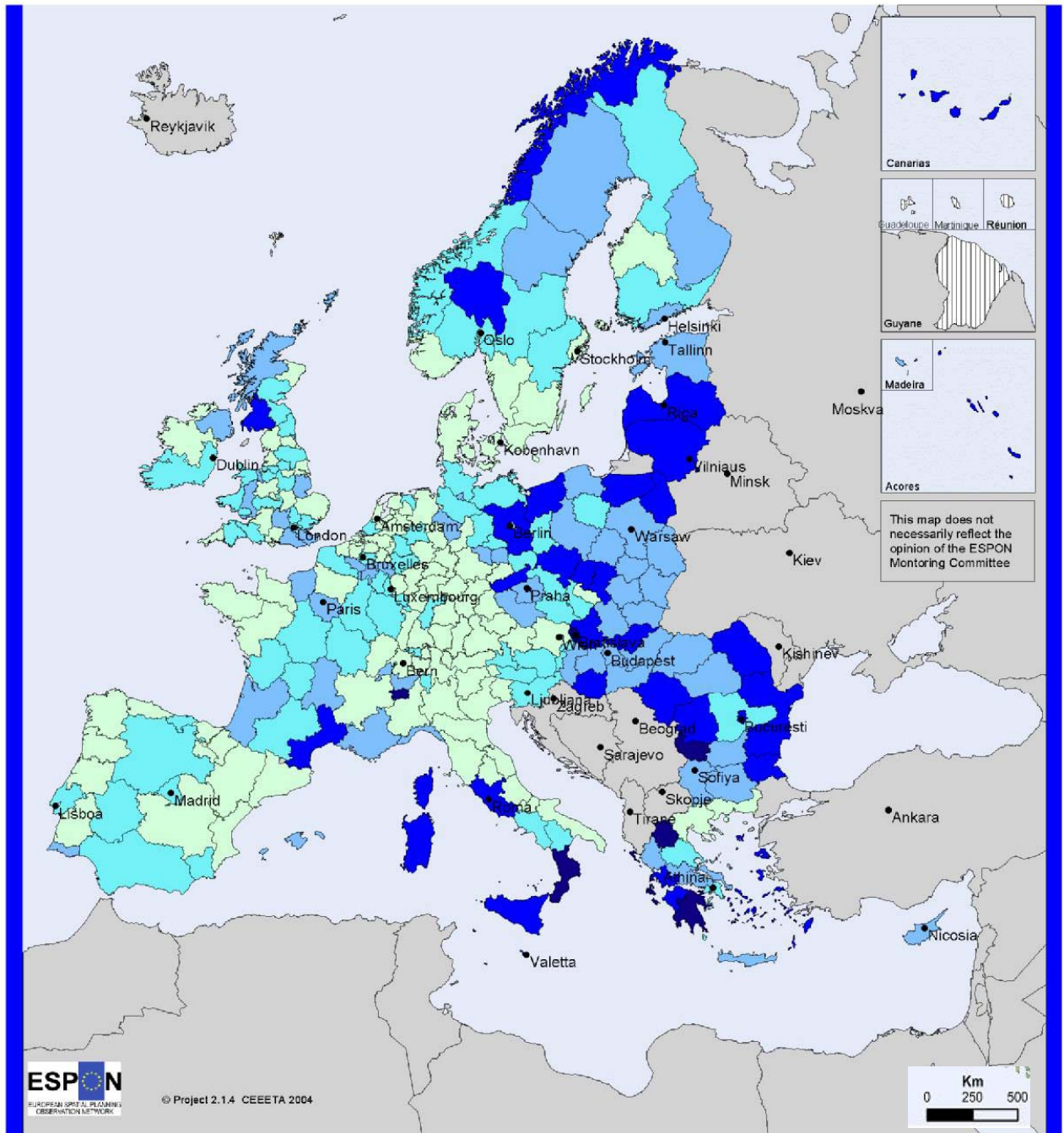


Employed persons in energy sector in 2001 (thousands)



© EuroGeographics Association for the administrative boundaries  
 Source: Eurostat, National Statistic  
 for Switzerland (2001)  
 and Malta (2000)

**Map 32 Share of employed persons in energy sector in total industrial employment at NUTS 2 in 2001 (%)**



Share of employed persons in energy sector in total industrial employment

Light green	No data
Light green	0 - 3
Light blue	3 - 5
Medium blue	5 - 8
Dark blue	8 - 12
Very dark blue	12 - 22

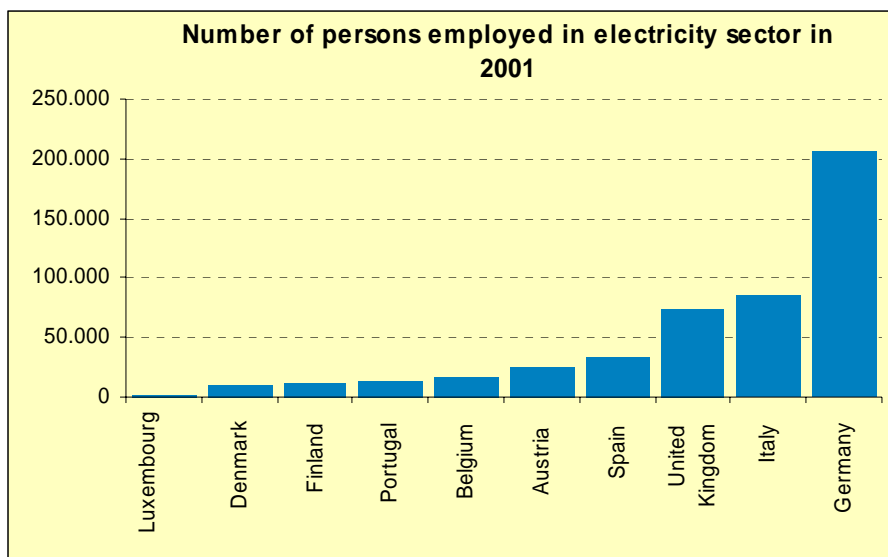
© EuroGeographics Association for the administrative boundaries  
 Source: Eurostat, National Statistic for Switzerland (2001) and Malta (2000)

In 2001 employment in energy sector represented in average five per cent of total industrial employment<sup>12</sup> with more significant importance in N10 countries (the greatest weights were in Lithuania and Latvia with 12% and 11% respectively).

At regional level NUTS 2 the differences are greater with a range of weight between regions from 1% to 22% of total industrial employment.

Regarding the electricity sector, information about employed persons by countries was more difficult to collect in some cases because of confidentiality and other cases data was not available at all, according to Eurostat source (data from structural business statistics).

**Figure 49** Number of persons employed in electricity sector in 2001.



Source: "Competition indicators in the electricity market, 1999-2001", Eurostat, 2003

Note: provisional data for Germany and Luxembourg; no available data for Greece, Ireland, Netherlands and Norway; confidential data for France and Sweden.

<sup>12</sup> Accordingly to statistical classification of economic activities of the European communities industrial sector is represented by NACE C+D+E (C is mining and quarrying, D is manufacturing and E is electricity/gas/water supply).

## 2 Energy and Territorial Development

In this section we present:

- a) Results of the analysis at country level in view of presenting the most significant aspects of energy territorial dimension and of identifying relevant relations between energy and development.
- b) A brief reference to the methodologies most frequently used to assess the economic impact of energy shocks, with a particular emphasis on the general equilibrium models. The most important references will be OECD Interlink model, IMF multimode model and GEM-E3 model. This will highlight the results we obtained by a much less sophisticated method.
- c) These references will be made in the context of a theoretical reasoning on what we can expect about energy territorial impact and of the presentation of results of some studies that aim to quantify the economic impact of changing the conditions of energy supply, namely recent studies on the impact of increasing oil prices. The conclusion of these studies point to a significant but small impact. The results we obtained are coherent with the conclusions of these studies.
- d) The framework we developed to assess energy territorial impact and the results obtained for different European countries and regions. Although this methodology presents several weaknesses, it seems feasible and able to reach a pertinent indicator.

### 2.1 Energy and Development: some results of a cross-country analysis

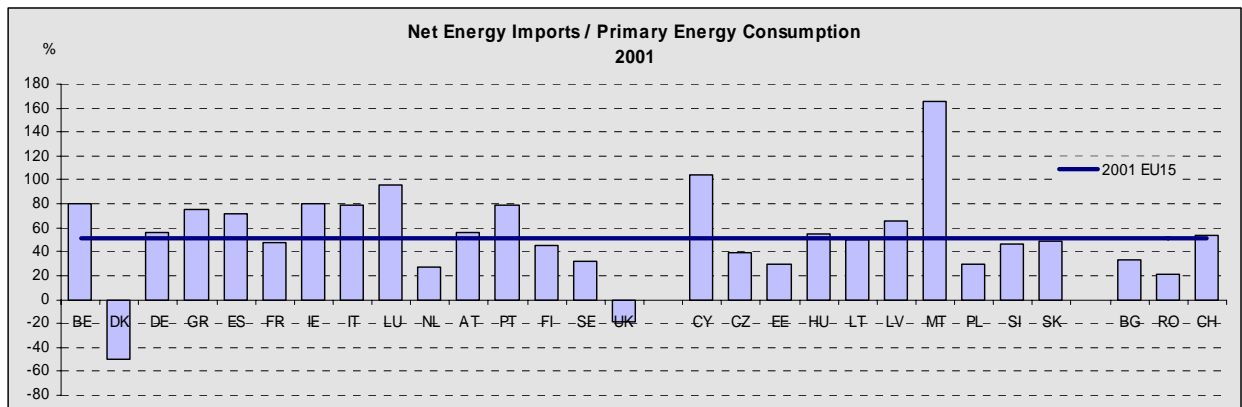
#### 2.1.1 Energy dependence and development

With the exception of Norway, United Kingdom and, more recently, Denmark, European countries are net importers of energy. Netherlands is a net exporter of gas and France a net exporter of electricity. Some new members are small exporters of electricity.



**European Union imports about 50% of its primary energy consumption** and the dependence rate increased from 51.6% in 2000 to 52.4% in 2001<sup>13</sup>. New members and candidate countries, as a whole, have a much lesser dependence rate, due to the low dependence level of Poland, Romania and Czech Republic, but several countries do not cover 50% of its energy needs. Europe is the largest net energy importer in the world.

**Figure 50 Net energy imports and primary energy consumption in 2001**



Source: Eurostat.

Note: For sake of legibility, Norway is not represented on this chart.

Energy is fundamental for almost every human activity and access to energy is crucial for economic development. The story of industrialization is, most of the times, told as the story of the energy sources. Industry developed, from the XVIII to the XX Centuries, at the pace of energy revolutions from water mills to electric engines.

The impact of energy in development is frequently seen as a sort of “energy ladder”<sup>14</sup> where energy supply and energy availability clearly acts as a determinant of economic development. Energy availability here means its existence (whether or not there are sources of energy that can be mobilized and used by industries and households), its cost (whether or not its cost allows industries and households to make affordable use of it) and its quality (whether or not industries and households can rely on energy supply without the heavy burden of long and frequent disruptions or stream variations).

<sup>13</sup> Eurostat, Statistics in Focus, Theme 8- 19/2002

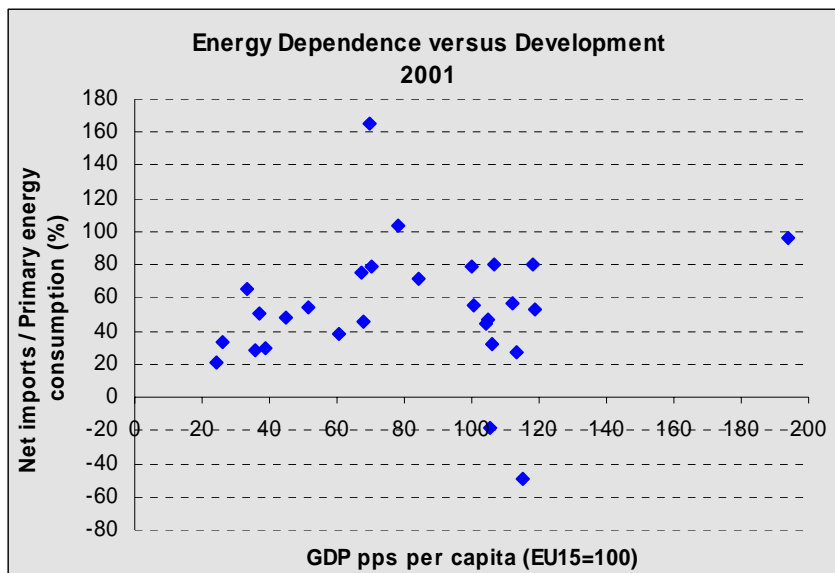
<sup>14</sup> The expression has been used by BARNES, D. and W.M. Floor (1996), “Rural Energy in Developing Countries: a Challenge for Economic Development”, Annual Review of Energy and Environment 21: 497-530, but a very large number of other works on Economic Development had used the idea before to define the pace of “industrial revolutions”, see for instance FREEMAN, Christopher (1988), Technology Policy and Economic Performance – Lessons from Japan, Pinter Publishers, London, pp.68 to 76.



This idea means that relations among economic development and energy change as economies progress through different development thresholds and we cannot expect to find a clear relationship between development and energy. Nowadays, energy is more or less easily transportable and, at least in the long term, countries and regions will be able to find a reasonable answer to their energy needs.

Although this doesn't mean that different conditions of energy supply do not impact on the rhythm and path of economic growth, the fact is that **there is no relation between the level of energetic self-sufficiency and economic development** when measured by the GDP per capita (pps).

**Figure 51 Energy Dependence and Economic Development, 2001**



Source: Eurostat.

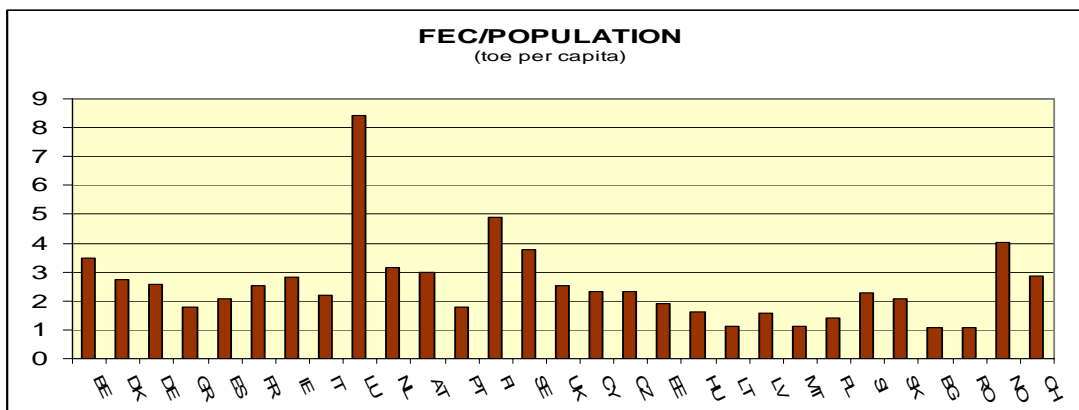
Note: For sake of legibility, Norway is not represented on this chart.

## 2.2 Differences in energy consumption

**In Europe, at country level the typology of energy consumption coincides with the typology of development.** Rich countries have greater final energy consumption per capita and a lower intensity of energy per unit of GDP. For EU27, correlation between GDP per capita (pps) and FEC per capita is 0,84 and between GDP per capita and the ratio FEC/GDP is clearly negative (-0.77).

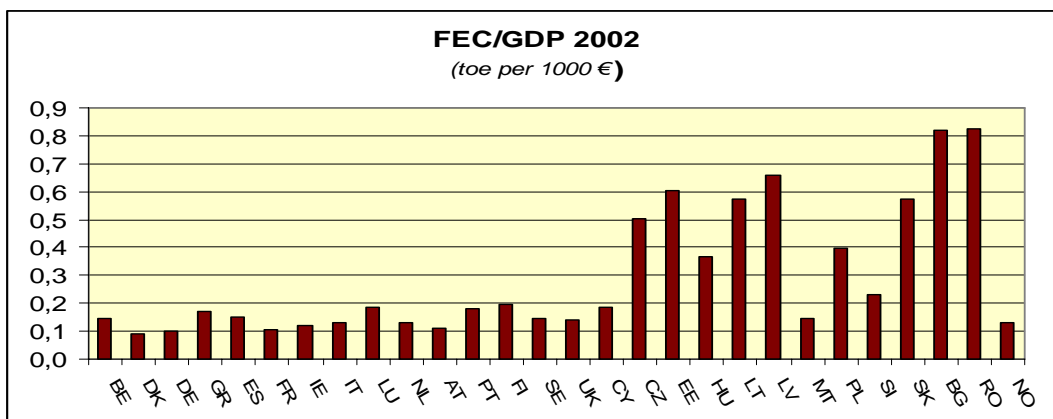
New EU Members (except Cyprus, Slovenia, Slovak Republic and Czech Republic), Bulgaria and Romania, with Portugal and Greece, have FEC per capita significantly lower than the more developed European countries.

**Figure 52 Final Energy Consumption per capita, 2002**



Source: DGET and Eurostat

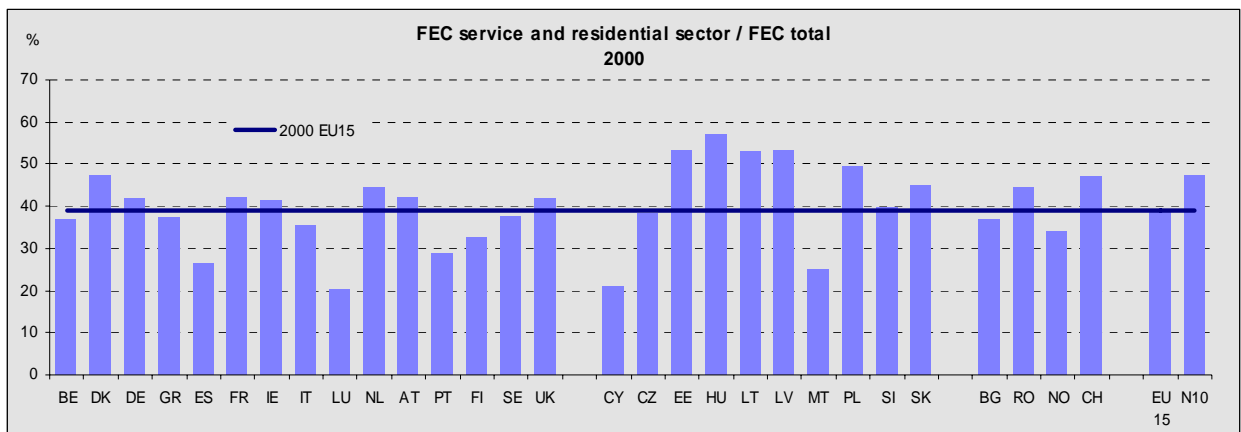
**Figure 53 Energy Intensity of GDP, 2002**



Source: DGET and Eurostat

One must take into account differences in economic structure and types of energy consumption. And in this respect there are important differences among European countries and (but we can't present numeric evidence) between regions. Figure below illustrates the share of service and residential energy consumption in FEC, which include also the effect of climate and building efficiency.

**Figure 54 Share of service and residential energy consumption in Final Energy Consumption**



Source: Eurostat and IEA Energy Statistics.

Note that New Member States and candidate countries, although having lower levels of service sector development and lower levels of electric domestic utilities, use a larger share of its electric consumption in services and residential sectors than EU average. This can only be explained by a lower development of industrial sector, industrial energy supply relying in other energy sources and lower building energy efficiency.

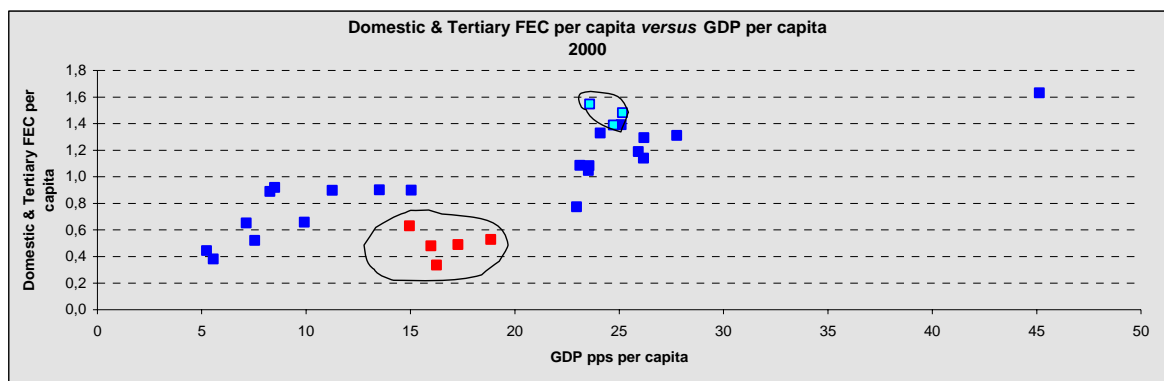
### 2.3 Energy consumption and economic development

The complexity of determinants of energy consumption and of relations between energy and economic growth and the severe lack of time series data on energy at regional level will make very difficult to identify significant spatial relations concerning the energy territorial impact.

In most energy models, is energy that responds to economic growth and this seems apparent in Europe. The result of the technological progress has been a decrease in energy intensity. In EU-15 energy intensity (GIC/GDP) per 1000 Euro was in 2001 almost 20 kgoe less than in 1992.

Climate variations are a relevant factor of different rates of energy consumption and may blur relations with other pertinent variables.

**Figure 55 Domestic and tertiary energy consumption and GDP per capita, 2000**

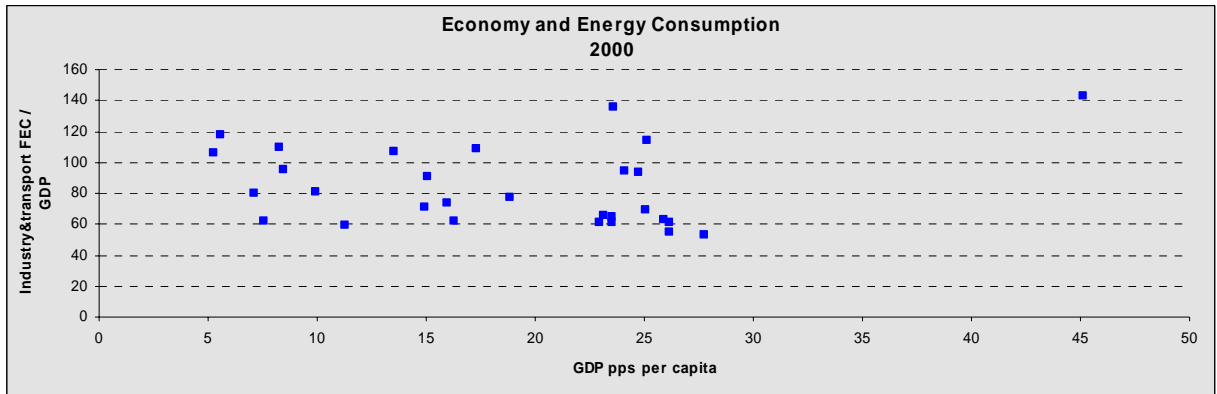


Source: Eurostat.

**For households and tertiary consumption differences of energy consumption are strongly dependent on the development level.** In Figure 6, the Mediterranean and Nordic countries are identified, but it is clear that, in what concerns households, the most important factor seem to be differences in wealth. There is a clear and linear relation between domestic and tertiary per capita energy consumption and GDP per capita (correlation = 0.77). This relation is even stronger ( $r=0,88$ ) when only EU-15 countries and households' consumption are considered.

**A higher level of development, besides a higher proportion of services, means also higher energy efficiency.** Excluding Norway, Finland and Luxemburg, it seems there to be an inverse relation between development and the intensity of economic uses of energy (industry and transport energy consumption divided by GDP (pps)).

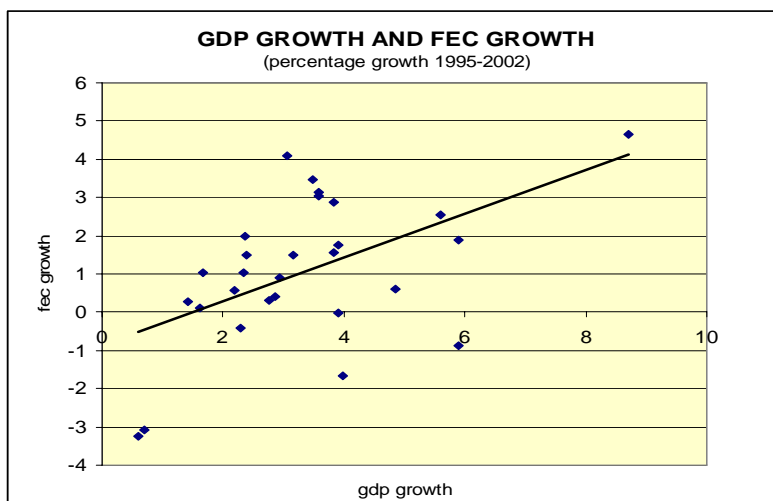
**Figure 56 Economic development and energy consumption, 2000**



Source: Eurostat.

**There is evidence that some decoupling between GDP growth and final energy consumption is achieved.** Except for Portugal, Greece, Spain and Cyprus, 1995-2002 final energy consumption growth rate is significantly lower than GDP growth rate. For 20 (among 29) countries FEC growth rate was lower than 60% of GDP growth rate. Poland, Latvia, Estonia and Hungary combined strong economic growth with small or even negative growth of FEC.

**Figure 57 GDP and FEC growth, 1995-2002**



Statistical relation is very weak but, it seems that elasticity of FEC/GDP is a little higher than 0,5, meaning a **continuous decreasing of energy intensity** of European Economies. Portugal, Spain and Greece seem to be the major exceptions.

In the period 1995-2002, only in Portugal and Spain energy intensity of GDP (toe of FEC per 1000 euros) did not decrease. Ireland, Estonia, Lithuania, Poland and Bulgaria registered a decrease higher than 20% and in most part of other EU countries the decrease was between 10% and 20%.

## 2.4 The need for regional data

When we go to the regional level, these relations will be, probably, weakened. Energy flows inside a given country are much easier and the normal situation is a small differentiation (if any) of energy prices among regions of the same country.

Unexpectedly, we faced a severe lack of energy data at regional level, preventing whatever type of analysis and the construction of pertinent regional typologies. Some countries interrupted the collection of energy data for reasons of competition among new actors in the energy field, following the liberalisation process that took place across Europe.

### **Minimal regional data requirements**

- Final energy consumption by fuel/product
- Final energy consumption by sector
- Electricity generation by source

We were not able to find data on energy consumption at regional level, but we can infer from some relations we have tried for French regions<sup>15</sup> with data referred to 1998:

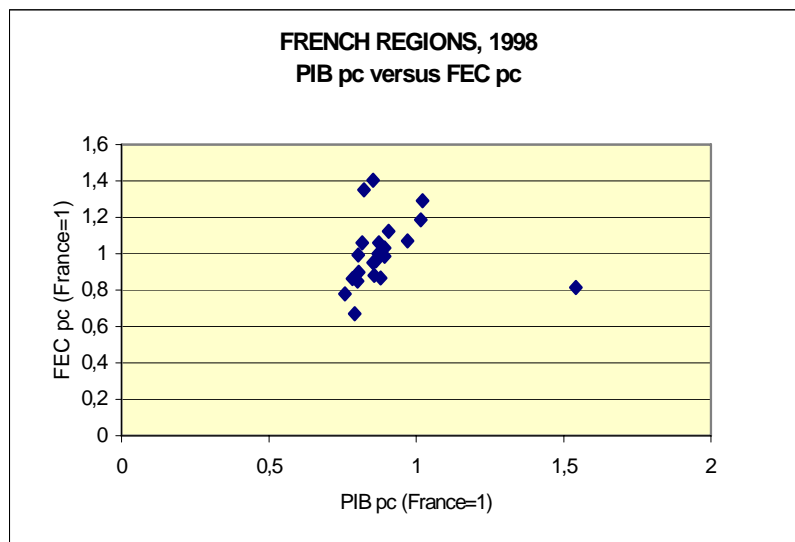
- a) Final energy consumption is much lesser concentrated in Ile-de-France than economic activity: Ile-de-France represents 29% of GDP but only 15% of FEC. Other regions represent a higher share of FEC than the respective share of GDP.

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<sup>15</sup> Source: Observatoire de l'Énergie

- b) There is no statistical relation between energy production and energy consumption, although the first region in primary energy production corresponds to the second economic region.
- c) Development level (GDP pc) does not discriminate among regions in what concerns the structure of consumer sectors.
- d) Even when Ile-de-France is excluded, only a weak relation ( $r=0.54$ ) exists between GDP per capita and FEC per capita and nothing can be said about the direction of the relation cause-effect.

**Figure 58 GDP and Final Energy consumption in French regions**



## 2.5 Energy prices

Spatial differences in energy consumption may arise from income and climate differences, from building efficiency and industrial technologies, from social technologies and from energy prices and energy quality.

In what concerns energy quality a good indicator can be unplanned electricity supply interruptions<sup>16</sup>. Data refer to non-standardised regions, not

<sup>16</sup> Source: "Second Benchmarking report on quality of electricity supply", Council of European Energy Regulators, September 2003 and "Quality of electricity supply" ERRA energy regulators regional association, April 2004

covering the entirety of each one of the 10 countries. Although it is a precarious indication and does not suitable to establish eventual relations with other variables, it points to **important differences between countries and regions in Europe in what concerns quality of electricity supply:**

- the minimum of minutes lost per customer among the regions of each country varies with a relation of 1 to 15; the corresponding maximum varies with a relation of 1 to 10;
- regional differences inside each country vary from a relation 1:2 (two regions in Ireland) to a relation of 1:10 (17 regions in Spain).

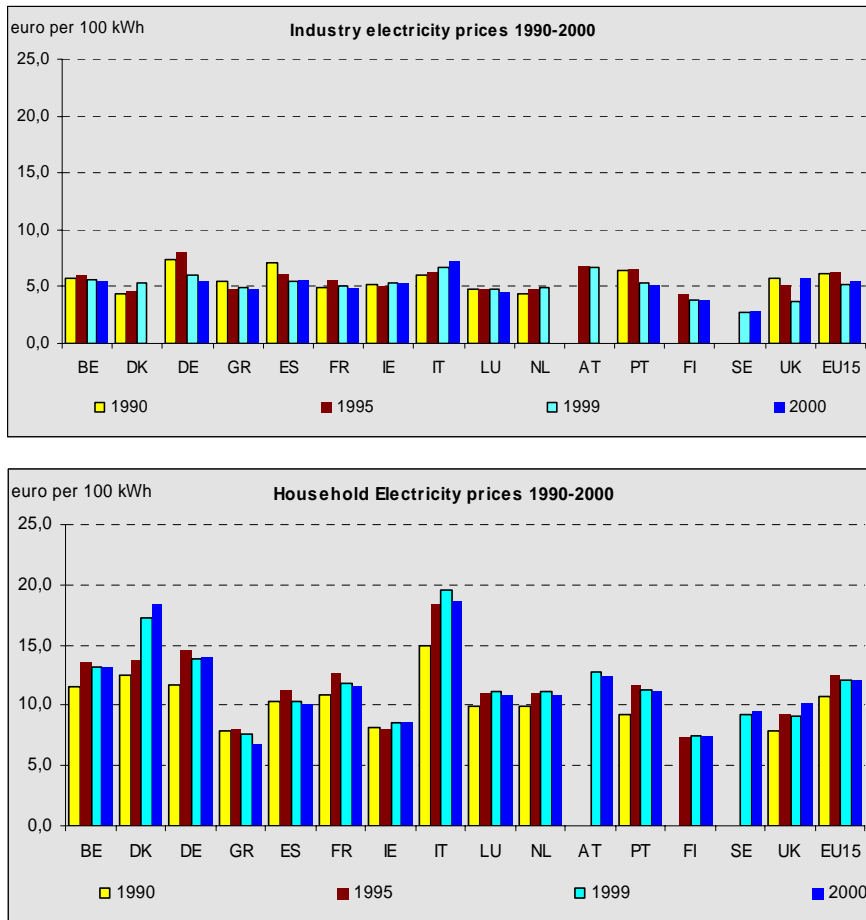
Regional differences in supply quality may be very important to the performance of economic activities. Besides the loss of work time, there are impacts in the life time and cost of maintaining the machinery and the equipments.

If we assume the ubiquity of energy with a more or less similar quality, energy prices will be the core variable through which territorial energy impacts will occur. But in spite of some weak statistical relations that can be estimated, **energy prices seem not relevant to explain either energy consumption or development differences between countries.** Energy sector has been a strongly regulated sector and energy prices include several components that are not determined by market forces. A very important parcel of energy prices are taxes and excise duties. With the accessible data, we were not able to find any significant statistical relation between energy prices, energy consumption or rhythm of economic growth. Perhaps, there is here a problem of time lag that needs time series or more sophisticated econometric relations asking for statistical data that doesn't exist on regional energy consumption and regional energy prices.

Next figures provide a picture of price trends of electricity in EU countries from 1990 to 2000.



**Figure 59 Industry and household electricity price trends 1990-2000**

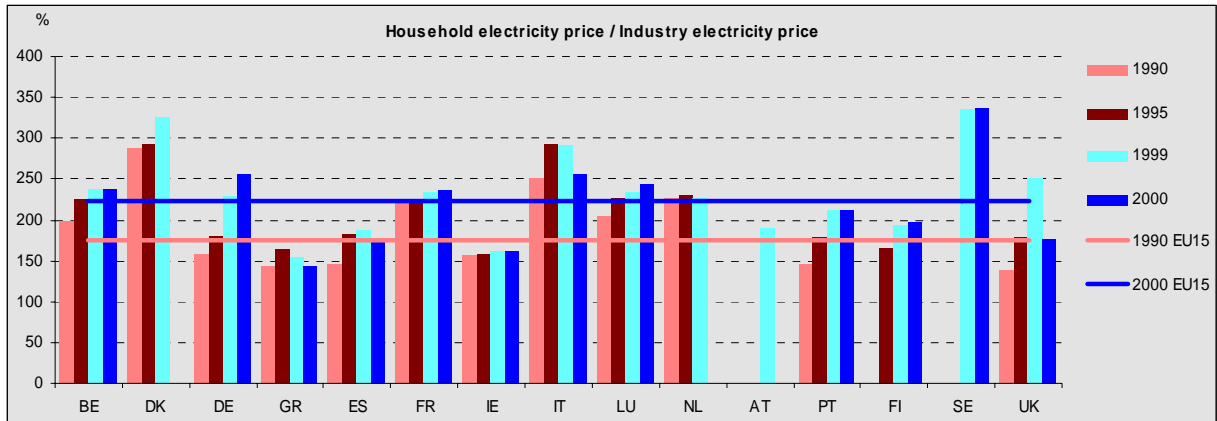


Source: Eurostat.

A number of features can be highlighted from this data. First the **heavy differences on prices from industry to domestic at country level**, the different trends in prices and the higher closeness of prices for industrial sector than for domestic uses.

Next figure pictures the average differences between industrial and residential prices on EU countries in the period 1990-2000. There is no uniform path, but **in several countries the gap between prices for industry and for households is widening**.

**Figure 60 Relation between household and industry electricity final prices**

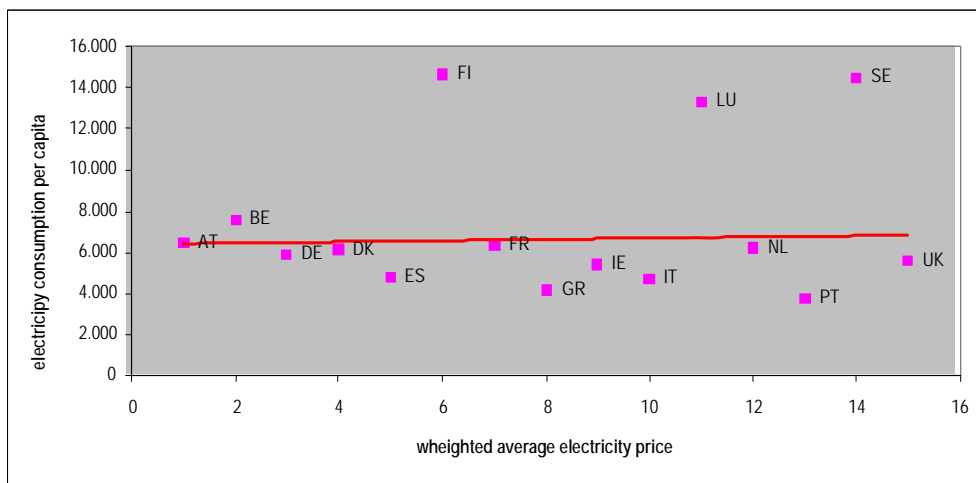


Source: Eurostat.

Note that, on average, the EU domestic prices are one and half times higher for households than for industrial facilities and cross-country differences go from three and a half times to one and a half higher. This evidence exposes that energy price policies strongly vary among EU countries. But differences in electricity prices seem not to be sufficient to affect in a meaningful way differences in economic performance of industry.

But no evidence can, again, be found of structural relation between electricity consumption and price level, as it is pictured in the next figure<sup>17</sup>.

**Figure 61 Electricity consumption and electricity prices in EU countries in 1999**

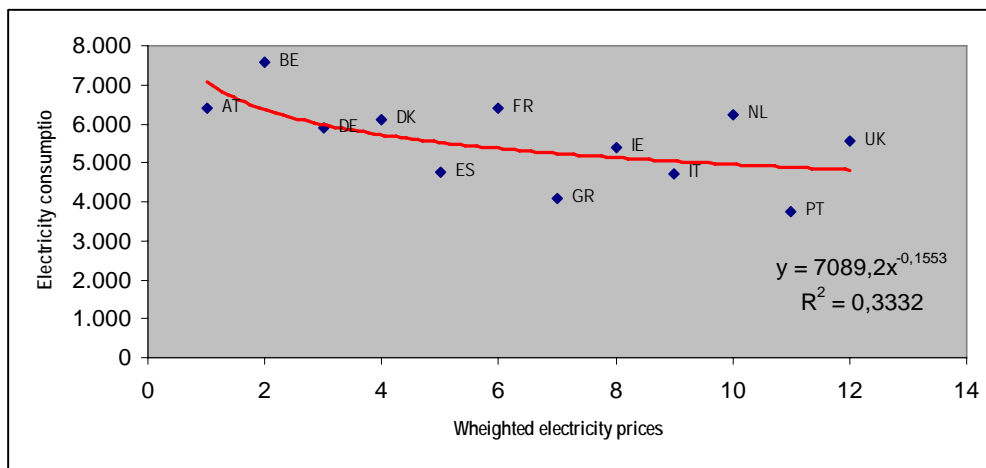


Source: Eurostat.

<sup>17</sup> Data is referred to 1999 and weighted prices are based on average prices per sector and relative share on total electricity consumption.

The picture clearly shows that EU countries have a distribution of electric consumption per capita that has no relation with price level. Differences in wealth would be a necessary second variable, but, looking to the position of some ones of the richest countries, we can conclude that it does not improve the statistical relation. But if we exclude from the analysis the countries that are shown out of the flock (Finland, Luxemburg and Sweden)<sup>18</sup>, a very weak relation among prices and consumptions seems to appear, as it is shown in the next figure.

**Figure 62 Electricity consumption and electricity prices in some EU countries in 1999**



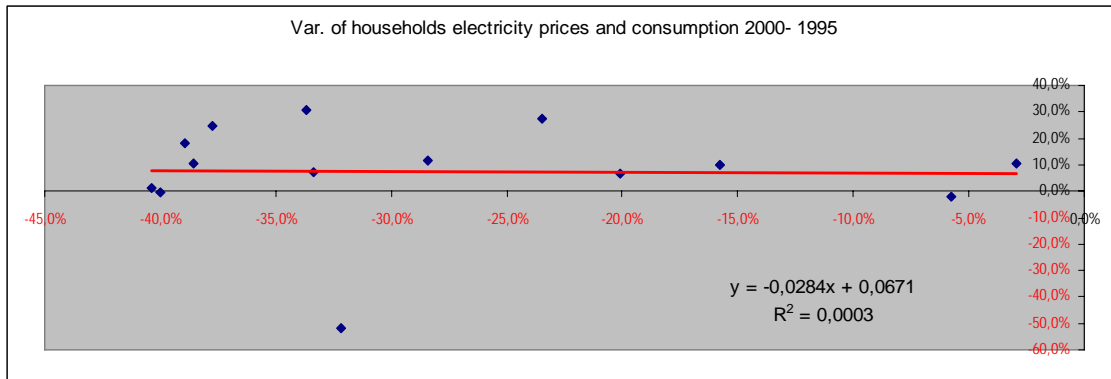
Source: Eurostat.

Obviously, no cause-effect relation can be deduced from that relation and if we consider the dynamics of prices and consumptions the outcome is also not very clear. Most variations are positive, so consumptions and prices grow. Again, the statistical relation is very weak, and it can be said little more that in a number of countries larger price increases may have lead to lower consumption growths. Differences in households' wealth and in the rate of changing the consumption patterns will be more relevant than electricity price variations.

If, again, we excluded from the regression countries that show different performance, in this case Belgium and Luxembourg for having abnormal consumption growth rates, statistical relation doesn't improve. Taking the period 1995-2000, the statistical relation does not hold either, even if the overall environment is one of price reduction for every surveyed country.

<sup>18</sup> This is acceptable because in Finland and Sweden climate generates different household consumption patterns and in the case of Luxembourg the urban agglomeration also implies a different analysis.

**Figure 63** Variation of electricity prices and consumptions on EU households from 1995 to 2000



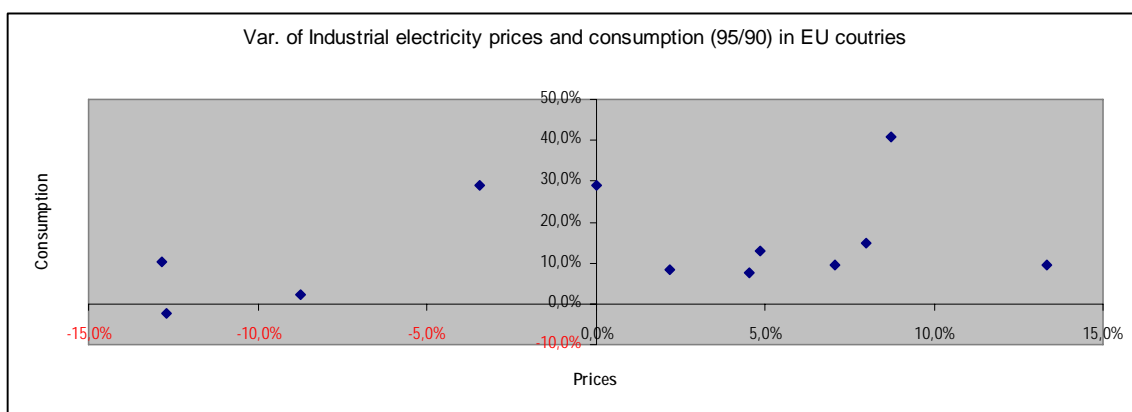
Source: Eurostat.

Countries with higher price reductions have experienced stagnant consumption (Germany and Spain) while others with price reductions above 25% have experienced significant increases (France, Greece, Ireland and Portugal).

More solid conclusions can be obtained in relation to industry.

In the 1990-1995 period a mix of policies can be portrayed with an overall outcome of consumption growth.

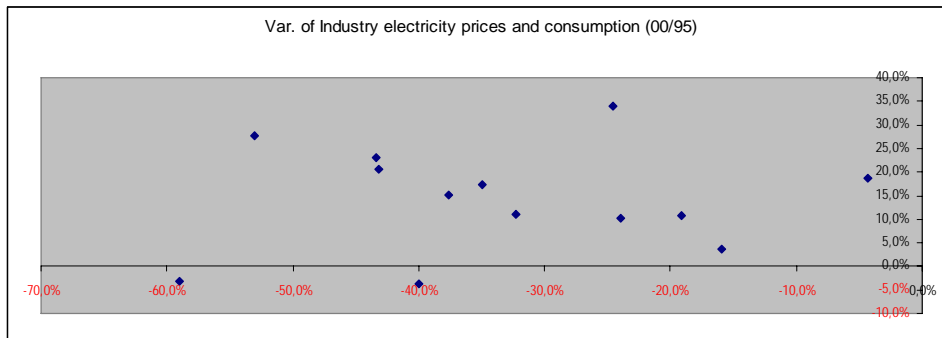
**Figure 64** Variation of industrial electricity prices and consumption (95/90) in EU countries



Source: Eurostat.

In the period 1995-2000 overall price trend is towards a general price reduction, but performances by industries are also mixed, even though an increase in consumption is more frequent.

**Figure 65** Variation of industry electricity prices and consumption (00/95)

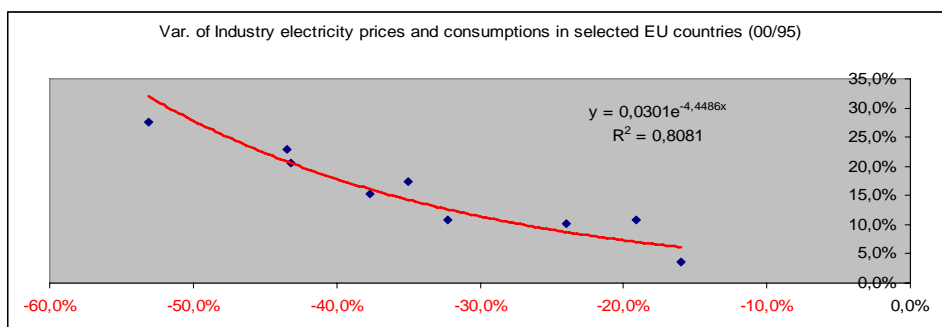


Source: Eurostat.

Anyway, it must be acknowledge that substitution of energy sources could have played a role here.

Figures point to an **inverse relation between prices growth and growth of electricity consumption** by industry. If we take a narrower set of EU countries (Italy Belgium, Denmark, Spain, Finland, Greece, Netherlands, Portugal and UK<sup>19</sup>) we get a solid statistical relation among price variation and consumption variation, which is pictured in the following figure.

**Figure 66** Variation of industry electricity prices and consumptions in selected EU countries (00/95)



Source: Eurostat.

<sup>19</sup> Thus excluding France, Germany, Ireland and Italy, for which data is available.

## 2.6 Relevant conclusions

In spite of some partial relations, national data does not establish an empirical support to put in evidence econometric relations between energy and the development level. Nevertheless, our analysis put in evidence some relevant conclusions:

- There is no relation between the level of energetic self-sufficiency and economic development when measured by the GDP per capita (pps);
- In Europe, at country level the typology of energy consumption coincides with the typology of development. Rich countries have a greater final energy consumption per capita and a lower intensity of energy per unit of GDP;
- For households and tertiary consumption differences of energy consumption are strongly dependent on the development level;
- A higher level of development means also higher energy efficiency. Excluding Norway, Finland and Luxemburg, it seems there to be an inverse relation between development and the intensity of economic uses of energy;
- There is evidence that some decoupling between GDP growth and final energy consumption is achieved, with continuous decreasing of energy intensity of European economies. Portugal, Spain and Greece seem to be the major exceptions;
- Although of a precarious nature, some data points to important differences between countries and regions in Europe in what concerns quality of electricity supply;
- Energy prices seem not relevant to explain either energy consumption or development differences between countries
- There are heavy differences of electricity prices for industry and for households at country level. In several countries the gap between prices for industry and for households is widening.
- Households' electricity consumption does not show any significant relation with electricity prices. For industry there is an inverse relation between electricity prices growth and growth of electricity consumption

## 2.7 Methods for assessment of energy territorial impact

### 2.7.1 The nature of territorial impact

One can identify five different types of energy territorial impacts:

#### *a) Direct employment and GDP*

As an economic activity energy represents an important parcel of employment and a significant contribution to the added value of national and regional economies. For instance, in France<sup>20</sup> the energy sector corresponds to 3% of GDP and about 230 000 (direct and indirect) jobs.

However, we may encounter examples of investments in energy infrastructures in a certain region that have but a very small impact at regional level. Wind farms are one example: equipment installation and exploitation are not supposed to have very important local effects. The main impacts of this renewable source are the global emission reductions. On the opposite sense, bio-mass can be an important contribution to employment in some rural areas.

#### *b) Location and competitiveness factor*

As an average, energy is not a very important direct cost for industry. For instance, in Belgian manufacturing, energy accounts only for 2.7% of total cost of acquisitions<sup>21</sup>. From input-output tables, we conclude that in UE 15 final energy represents from 2.1% of total acquisitions (excluding energy exports) in Sweden to 3.3% in Portugal and 3.4% in Italy, a higher values belonging to France (4.4%). For new Members, the corresponding values go from 4.3% in Estonia to more than 6% in Poland.

But its importance can be much higher, namely in what concerns activities like non-metallic mineral products, chemical industries or manufacture of basic metals.

On the other hand, there are very important differences of energy prices between countries and between energy sources. The 2002 average EU-15 electricity prices for industry was € 5.49 per 100 kWh and the average natural gas prices was € 4.91 per GJ(GCV). Differences between countries

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<sup>20</sup> Repères sur l'énergie en France, ([http://www.industrie.gouv.fr/energie/statisti/se\\_stats.htm](http://www.industrie.gouv.fr/energie/statisti/se_stats.htm))

<sup>21</sup> <http://www.statbel.fgov.be>

were in the order of € 2.62 (S) to € 8.32 (I), in the case of electricity, and in the order of € 4.17 (P) and € 7.73 (S) in natural gas<sup>22</sup>.

Market liberalization and European energy networks integration will have significant impacts in prices<sup>23</sup> and different impacts on the competitiveness of economic activities in each territory. Such impacts will be stronger in territories with a more energy-intensive economy.

Persistent market segmentation factors (e.g. taxation), the entry of new operators in the market and uneven conditions of access to different energy sources (e.g. unavailable access to natural gas in some regions) will maintain the existing large price gaps between different regions, impacting on corporate competitiveness and on decisions made in connection with business location.

However the relation between regional development and energy policy vectors is not always obvious.

*c) Income transfer*

Europe is heavily dependent on imported energy and there is no coincidence of the regions that produce and the places of consumption of the energy. Regions that “export” energy may have in this activity an important source of income, although in most cases, mainly in cases of hydro-electricity or wind or solar energy, the revenue for producing regions may be extremely weak in as much as these facilities are owned by non residents in the region. In some cases the economic advantages for these regions are limited to some kind of relevance paid to territorial communities for the use of natural resources.

*d) Households behaviour and quality of life*

Domestic and tertiary consumption accounts for 40% in 2002 of EU final energy consumption and transport for another one third. Energy and transport represent a substantial part of household’s expenses. It seems there to be a close relationship between energy consumption and households’ wealth.

This means that energy has a strong potential to become an important factor of life cost and of quality of life and a determinant of residential and urban location choices. Namely, energy can be a decisive factor of mobility choices and impact strongly in urban form and in the use of

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<sup>22</sup> Excise taxes included ([www.europa.eu.int/comm/energy\\_transport/etif/list\\_of\\_tables.html](http://www.europa.eu.int/comm/energy_transport/etif/list_of_tables.html))

<sup>23</sup> Numbers presented on DGTREN site show a down sloping trend in electricity prices (excise taxes included) for industry and no clear trend for natural gas prices. The reduction of energy prices may be the result of liberalization and of the evolution of fuel costs.



urban space. Fuel prices may have an important impact on modal split between car and public transport. In what concerns transport, there is an evident relationship between physical planning and energy consumption.

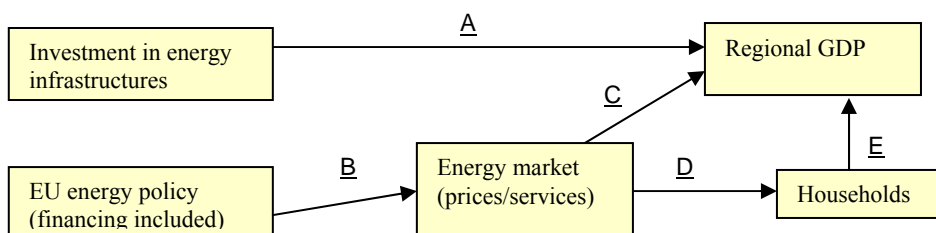
Different prices and environmental conditions resulting from energy production and use will impact on location decisions made by households, in contexts marked both by growing mobility and telework opportunities.

*e) Environment*

In spite of a trend to lower energy intensity, CO<sub>2</sub> emissions will keep growing, along with an international commitment to stabilize, and after reduce, those emissions<sup>24</sup>. This puts a major challenge on the efficient use of energy, on energy saving, on the introduction of clean and renewable energies. If, on the other hand, emissions trading schemes become reality and enterprises are obliged to internalise atmospheric pollution costs, one could expect significant territorial impacts concerning economic activity location.

The final result depends on the combination of energy sources and energy uses. Transport is, perhaps, the instrumental sector to achieve international commitments and transport policy aiming at the development of more energy efficient transport modes (train, maritime and inland water transport) will cause, indirectly, considerable territorial impact.

The aim of a territorial impact assessment should be to clarify the differentiated territorial effects of energy policy and to quantify its effects on the economy and environment of the different European regions. In economic terms, the question is to find five sets of regional parameters A, B, C, D, E that permit the following transformations:



<sup>24</sup> Some EU countries (DK, DE, FR, LU, SE) had been able to reduce greenhouse emissions since 1990, accompanied, maybe with different causes, by the most part of new Members.

Nonetheless, our attention will be focused on the impacts operating through energy prices, that is, the impact on industry location and territorial competitiveness, since:

- Spatial pattern of energy production in Europe seems stable and new production plants will have a much localised impact. Major changes could be in what concerns renewables, but equipment installation and exploitation are not supposed to have very important local effects<sup>25</sup>;
- Changing energy prices or the spatial pattern of energy production may affect income transfer in territorial and social terms. But there is no guarantee that this impact benefits regions where production facilities area located. The exact territorial impact only could be assessed through an analysis of the spatial distribution of the owners of the production facilities;
- Household's behaviour is only relevant at the urban level and results would be meaningful only if referred to an urban region in particular.

Besides investments in energy facilities, the impacts of energy policy will be mediated by energy prices. It is why we will concentrate our attention on the relations between energy price and GDP growth, that is, in the search of a suitable operator C that can evaluate the effects of energy prices on regional GDP.

### 2.7.2 Energy and industrial location: what we can expect

Energy is fundamental for almost every human activity. So, energy availability is a necessary condition for economic growth and differences on access to energy was an important determinant of spatial patterns and territorial development. But nowadays, in developed countries the potential of energy to territorial changes seems to be weak and relevant only at a small territorial level.

From location theory we know that the importance of a location factor is defined by the weight of this factor in the objective function (cost for enterprises or utility function for households) and by the spatial variability in the conditions of access to it.

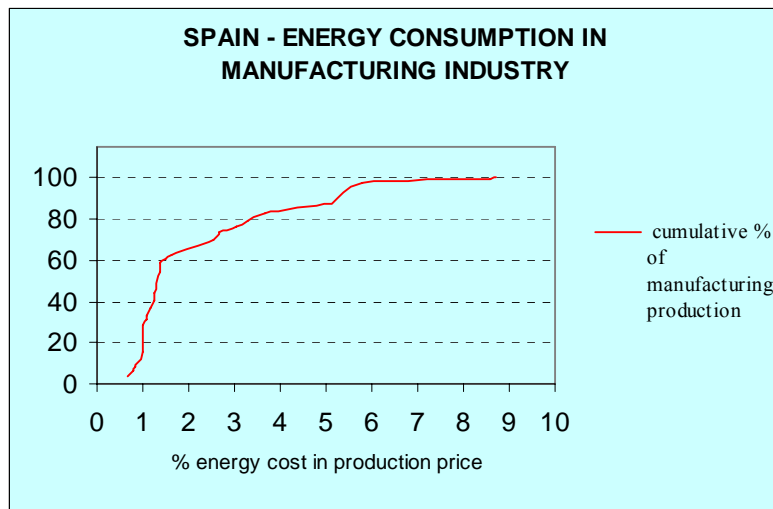
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<sup>25</sup> But they may have important environmental impacts.

In what concerns energy, its weight in total costs is rather small and only significant to a small number of industries<sup>26</sup>. If we take the case of Spain, for example, for about 2/3 of manufacturing productions the weight of energy in total production costs is less than 2%, and only for 12% of production that weight is higher than 5%. Industries for which energy has a higher weight in production prices are industries whose location faces the burden of transport costs.

Given this small weight, only great spatial variations in energy conditions can have a visible impact on location choices. The fact that those variations are small or inexistent inside the same country, we can expect a small impact of energy in actual transformation of spatial patterns.

**Figure 67** Energy costs in industry production prices, 1998



It is not frequent to find studies that search to quantify the economic impact of changing energy conditions on industrial location, but some light can be thread by a paper from Stephan J. Goetz<sup>27</sup>. In this study the author “examines the location decisions between 1988 and 1994 of a certain class of manufacturing establishments – those that use a relatively large share (more than 5 percent) of electric energy among intermediate inputs - and identifies economic factors systematically associated with new establishment

<sup>26</sup> Perhaps, energy costs would be more relevant for households. For instance, in France energy costs represent about 6% of total households’ expenses. But a great part of these expenses are transport costs.

<sup>27</sup> Stephan J. Goetz- “Location Decisions of Energy-Intensive Manufacturing Firms: Estimating the Potential Impact of Electric Utilities Deregulation”, TVA Rural Studies Program/ Contractor Paper 98-3 (<http://www.rural.org/publications>)

locations. A key question is whether electric-energy-intensive firms will relocate to take advantage of lower electricity rates”.

The author analyses separately firms from: “paper and allied products”; “chemicals and allied products”; “stone, clay and glass products”; and “primary metal industries”. The dependent variable is the “county-level net change in the number of energy-intensive establishment between 1988 and 1994” for the more than 3000 continental US counties. The author seeks to explain the dependent variable by a set of near 30 independent variables: market variables, labour force variables, policy variables, agglomeration factors, and other variables. “Energy prices” is one of those variables. For that, the author uses the Ordinary Least Square (OLS) method and two variants of maximum likelihood methods that take account of the fact that explaining increases in the dependent variable may involve factors different from those that explain decreasing behaviours.

When a “short model” (only some few independent variables) is considered, the author concludes that “...results confirm that electric-energy-intensive firms are sensitive to electric energy costs and that they may react to deregulation by relocating their manufacturing establishments to lower-cost states and counties...”. But the analysis of the numerical results shows that for one of the sectors (paper...) the sign result of energy price is contrary to what would be expected and the statistical significance seems to be low and the weight of energy price too small when compared with remaining independent variables. Results are not better for the “full model”: the author recognizes that the responsiveness of firms to energy prices seems dubious in contrast with the other variables, although concluding that “... it would not be prudent to conclude from this analysis that energy prices do not matter...”. In our opinion, the relevance of the study is just the evidence of the small impact of energy prices when other location factors are considered.

### 2.7.3 Results from econometric models

These models seek statistically significant relations between a dependent variable (GDP growth, energy-intensive establishments, etc.) and explaining variables with special relevance to variables concerning conditions of access to energy (prices, quality, etc.). Econometrics has the tools to establish relations of the kind  $Y = f(X_1, X_2, \dots, X_n)$ . The difficulty lies in the correct specification of the relation and, mainly, in the lack of the pertinent data.

Frequently, one uses Vector Auto-Regression (VAR) models<sup>28</sup> that are more useful to identify causal relations among variables than ordinary linear regression. Some tests permit to identify the directions of causality. Despite the sophistication of econometric methods, results are not always consistent.

Stern<sup>29</sup> synthesises results obtained through this methods and says “Many analysts [...] used Granger (1969) causality tests or the related test developed by Sims (1972) to test whether energy use causes economic growth or whether energy use is determined by the level of output in the context of a bivariate vector autoregression. The results have been generally inconclusive. Where significant results were obtained they indicate that causality runs from output to energy use. (...)”. And continues with references to work that conclude in one and another senses. Finally, he refers his own works with some innovations in the model specification supporting the conclusion that energy causes GDP.

In the same sense, a recent working paper by Gaudreault<sup>30</sup> uses this methodology to analyse the impact of the energy price upon the economy of Canada. Following a presentation of several empirical studies on the USA, he uses different specifications of a VAR model to estimate the impact of energy price on GDP in Canada. The main conclusions are:

*«Pour évaluer la présence d'une relation empirique entre l'activité économique au Canada et le prix de l'énergie, nous utilisons premièrement des tests bivariés et multivariés de causalité à la Granger. Les résultats des tests bivariés montrent la présence d'une relation négative significative entre les hausses de prix du pétrole et l'activité économique au Canada pour la période allant du premier trimestre 1962 au quatrième trimestre 2001. Cette relation est asymétrique puisque les coefficients associés aux variables de baisses de prix du pétrole ne sont pas conjointement significatifs.*

*Les tests multivariés corroborent ce résultat pour certaines spécifications de prix réel du pétrole seulement, notamment le niveau, la volatilité et les chocs normalisés positifs du prix réel du pétrole. De plus, l'inclusion de différentes variables dans les équations ne fait pas apparaître de relation causale significative entre le prix du gaz naturel*

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<sup>28</sup> The reduced form of a VAR can be  $Y_t = \alpha + \sum_{i=1}^n \beta_i Y_{t-i} + \sum_{i=1}^n \lambda_i X_{t-i} + \varepsilon_t$  (t=time)

<sup>29</sup> Stern, David I. (2003)- “Energy and Economic Growth”, Rensselaer Polytechnic Institute, NY. A version of this paper can be obtained in <http://www.rpi.edu/~sternd/>

<sup>30</sup> Gaudreault, Carl, Le Prix de l'énergie et l'activité économique au Canada, Department of Finance, working paper 2003-14 (<http://econpapers.hhs.se/paper/fcawpfnca/2003-14.htm>)

*(ou les indices de prix de l'énergie) et l'activité économique du Canada.» (Gaudreault, 2003, 51)*

The author carried out a more in-deep analysis that permitted the evaluation of the impact on GDP of a 1% increase in the oil price. The results were sensitive to the specification of the model and to the time period considered. The cumulative impact, at the end of the second year, of 1% increase of the oil price, could be between -0,04% and -0,10% depending of specification of the price variable<sup>31</sup>.

The difficulty with this kind of methods comes from the difficulty in isolating the effect of energy price. For instance, the reaction of economic authorities to inflation pressure as a result of growing energy prices may be more relevant than the energy price increase and the consequent normal reaction of enterprises and householders.

At this point one must be aware of the complex factors that can hide the relations between energy and development.

Increased energy efficiency is embedded in economic development, leading to lower energy intensity of GDP. Besides that, the intensity patterns seem to have a turning point that has become evident at lower stages of the development ladder.

These efficiency gains, which are recognized by all the available research data, place the issue in the energy/capital trade off, raising the always difficult question of technological change.

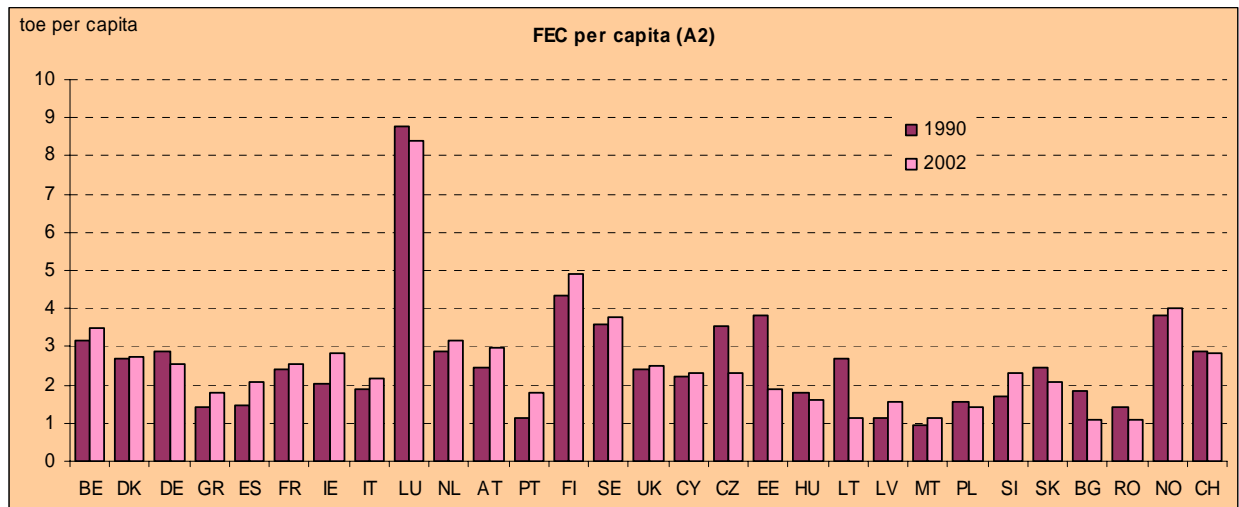
No matter, practical application of this possible indicator is burdened by a number of factors like impact of climate conditions in the overall energy consumption. Data series shows more than one turning point in several of the sampled countries.

And household consumptions follow a different path, seeming to be much more resilient to decrease, leading to overall increases in energy consumptions.

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<sup>31</sup> This seems to be a much higher impact than that calculated in recent works to the OECD countries.

**Figure 68 Final Energy Consumption per capita**



Source: Eurostat, IEA

This raises the central question of relation between prices and consumption. A number of hypotheses and research conclusions are identifiable in the literature:

- a) that electricity consumption is inelastic in the short run;
- b) that industries and households use fixed energy budgets given the GDP level;
- c) that energy costs are negligible for the major part of the industries.

In this context the efficiency of using price mechanisms to adjust energy markets are yet to be evaluated.

Using the fixed energy budget hypothesis<sup>32</sup>, the one that is more stringent towards the efficiency of price mechanisms on energy markets, points to two main effects:

- i. in the short run, price changes have some effect on growth, price increases implying lower levels of economic activities, and price decreases leading to enlarged aggregate supply, but with much larger elasticity to price increases;

<sup>32</sup> BOURDAIRE, J.M. (2000), "Le lien entre consommation d'énergie et développement économique", Revue de l'Énergie, n° 15, mars-avril 2000.

- ii. in the long run we can expect technological change and, eventually, some delocalisation of more energy intensive industries.

In any case, in our research we couldn't make use of this kind of methods on account of a severe lack of energy data (consumption and prices) at regional level.

#### 2.7.4 Modelling the economy

These are forecast or simulation models of the economy, where energy plays the role of a production factor or, by price mechanisms, affect costs and technology. Example of this kind of models is OECD Interlink model, IMF Multimod model and GEM-E3 model.

OECD Interlink model was used recently by the International Energy Agency to analyse the impact of high oil prices on the global economy<sup>33</sup>.

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<sup>33</sup> IEA, Analysis of the Impact of High Oil Prices on the Global Economy, May 2004 ([http://www.iea.org/Textbase/Papers/2004/High\\_Oil\\_Prices.pdf](http://www.iea.org/Textbase/Papers/2004/High_Oil_Prices.pdf))



**OECD INTERLINK model**

- *INTERLINK follows the tradition of many other macroeconomic models, combining short-term “keynesian” features with long-term neo-classical properties.*
- *The core of each country model consists of: a) a production function determining output in the long term; b) a wage-price block, which in combination with factor demand equations (for capital and labour) essentially determines the speed of adjustment following a shock; c) behavioral equations for private consumption as well as for prices and volumes of imports and exports.*
- *The supply side of most country models is determined by a constant-returns-to-scale Cobb-Douglas production function with capital and labour as production factors. Labour is assumed to be a homogenous production factor and no distinction is made between skilled and unskilled labour. Technological progress is disembodied and specified in terms of a labour efficiency index (which, given the Cobb-Douglas specification, can easily be rewritten as a total factor productivity index)*
- *Prices are determined as a constant mark-up over marginal costs in the long term. In the short run, prices are sensitive to demand pressure and may therefore deviate from unit costs*
- *Private consumption depends on disposable income and wealth, proxied by the real interest rate and the rate of inflation.*
- *The presence of inflation in the consumption equation can be perceived as a proxy for real balance effects (higher inflation reduces real balances and hence consumption).*
- *An **oil price increase** mainly works its way through the system as terms of trade shock. For net oil importing countries there is an initial loss in real disposable incomes as prices of oil- and energy-related goods and services increase. This simultaneously leads to lower output and higher inflation (i.e. a negative supply shock). The degree of the downturn in demand depends partly on the extent to which consumption responds to lower disposable incomes and higher inflation and investment to lower output. A further effect arises from the net export side, since market growth slows and competitiveness changes (positively if inflation increases by less than among trading partners, otherwise negatively). Second-round effects depend on the response of wages to higher consumer prices. To the extent most wage earners are willing to accept a decline in real wages, unemployment will only increase modestly and inflation will soon be back to around its initial level.*

From:

OECD, Standard Shocks in the OECD INTERLINK model, ECO/WKP (2001) 32

INTERLINK is used mainly for analysing effects and international spillovers of macroeconomic policy, and in this particular case, was used to test the vulnerability of OECD economy to higher oil prices.

Although the “amount of oil the OECD uses to produce one dollar of real GDP halved between 1973 and 2002”, OECD remain vulnerable to oil-price increases and the simulation carried out concluded that:

- A sustained \$10 per barrel increase in oil prices from \$25 to \$35 (a 40% increase) would result in the OECD as a whole losing 0.4% of GDP in the first and second years of higher prices
- These losses start to diminish in the following years as global trade in non-oil goods and services recovers and, throughout the whole five-

year projection period, GDP is 0.3% lower on average than in the base case

- Euro-zone countries, which are highly dependent on oil imports, would suffer most in the short term, their GDP dropping by 0.5%
- The impact of higher oil prices on the rate of inflation is more marked. The consumer price index is on average 0.5% higher than in the base case over the five year projection period.

The study analyses also the impact on developing countries and transition economies and on the global economy. In some developing countries the impact on GDP may reach more than 1.5% after one year.

IMF MULTIMOD model «is a dynamic multicountry macro model of the world economy that has been designed to study the transmission of shocks across countries as well as the short-run and medium-run consequences of alternative monetary and fiscal policies»<sup>34</sup>.

The basic structure and properties of MULTIMOD are meant to represent well-established views about how modern industrial economies function and interact with each other. In the construction of the model, theoretical foundations prevailed upon goodness of fit. « (...) The main criteria for incorporating an estimated equation specification are that the specification should be based to a large extent on underlying theory and should not generate an unrealistic degree of macroeconomic variability when embedded into the MULTIMOD system of equations. Thus, in comparison with models for which short-term forecasting accuracy is a high priority, MULTIMOD has been estimated with a relatively low willingness to sacrifice theoretical foundations in order to obtain better goodness of fit.» (Laxton et alii, 1998).

A working paper prepared by the IMF Research Department in 2000<sup>35</sup>, analysed the potential impact of a sustained \$5/barrel increase in the price of oil on the global economy, over a baseline around \$25 (a 20% increase) in 2000-2001. The model can take into account the several channels through which oil prices may affect the economy.

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<sup>34</sup> Douglas Laxton, Peter Isard, Hamid Faruqee, Eswar Prasad, and Bart Turtelboom (1998), MULTIMOD Mark III The Core Dynamic and Steady-State Models, IMF occasional paper 164, present a full description of the model. MULTIMOD is available to the public and can be obtained through <http://www.imf.org/external/np/res/mmod/index.htm>. Posterior versions of the model were developed.

<sup>35</sup> IMF, "The Impact of Higher Oil Prices on the Global Economy", Prepared by the Research Department, December 2000. (<http://www.imf.org/external/pubs/ft/oil/2000/oilrep.PDF>)

#### THE TRANSMISSION OF OIL PRICES SHOCKS IN MULTIMOD

*An oil price increase can influence macroeconomic behavior through several channels. Five of these seem particularly relevant in the first few years following the shock. First, the transfer of income from oil-importing countries to oil-exporting countries is expected to reduce global demand as demand in the oil-importing countries is likely to decline more than it will rise in the oil-exporting countries. (...). Second, the increase in the cost of inputs to production can reduce the amount of non-oil (potential) output that can be profitably supplied in the short run, given the existing capital stock and assuming that wages are relatively inflexible in the short-run. Third, workers and producers may resist declines in their real wages and profit margins, putting upward pressure on unit labor costs and prices of finished goods and services. Fourth, the impact of higher energy prices on headline price indexes (e.g., consumer price levels) and the potential pass-through into core inflation may induce central banks to tighten monetary policy. And fifth, the extent those policy reactions seem inconsistent with announced policy objectives, the credibility of the monetary authorities may be eroded, with consequences for inflation expectations and the inflation process.*

From:

Hunt, Isard, Laxton, "The Macroeconomic Effects of Higher Oil Prices", IMF, WP/01/14,  
(<http://www.imf.org/external/pubs/ft/wp/2001/wp0114.pdf>)

The results of different simulations are consistent with those of INTERLINK models. For industrialised countries the impact on GDP (percent deviation from baseline) would reach a peak of  $-0,3\%$  in 2001 and 2002 and would decline to  $-0,1\%$  in 2004. For Euro Area the impact on GDP would be of  $-0,4\%$  in 2001 and 2002, decreasing to  $-0,1\%$  in 2004.

Comparing with the results of other models, MULTIMOD seems estimate results substantially higher than OECD INTERLINK model.

GEM-E3 model is an applied general equilibrium model for the European Union member states taken individually or as a whole, which provides details on the macro-economy and its interaction with the environment and the energy system<sup>36</sup>. Partly financed by the European Commission, the model is being used to evaluate policy issues for the European Commission.

The model involves the specification of production and consumption functions. Production is modelled through KLEM (capital, labour, energy and materials) production functions involving many factors (all intermediate products and two primary factors – capital and labour). At the same time consumers can also endogenously decide the structure of their demand for goods and services. Their consumption mix is decided through a flexible expenditure system involving durable and non-durable goods. The model

<sup>36</sup> Capros et al., 1997, The GEM-E3 model: Reference Manual, <http://gem-e3.zew.de>

includes an environmental module focusing in some pollution variables and distinguishes between productive branches<sup>37</sup>.

GEM- E3 was used by Kouvaritakis et alii<sup>38</sup> for analysing the economic impacts of energy tax policies in the EU. The study presents, among other results, the impact on macro economic aggregates and sectoral production. The study concludes that “The energy tax reform imposing minimum taxes (...) has very small effects at macroeconomic level and negligible positive environmental effects, as the rates proposed are not very high and below the existing rates in nearly half of EU countries.”. Meaningful is the fact that, even in countries where those taxes may imply a relevant increase in energy price, the impact on GDP is of only a few decimals of percent.

This study makes assumptions about the use of taxes revenue, and does not present the results in a way that permit comparison with the results of other models.

### 2.7.5 Other studies

Other studies also concluded by a small impact of energy price changes on GDP.

For instance, a similar result was obtained for Taiwan, where one<sup>39</sup> estimates that the impact of petroleum fund fee of 2,785% on oil prices will be a reduction of GDP of only a negligible 0.08%.

Concerning other energy forms, a study by Barnett et alii<sup>40</sup> analysed the economic impact of retail electric competition in Alabama. This study discusses the potential consequences of retail competition pointing to the possible effect of reducing regional disparities in energy price and, in consequence, to reduce incentive to change location and estimates the

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<sup>37</sup> For a detailed description, GEM-E3- Computable General Equilibrium Model for studying Economy-Energy-Environment Interactions for Europe and the World (<http://www.gem-e3.net>)

<sup>38</sup> Nikos Kouvaritakis, Leonidas Parousso and Denise Van Regemorter, 2003 - “The macroeconomic evaluation of energy tax policies within the EU, with the GEM-E3-Euope model”, study for the European Commission DG TAXUD, December 2002 ([http://www.europa.eu.int/comm/taxation\\_customs/taxation/economictaxation\\_final\\_report.pdf](http://www.europa.eu.int/comm/taxation_customs/taxation/economictaxation_final_report.pdf)).

<sup>39</sup> Chi-Yan Liang, “The effect of petroleum Fund Fee on oil prices and the economy of Taiwan”, NPF Research Report, July 2002 (<http://www.npf.org.tw>)

<sup>40</sup> Andy Barnett, Henry Thompson, Samuel Addy, Ahmad Ijaz – Economic Impact of Retail Electric Competition in Alabama, Economic Development Institute, Auburn University (<http://web6.duc.auburn.edu/outreach/edi/electricstudy.pdf>)

potential economic impact of possible reductions in the price of electricity. The study uses the Alabama Econometric Model that is said that “is a simultaneous equation model with over 250 equations describing the state economy. These equations include both behavioural and stochastic equations, as well as numerous identities.” The methodology is one of comparing economic scenarios, assuming different policies conducting to different electricity prices.

Here, our interest is not in the structure of the model but on the scale of the estimated impacts. From the results presented we can conclude (our calculations over the table presented) that the study estimates an increase of 0.05% in gross state production (GSP) in consequence of a reduction of 2.8% in the price of electricity. Accordingly, two scenarios where electricity prices differ 5.6% imply a difference in GSP of 0.15%. Some productive sectors will suffer a greater impact but, in general, differences in electricity prices have a very small impact in economic growth.

#### 2.7.6 Relevant conclusions

The objective of the previous references was twofold:

- *First, to present alternative methods of evaluating the energy impact on economic activity.*

At an earlier phase of our work we put a special focus on econometric models as a privileged tool to assess territorial impact of energy policies. But, we were not aware of the lack of energy data at regional level. When one can't know even the energy consumption at NUTS II level, there is no possibility to use methods that depends on the availability of time series of relevant data for, at least, the most part of territorial unities. **The construction of an energy database consistent at the territorial level must be the principal target of future research projects.**

The use of a general equilibrium model of the kind of those mentioned was only briefly envisaged. First, the calibration of such a model for the 29 countries is a specific project that one couldn't carry out in the context and conditions of the actual contract. Second, even if that calibration was possible, the question of assessing the impacts at a regional level remained. Finally, and most important, the complexity of feedbacks in a GEM would make very difficult to isolate the impact of

the energy shock (for instance, a great part of the impact of oil shocks can be attributed to the reaction of monetary authorities to the consequent price increase).

- *Second, to obtain quantitative references for the results we obtained using a much more simplified framework.*

All the empirical results point to a very small elasticity of GDP relatively to energy price. For Euro Area, the above results are a decrease of GDP of 0,4% for a 20% increase in oil price (MULTIMOD) or of about 0,5% for a 40% oil price increase (INTERLINK).

Our results do not differ too much from those obtained by INTERLINK model. If we hypothesise a growth of 40% in the price of the products of the branch "oil and gas extraction", or the correspondent imports, we obtain a decrease of GDP of -0,43% in Portugal, -0,39% in Spain, -0,44% in Austria or -0,50% in Germany. The impact follows the weight of the branch in the economy. These impacts are in line with those from other studies and, although we use a very simplified framework with very restrictive hypothesis, we think we can use our results as a good indicator of territorial impact of variations in energy price.

## 2.8 A simplified framework for territorial impact assessment of energy

### 2.8.1 The computing procedure

Given the above-mentioned difficulties that impede the calculus of direct energy impact on a region, the procedure we used consists in the distribution of the impact calculated at a national level among the different regions of a specific country.

For that, in a first step, we calculated the impact of a decrease<sup>41</sup> in the price of final energy on gross value added of each national branch and, in a second moment, we distributed the impact of each branch among the different regions of that country. This corresponds to assume that:

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<sup>41</sup> The option by a price decrease is explained by the fact that, at the end, this is the aim of Community energy policy, either by an effective price decrease or by improvements in energy quality and efficiency.

- The energy price is the same in every region of a specific country: this is not a too much restrictive hypothesis given the small spatial variations, and even uniformity, of energy prices at national level.
- We can find a suitable key to distribute the impact on a specific branch among regions. Here we may have an important weakness of our procedure because we were obliged, as a consequence of the lack of other pertinent data, to use employment, frequently at a high aggregation level. Doing so, we implicit assume that not only internal structure of a particular branch and technology do not vary between regions as the labour productivity of that branch is the same in every region. A greater disaggregation of activities means a small impact of these hypotheses<sup>42</sup>.

The last assumption may affect significantly the results obtained, but an improvement is only possible with better regional data.

**THE PROCEDURE**

1. Calculate the impact of a final energy price variation on gross value added of different national branch
2. Distribute the impact on each branch among regions

For the assessment of the national (branch) impact of a variation in energy price a framework that corresponds to the first generation of impact assessment methods seems the most adequate in the actual circumstances.

We can think energy price variation as an exogenous one that doesn't affect the gross value added per unit of product of each branch. This may occur if price variation is the result, for instance, of cheaper energy imports or it results from a greater efficiency of energy distribution (e.g. reduction of losses in the network), from State subsidies, etc. and each branch passes on the reduction of costs completely to lower prices supported by customers. In this case, an energy price decrease would imply: (i) the maintenance of GVA per product (physical) unit in all branches (including the energy sector); and (ii) a reduction in the price of different products in response of a decrease in the energy price.

Price reduction has an income effect and a substitution effect. Income effect means that one can buy more of all the goods and services, as if he had benefited from an income increase. So, at this stage, we think that an input-

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<sup>42</sup> In practice, we considered a variation of branch productivity among regions assuming that  $q_{ij}/q_j = q_i/q_j$ , where  $q$  is productivity of the economy,  $i$  denotes region and  $j$  denotes the branch

output framework will be the most suitable method for analysing this type of impacts.

Input-output models are accounting apparatus identifying inter-industry linkages, usually used to quantify the global impact of increases or decreases in spending. The standard model is  $X = AX + Q$ , where  $Q$  is a  $n \times 1$  vector of the final demand of products from different productive sectors,  $X$  is a  $n \times 1$  vector of total output from each sector and  $A$  is a  $n \times n$  matrix of coefficients  $a_{ij}$  of the intermediary consumption of products  $i$  necessary to obtain an unity of product  $j$ <sup>43</sup>. As investment is a component of final demand, the standard model can be used to evaluate the impact of energy investments or of an increase in energy demand.

Although input-output models were not constructed to evaluate the impact of cost variations, we can use the input-output framework to calculate the impact of an energy price variation in the set of prices of all the production branches.

In an input-output framework the following relation can be verified  $B'P + V = P$ , where  $P$  is a  $n \times 1$  vector of product prices;  $B$  is a  $n \times n$  matrix of coefficients  $b_{ij}$  of physical quantities of product  $i$  needed to the production of a (physical) unit of  $j$ ;  $V$  is a  $n \times 1$  vector of the value of primary inputs needed to an unity of different sectoral productions; and  $B'$  is the transpose of matrix  $B$ . The above equality comes from  $p_j = b_{1j}p_1 + b_{2j}p_2 + \dots + b_{nj}p_n + v_j$ . Solving, we obtain  $P = (I - B')^{-1}V$ . Although formally  $b_{ij}$  is measured in physical units, if we are interested only in the relative variation of prices we can make  $b_{ij} = a_{ij}$  and, then  $\Delta P = (I - A')^{-1}\Delta V$ .

This procedure presupposes that a variation in energy prices does not imply any input substitution, so that (technical) input coefficients remain constants. This could be a strong hypothesis, regarding the long-term trends to diminishing energy intensity. However, the most important impacts on GDP, obtained by other methods, seem to be short-term or medium-term impacts, pointing to a main influence of demand variations.

We used the last equation to calculate the impact (in relative terms) on different prices of an exogenous reduction of energy price. For calculation effects only, this fall of energy prices was assumed as a reduction in primary inputs<sup>44</sup>.

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<sup>43</sup> Normally  $a_{ij}$  is the monetary amount of product  $i$  that is necessary to obtain a monetary unit of product  $j$ . The total output (including imports) of a product  $X_i$  is used to intermediary consumption ( $\sum_j a_{ij}X_j$ ) and to final consumption ( $Q_i$ ), that is,  $X_i = \sum_j a_{ij}X_j + Q_i$

<sup>44</sup> There are other equivalent procedures to obtain the numerical solution of the system. We used the Solver tool of Microsoft Excel



Input-output table is not useful to pass from price variation to GDP variation. Here, we need some additional hypothesis about the way demand reacts to a price variation:

- a) First, we assume that final consumers will not change their budgets, so we hypothesize that the entire price savings will be transferred to final demand. This corresponds to income effect, but maybe it overestimates the demand growth, as it is possible that some consumers transfer the “additional” real income to additional savings. It is a restrictive hypothesis that could be improved if we could obtain information on price-elasticity and on demand functions.
- b) Second, we must take into account the substitution effect, what was done by distributing the “additional” demand among different branches proportionally to the weight in total final demand and to the relative price variation of each branch.

These are two very restrictive hypotheses, which were necessary in the absence of information on price elasticity's and on demand functions. However, the aim of finding an indicator of the territorial pattern of energy impact is not put in risk if these hypotheses are applied to all countries.

With this two hypothesis we calculate the increase of final demand of products of each branch as  $\Delta Q_i = y \cdot (z_i/z)$ , where  $y = \sum_i (1-p_i) \cdot Q_i$ ,  $z_i = Q_i/p_i$ ,  $z = \sum_i z_i$  and  $p_i$  is the proportional variation of prices (initial prices=1).

Now we can estimate the growth of total uses of each branch through the known relation  $\Delta X = (I-A)^{-1} \Delta Q$ . If we hypothesize a constant relation between “total uses” and the gross added value, we can calculate the impact on Gross Added Value of each sector<sup>45</sup>.

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<sup>45</sup> We hypothesized that added value per physical unit would not change following a variation of energy price. Although all this calculations are done in monetary terms, at the end this hypothesis is respected, taking into account that  $a_{ij} = b_{ij} \cdot p_i / p_j$

**ESTIMATING THE IMPACT BY BRANCH AT NATIONAL LEVEL**

1. Estimating the impact on price of the different branches:  $\Delta P=(I-A')^{-1}\Delta V$   
*Critical hypotheses:* (i) there is no technical change in sequence of an energy price increase; (ii) firms pass on cost variations completely to customers and the added value per physical unit remains unchanged.
2. Calculating additional demand:  $\Delta Q_i = y*(z_i/z)$ , where  $y=\sum_i(1-p_i)*Q_i$ ,  $z_i=Q_i/p_i$ ,  $z= \sum_i z_i$  and  $p_i$  is the proportional variation of prices  
*Critical hypotheses:* (i) the budget of final consumers remains unchanged and the entire price savings goes to additional purchases; (ii) The additional demand is distributed proportionally to initial consumptions and to price variations.
3. Calculating the additional gross value by branch:  $\Delta X=(I-A)^{-1}\Delta Q$  and  $\Delta V_i=\beta_i.\Delta X_i$ , where  $\beta_i$  is the relation between the Added Value and Total Uses in branch  $i$ .  
*Critical hypotheses:* (i) the added value per physical unit remains constant in each sector; (ii) the proportion between imports and total uses doesn't change.

Finally, we must have a distribution key of the increase in the value added of a given sector between different regions. This can be done assuming the initial regional location of different sectors, supposing that a growth of added value of a given industry is uniformly distributed among regions according with the initial distribution of that industry.

Ideally, the initial spatial pattern of the branch production would be the best key of territorial distribution of the increase of the value added.

Unfortunately there is no such data for the set of NUTS II. The best key we could find is employment by industrial sector, but frequently the branch classification of regional employment doesn't coincide with the branch classification of input-output matrix and normally there is no sufficient product desegregation to take in due account the different intensity of impacts in the growth of each product. Perhaps this is the main practical weakness: at a greater level of aggregation it is difficult to assume any relation concerning the behaviour of branch productivity among regions. What we did was to assume that in a given region all the branches maintained a constant relation with the corresponding national productivity. Following our results, inside the same country, generally more developed regions would be the more benefited from an energy price decrease. This in part may be due to an overestimation of the share of these regions in the increase of added value.

**DISTRIBUTING THE IMPACT ON ADDED VALUE AMONG REGIONS**

For the regions of a specific country  $R=MV$  ( $M$  is an  $rxn$  matrix with  $m_{ij}$  = share of region  $i$  in the production sector  $j$ ). Normally  $M$  was obtained on the base of employment data.

*Critical hypotheses:* (i) interregional flows of goods and services remain proportionally unchanged; (ii) Prices of the products of a given branch do not vary among regions; (iii) the same happens for energy intensity; (iv) a constant relation, among branches of a given region, between regional productivity and global productivity

In the above boxes, we have presented the critical hypothesis in the different steps. These hypotheses configure weaknesses of the methodological framework we used, which will justify an eventual severe criticism. We are aware of those insufficiencies, but we can't say that these hypotheses are more unrealistic than those implicit in more sophisticated models.

In any case, these weaknesses are aggravated by the quality of input-output data we had to use. We could obtain input-output devices for 26 of the 29 countries<sup>46</sup>. But these matrixes are related to different years, in some cases distant enough to make difficult to assume there were no meaningful technological changes. In some cases, it is not possible a total separation of energy branches and in this cases the impacts may be overestimated. In addition, four tables are of a different nature. For France, Czech Republic, Slovakia and Bulgaria we only dispose of "use tables". Unlike input-output, use tables have a problem of symmetry: they show products by industry of use. The accuracy of results depends crucially on the assumption that each industry only produces a homogeneous good or service, which normally doesn't happen.

In the next table, one can see the main characteristics of data we used.

The calculation procedure is, by construction, a linear application. This means that impacts will be proportional to the percentage variation of energy price. And it is symmetric in the sense that energy price increases or price decreases will have symmetric results. This is another result that does not match empirical results that point to a stronger effect of energy price increases.

## 2.8.2 The results

### a) The impact of an oil price increase

An oil price increase will put in action a complex of economic relations, which will have a more important impact than oil price increase by itself.

Sophisticated economic models consider: income transfer to oil exporter countries, the reaction of inflation rate and interest rate, the changes in the

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<sup>46</sup> In an earlier version (Third Interim Report) we were obliged to use "use tables". After we obtained from Eurostat standardized input-output tables, but remains the problem of the outdated of the tables for some countries.

expectations of economic actors, the response of monetary policy, etc. These models can distinguish between temporary and permanent shocks and calculate the impact along several years.

The procedure we use is a very elementary one. It was developed to construct an index of the impact of energy prices among European regions. It seems to us that it is efficient in establishing relative positions, although it only assess the immediate impact through demand variations.

It was not developed to take into account the cross impacts among countries and regions. For that, it is not adequate to analyse the impact of an increase in crude oil price, because what characterizes this impact is an alteration in international market which obliges to take in consideration the impacts that act through international trade.

**Table 2 Data used to estimate regional energy impact**

Country	Tables	year	number of sectors	Regional Gross Value Added	Regional Employment	NUTS level	NACE code Final Energy	
BE	Belgium	I-O	1995	57	1995	2001	2	23, 40
DK	Denmark	I-O	2000	59	2000	-	0	23, 40
DE	Germany	I-O	2000	58	2000	2001	2	23, 40
GR	Greece	I-O	1998	58	1998	2001	2	23, 40
ES	Spain	I-O	1995	58	1995	2001	2	23, 40
FR	France	Use table	2000	56	2000	2001	2	23, 40
IE	Ireland	I-O	1998	48	1998	2000	2	40
IT	Italy	I-O	2000	58	2000	2001	2	23, 40
LU	Luxembourg	n.a.	-	-	-	-	0	-
NL	Netherlands	I-O	2000	56	2000	2001	2	23, 40
AT	Austria	I-O	2000	57	2000	2001	2	23, 40
PT	Portugal	I-O	1999	59	1999	1999	2	23, 40
FI	Finland	I-O	2000	58	2000	2001	2	23, 40
SE	Sweden	I-O	2000	56	2000	2001	2	23, 40
UK	United Kingdom	I-O	1995	58	1995	2001	2	23, 40
CY	Cyprus	I-O	1986	33	1986	-	0	23+24,40
CZ	Chzech Republic	Use table	1999	30	1999	1999	2	23, 40+41
EE	Estonia	I-O	1997	56	1997	-	0	23, 40
HU	Hungary	I-O	1998	57	1998	2001	2	23, 40
LT	Lithuania	I-O	2001	57	2001	-	0	23, 40
LV	Latvia	I-O	1997	56	1997	-	0	23, 40
MT	Malta	n.a.		-	-	-	0	-
PL	Poland	I-O	1995	54	1995	2001	2	23, 40
SI	Eslovenia	I-O	1996	58	1996	-	0	23, 40
SK	Slovakia	Use table	1998	47	1998	2001	2	23+24,40
BG	Bulgaria	Use Table	1997	53	1997	2001	2	23, 40+41
RO	Romenia	Use Table	2000	17	2000	2000	2	23, 40
NO	Norway	I-O	2001	58	2001	2001	2	23, 40
CH	Switzerland	n.a.	-	-	-	-	2	-

**Notes:**

n.a. - not available

NACE Rev. 1.1- Statistical Classification of Economic Activities of the European Communities. In sectors 23 and 40 prices reduced 10%.

In some cases it was necessary to aggregate the sectors.

code 23 - Manufacture of coke, refined petroleum products and nuclear fuel;

code 24 - Manufacture of chemicals and chemical products

code 40 - Electricity, gas, steam and hot water supply

code 41 - Collection, purification and distribution of water

Being aware of the difficulties, we present the results of some calculations aiming at evaluating the impact of an oil price<sup>47</sup> increase of 60%. This percentage takes into consideration the recent perturbations in oil market, but given the linearity of the procedure we can easily convert the results to any other percentage increase. We consider three hypotheses:

- H.1. crude petroleum exports have an inelastic demand, the refined products react to price increases through a reduction of exports<sup>48</sup> and the oil exporters freeze the additional income;
- H.2. idem, with the additional hypothesis of an inelastic demand for the exports of refined products.
- H.3. idem, with the hypothesis that additional income for oil exporters is converted in additional demand.

**Table 3 The estimated impact on GDP of a 60% oil price increase<sup>49</sup>**

Country	H1	H2	H3
<b>Belgium</b>	- 0,48	- 0,35	
<b>Denmark</b>	- 0,82	- 0,62	- 0,09
<b>Germany</b>	- 0,82	- 0,75	
<b>Greece</b>	- 0,77	- 0,55	
<b>Spain</b>	- 0,68	- 0,58	
<b>France</b>	- 0,79 (a)	- 0,73 (a)	
<b>Italy</b>	- 1,33	-1,23	
<b>Netherlands</b>	- 2,05 (b)	-1,28 (b)	
<b>Austria</b>	- 0,69	- 0,66	
<b>Portugal</b>	- 0,76	- 0,65	
<b>Finland</b>	- 1,15	- 0,73	
<b>Sweden</b>	- 0,86	- 0,52	
<b>United Kingdom</b>	- 0,90	- 0,78	- 0,54
<b>Hungary</b>	- 1,26	- 1,17	
<b>Lithuania</b>	- 4,02	- 2,07	
<b>Poland</b>	- 0,74	- 0,67	
<b>Norway</b>	- 1,41	- 1,18	8,89

(a) Probably overestimated. Results on the base of a "use table"; (b) overestimated: we could not isolate crude petroleum from coal and lignite

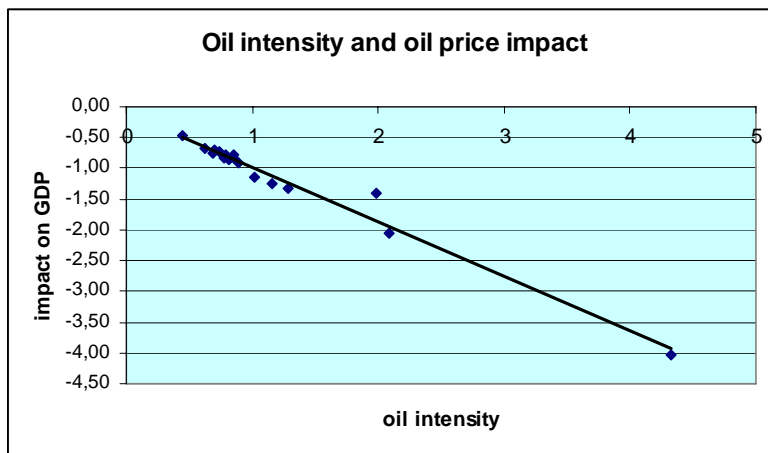
<sup>47</sup> In fact, for reason of the construction of input-output tables, these impacts refer to an oil and gas price increase. This will be a minor problem if gas price follows oil price.

<sup>48</sup> In the absence of a demand function, we hypothesize a price elasticity equal to 1

<sup>49</sup> For some countries, that have a great percentage of imports of refined products, the price of these products did not answered in a reasonable way to the oil price increase. They were excluded from this table.

These results presuppose a permanent shock and they follow precisely the oil (and gas) intensity of the different economies. Here we measured oil intensity by internal uses of crude oil (except exports) on the total of acquisitions. Similar conclusions would be obtained if we measured oil intensity in relation to GDP. No relation can be found between this impact and the level of development of different countries.

**Figure 69 Oil intensity and oil price impact**



b) The regional impact of a final energy price decrease

The aim is to construct an index of the sensibility of different regions to a decrease in the price of final energy.

Given linearity of the procedure, we choose an arbitrary percentage decrease of 10% in the price of final energy. In practice, that corresponds to a decrease of 10% in the price of the products of NACE classes referred in the last column of the table referring the data used to estimate regional energy impacts. In some cases a complete isolation of energy branches was not possible.

As explained above, we admit that an energy price decrease will have a differentiated positive impact in the production of different economic branches and that this impact in a given branch will be proportional to the importance of that branch in a given region. Unfortunately, we do not dispose of sufficient branch desegregation, so the regionalization of national impacts results in a lower differentiation among regions. The small dispersion around national average is a consequence of lack of information.

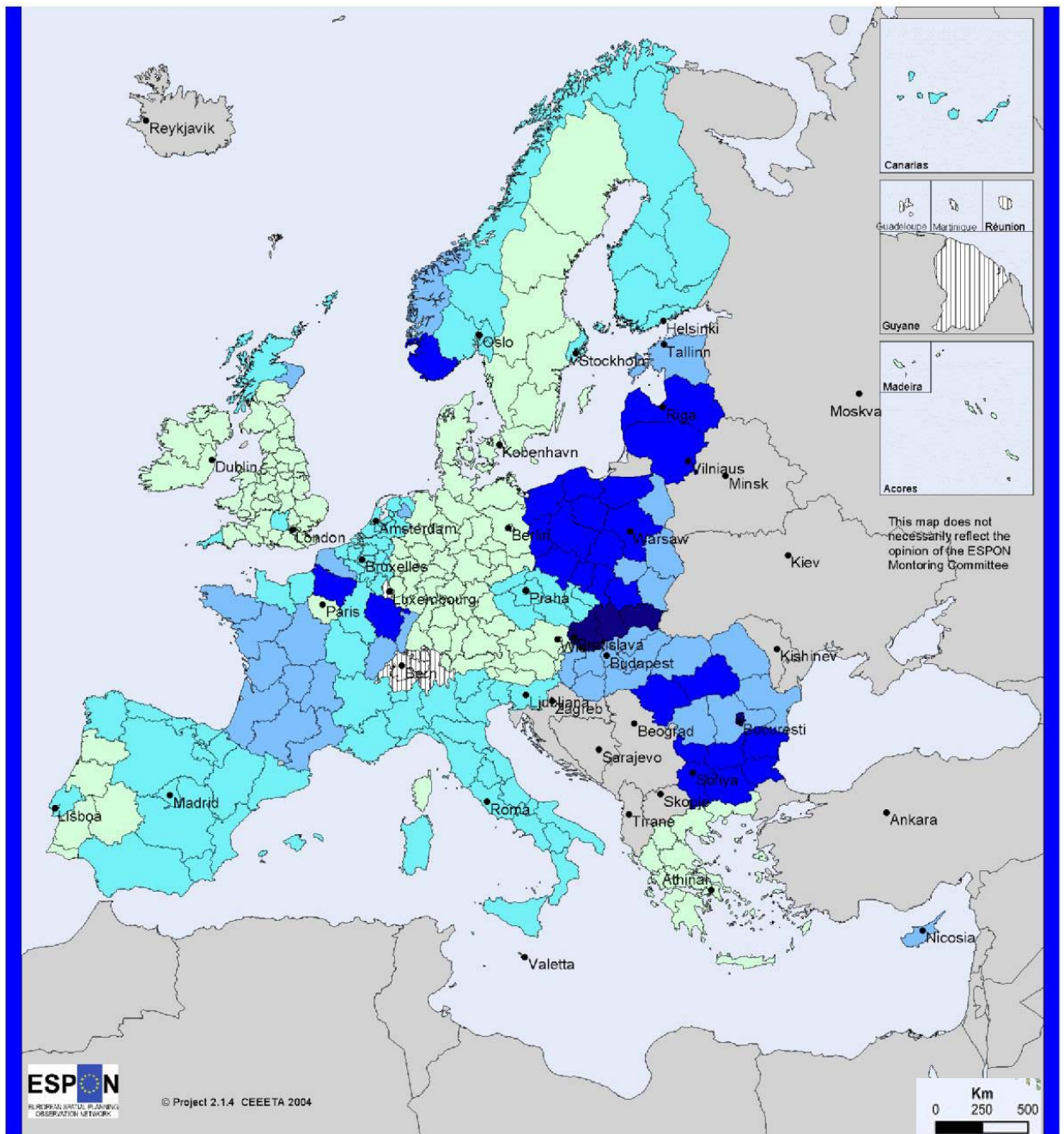
Results by regions NUTS II are presented in next tables and map<sup>50</sup>. It must be stressed that regional results are dependent on the regional pattern of employment of branches more impacted by energy prices and are distributed around the national value.

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<sup>50</sup> These numbers differ from those of an earlier version (Third Interim Report) in the way it is now possible to use input-output tables. For those countries marked yellow only a “use table” is available. We adjust results following results obtained for other countries. For Ireland the impact refers to electricity.



**Map 33 Estimated impact of 10% decrease in energy prices on regional GDP (percentage points)**



**Regional impact estimate of energy prices variation**

- 0.16 - 0.46
- 0.46 - 0.64
- 0.64 - 0.88
- 0.88 - 1.19
- 1.19 - 1.82
- No Data

© EuroGeographics Association for the administrative boundaries

Source: Eurostat, National Statistics

The impacts vary significantly among countries: in 3 countries the impact would be less than 0,4%; in 12 between 0,4% and 0,6%, in another 8 between 0,6% and 1% and in 3 countries impact could be more than 1%.

**Table 4 IMPACT ON GDP OF A 10% DECREASE IN FINAL ENERGY PRICE**

NUTS_2	REGION	GDP growth %
<b>AT</b>	<b>Austria</b>	<b>0,40</b>
AT11	Burgenland	0,38
AT12	Niederösterreich	0,38
AT13	Wien	0,43
AT21	Kärnten	0,38
AT22	Steiermark	0,39
AT31	Oberösterreich	0,39
AT32	Salzburg	0,39
AT33	Tirol	0,38
AT34	Vorarlberg	0,40
<b>BE</b>	<b>Belgium</b>	<b>0,52</b>
BE1	Région Bruxelles-capitale/Brus	0,54
BE21	Antwerpen	0,53
BE22	Limburg (B)	0,51
BE23	Oost-Vlaanderen	0,53
BE24	Vlaams Brabant	0,54
BE25	West-Vlaanderen	0,51
BE31	Brabant Wallon	0,54
BE32	Hainaut	0,50
BE33	Liège	0,51
BE34	Luxembourg (B)	0,50
BE35	Namur	0,49
<b>BG</b>	<b>Bulgaria</b>	<b>1,11</b>
BG01	Severozapaden	1,19
BG02	Severen Tsentralen	1,08
BG03	Severoiztochen	1,16
BG04	Yugozapaden	1,08
BG05	Yuzhen Tsentralen	1,11
BG06	Yugoiztochen	1,13
<b>CH</b>	<b>Switzerland</b>	
CH01	Région Lémanique	
CH02	Espace Mittelland	
CH03	Suisse Du Nord-Est	
CH04	Zürich	
CH05	Suisse Orientale	
CH06	Suisse Centrale	
CH07	Ticino	
<b>CY</b>	<b>Kypros</b>	<b>0,69</b>
<b>CZ</b>	<b>Czech Republic</b>	<b>0,61</b>
CZ01	Praha	0,63
CZ02	Strední Cechy	0,62
CZ03	Jihozápad	0,60
CZ04	Severozápad	0,62
CZ05	Severovýchod	0,60
CZ06	Jihovýchod	0,60
CZ07	Strední Morava	0,59
CZ08	Moravskoslezsko	0,60

NUTS_2	REGION	GDP growth %
<b>DE</b>	<b>Germany</b>	<b>0,38</b>
DE11	Stuttgart	0,37
DE12	Karlsruhe	0,40
DE13	Freiburg	0,36
DE14	Tübingen	0,37
DE21	Oberbayern	0,41
DE22	Niederbayern	0,35
DE23	Oberpfalz	0,35
DE24	Oberfranken	0,35
DE25	Mittelfranken	0,38
DE26	Unterfranken	0,36
DE27	Schwaben	0,36
DE3	Berlin	0,42
DE4	Brandenburg	0,36
DE5	Bremen	0,39
DE6	Hamburg	0,43
DE71	Darmstadt	0,42
DE72	Gießen	0,37
DE73	Kassel	0,36
DE8	Mecklenburg-Vorpommern	0,34
DE91	Braunschweig	0,37
DE92	Hannover	0,37
DE93	Lüneburg	0,36
DE94	Weser-Ems	0,35
DEA1	Düsseldorf	0,39
DEA2	Köln	0,38
DEA3	Münster	0,35
DEA4	Detmold	0,36
DEA5	Arnsberg	0,36
DEB1	Koblenz	0,36
DEB2	Trier	0,36
DEB3	Rheinhessen-Pfalz	0,36
DEC	Saarland	0,35
DED1	Chemnitz	0,37
DED2	Dresden	0,39
DED3	Leipzig	0,39
DEE1	Dessau	0,34
DEE2	Halle	0,35
DEE3	Magdeburg	0,34
DEF	Schleswig-Holstein	0,37
DEG	Thüringen	0,34
<b>DK</b>	<b>Danmark</b>	<b>0,45</b>
<b>EE</b>	<b>Eesti</b>	<b>0,75</b>

NUTS_2	REGION	GDP growth %
ES	Spain	0,50
ES11	Galicia	0,47
ES12	Principado de Asturias	0,49
ES13	Cantabria	0,50
ES21	Pais Vasco	0,51
ES22	Comunidad Foral de Navarra	0,49
ES23	La Rioja	0,49
ES24	Aragón	0,49
ES3	Comunidad de Madrid	0,55
ES41	Castilla y León	0,50
ES42	Castilla-la Mancha	0,47
ES43	Extremadura	0,46
ES51	Cataluña	0,52
ES52	Comunidad Valenciana	0,49
ES53	Islas Baleares	0,51
ES61	Andalucía	0,48
ES62	Région de Murcia	0,48
ES63	Ceuta y Melilla (ES)	0,51
ES7	Canarias (ES)	0,50
FI	Finland	0,53
FI13	Itä-Suomi	0,50
FI14	Väli-Suomi	0,52
FI15	Pohjois-Suomi	0,51
FI16	Uusimaa (suuralue)	0,55
FI17	Etelä-Suomi	0,54
FI2	Åland	0,52
FR	France	0,60
FR1	Île de France	0,37
FR21	Champagne-Ardenne	0,63
FR22	Picardie	0,90
FR23	Haute-Normandie	0,59
FR24	Centre	0,73
FR25	Basse-Normandie	0,59
FR26	Bourgogne	0,56
FR3	Nord - Pas-de-Calais	0,77
FR41	Lorraine	1,06
FR42	Alsace	0,68
FR43	Franche-Comté	0,87
FR51	Pays de la Loire	0,66
FR52	Bretagne	0,87
FR53	Poitou-Charentes	0,75
FR61	Aquitaine	0,79
FR62	Midi-Pyrénées	0,81
FR63	Limousin	0,74
FR71	Rhône-Alpes	0,61
FR72	Auvergne	0,66
FR81	Languedoc-Roussillon	0,75
FR82	Provence-Alpes-Côte d'Azur	0,54
FR83	Corse	0,16
GR	Greece	0,41
GR11	Anatoliki Makedonia, Thraki	0,35
GR12	Kentriki Makedonia	0,40
GR13	Dytiki Makedonia	0,41
GR14	Thessalia	0,36
GR21	Ipeiros	0,39
GR22	Ionia Nisia	0,40
GR23	Dytiki Ellada	0,36
GR24	Sterea Ellada	0,37
GR25	Peloponnisos	0,36
GR3	Attiki	0,46
GR41	Voreio Aigaio	0,39
GR42	Notio Aigaio	0,43
GR43	Kriti	0,37

NUTS_2	REGION	GDP growth %
HU	Hungary	0,78
HU01	Közép-Magyarország	0,81
HU02	Közép-Dunántúl	0,77
HU03	Nyugat-Dunántúl	0,75
HU04	Dél-Dunántúl	0,77
HU05	Észak-Magyarország	0,76
HU06	Észak-Alföld	0,77
HU07	Dél-Alföld	0,76
IE	Ireland	0,20
IE01	Border, Midlands and Western	0,19
IE02	Southern and Eastern	0,20
IT	Italy	0,54
IT11	Piemonte	0,55
IT12	Valle d'Aosta	0,53
IT13	Liguria	0,57
IT2	Lombardia	0,57
IT31	Trentino-Alto Adige	0,51
IT32	Veneto	0,54
IT33	Friuli-Venezia Giulia	0,56
IT4	Emilia-Romagna	0,54
IT51	Toscana	0,54
IT52	Umbria	0,54
IT53	Marche	0,52
IT6	Lazio	0,57
IT71	Abruzzo	0,50
IT72	Molise	0,49
IT8	Campania	0,50
IT91	Puglia	0,47
IT92	Basilicata	0,48
IT93	Calabria	0,49
ITA	Sicilia	0,48
ITB	Sardegna	0,51
LT	Lietuva	1,15
LU	Luxembourg	
LV	Latvija	0,91
MT	Malta	
NL	Netherlands	0,58
NL11	Groningen	0,59
NL12	Friesland	0,57
NL13	Drenthe	0,67
NL21	Overijssel	0,58
NL22	Gelderland	0,57
NL23	Flevoland	0,56
NL31	Utrecht	0,58
NL32	Noord-Holland	0,60
NL33	Zuid-Holland	0,58
NL34	Zeeland	0,56
NL41	Noord-Brabant	0,57
NL42	Limburg (NL)	0,59
NO	Norway	0,46
NO01	Oslo Og Akershus	0,52
NO02	Hedmark Og Oppland	0,47
NO03	Sør-Østlandet	0,48
NO04	Agder Og Rogaland	0,90
NO05	Vestlandet	0,68
NO06	Trøndelag	0,52
NO07	Nord-Norge	0,49

NUTS_2	REGION	GDP growth %
PL	Poland	0,98
PL01	Dolnoslaskie	1,02
PL02	Kujawsko-Pomorskie	0,94
PL03	Lubelskie	0,82
PL04	Lubuskie	1,02
PL05	Lódzkie	0,98
PL06	Malopolskie	0,92
PL07	Mazowieckie	0,98
PL08	Opolskie	0,96
PL09	Podkarpackie	0,86
PL0A	Podlaskie	0,82
PL0B	Pomorskie	1,03
PL0C	Slaskie	1,09
PL0D	Swietokrzyskie	0,88
PL0E	Warminsko-Mazurskie	0,99
PL0F	Wielkopolskie	0,97
PL0G	Zachodniopomorskie	1,04
PT	Portugal	0,46
PT11	Norte	0,42
PT12	Centro (PT)	0,44
PT13	Lisboa e Vale do Tejo	0,49
PT14	Alentejo	0,44
PT15	Algarve	0,46
PT2	Açores (PT)	0,44
PT3	Madeira (PT)	0,42
RO	Romenia	0,89
RO01	Nord-Est	0,73
RO02	Sud-Est	0,83
RO03	Sud	0,78
RO04	Sud-Vest	0,76
RO05	Vest	0,90
RO06	Nord-Vest	0,79
RO07	Centru	0,89
RO08	Bucuresti	1,31
SE	Sweden	0,44
SE01	Stockholm	0,47
SE02	Östra Mellansverige	0,44
SE04	Sydsverige	0,42
SE06	Norra Mellansverige	0,42
SE07	Mellersta Norrland	0,43
SE08	Övre Norrland	0,42
SE09	Småland med öarna	0,43
SE0A	Västssverige	0,43
SI	Slovenija	0,64

NUTS_2	REGION	GDP growth %
SK	Slovakia	1,64
SK01	Bratislavský	1,81
SK02	Západné Slovensko	1,59
SK03	Stredné Slovensko	1,58
SK04	Východné Slovensko	1,57
UK	United Kingdom	0,44
UKC1	Tees Valley and Durham	0,43
UKC2	Northumberland, Tyne and W	0,44
UKD1	Cumbria	0,43
UKD2	Cheshire	0,45
UKD3	Greater Manchester	0,43
UKD4	Lancashire	0,44
UKD5	Merseyside	0,42
UKE1	East Riding and North Lincoln	0,43
UKE2	North Yorkshire	0,43
UKE3	South Yorkshire	0,43
UKE4	West Yorkshire	0,45
UKF1	Derbyshire and Nottinghamsh	0,46
UKF2	Leicestershire, Rutland and N	0,45
UKF3	Lincolnshire	0,44
UKG1	Herefordshire, Worcestershir	0,45
UKG2	Shropshire and Staffordshire	0,45
UKG3	West Midlands	0,44
UKH1	East Anglia	0,44
UKH2	Bedfordshire, Hertfordshire	0,45
UKH3	Essex	0,45
UKI1	Inner London	0,46
UKI2	Outer London	0,45
UKJ1	Berkshire, Bucks and Oxford	0,47
UKJ2	Surrey, East and West Susse	0,45
UKJ3	Hampshire and Isle of Wight	0,44
UKJ4	Kent	0,43
UKK1	Gloucestershire, Wiltshire an	0,44
UKK2	Dorset and Somerset	0,45
UKK3	Cornwall and Isles of Scilly	0,48
UKK4	Devon	0,44
UKL1	West Wales and The Valleys	0,42
UKL2	East Wales	0,43
UKM1	North Eastern Scotland	0,65
UKM2	Eastern Scotland	0,44
UKM3	South Western Scotland	0,44
UKM4	Highlands and Islands	0,47
UKN	Northern Ireland	0,43

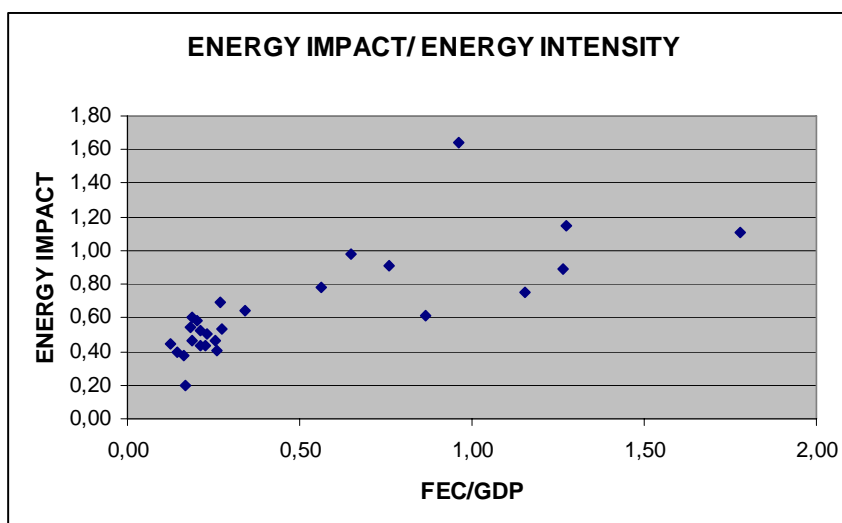
Several factors may determine the intensity of the impact.

First, the industrial structure and the degree of integration of productive fabric determine how the variation of energy price spreads over the different economic branches. The share of energy going to intermediary inputs and to final consumption is also relevant for the total impact.

Second, the energy intensity of the economy determines the amount of the percentage impact. Next chart shows the relation between energy intensity of GDP and the impact of the energy price increase.

Third, differences in energy prices imply that energy has an economic weight different of that indicated by energy intensity. From input-output tables we calculate that the percentage of final energy in “total uses” vary in a relation of 1:4 and the correlation between this weight and the calculated energy price impact is about 0,87.

**Figure 70 Energy impact / Energy intensity**



It seems there is an inverse relation between energy impact and development level (correlation=-0,75). Except for Czech Republic and Slovenia, Eastern countries occupy the first seven positions in terms of energy price impact and the most developed countries are normally in the lower half of the ranking. This implies that energy policy can be a relevant contribute to European cohesion, although no such relation can be found for regional distribution inside each country.

Having in mind the severe difficulties of gathering pertinent data to establish econometric relations between spatial patterns of energy and development,

it seems that achieving an impact indicator in the way above mentioned is a great advance in understanding the territorial impact of energy policy.

We are perfectly aware of the meaning of the restrictive hypothesis and of the weakness of the model, although our main objective has been to construct an indicator of territorial impact, and, for an indicator, correct proportionality is the more important feature.

When we go to regional level, comes clear that this methodological framework does not take into account the potential impacts on location of different firms and assumes a constant regional pattern of a given sector. But, change in regional pattern is a question of long term and energy impacts seem to be small and to vanish in the long term. Changes in location caused by energy can occur at a small territorial level (where may be relevant to have or not to have access to cheaper energy source) but will be insignificant at a macro-regional scale, even for energy-intensive industries where other location factors will be more relevant. In addition, market liberalisation will tend to reduce (regional) disparities in energy prices for a given kind of consumers and make the price less dependent on consumers' location. Also, it does not consider the impacts on interregional trade. As it is presented, the model assumes some impact derived from national exports. But it is not symmetrical as there are no corresponding imports in any other country.

### 2.8.3 Relevant conclusions

Energy is a crucial development factor. But European societies reached to make energy available almost everywhere and territorial differences in energy will have only a small impact on regional performances.

Although we estimate a small economic impact of energy price (elasticity of GDP related to energy price is less than 0.06 for 13 countries), our estimates point to important differences between countries and regions, with elasticity GDP/energy ranging from 0,038 in Germany<sup>51</sup> to 0,164 in Slovak Republic.

As impact tends to be higher in less developed countries, energy policy can be a tool of the European cohesion policy.

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<sup>51</sup> The lower value of Ireland is not directly comparable.

### 3 European Union Energy policy and indicators

EU energy policy is still directed towards the long-term energy objectives set out in 1995 in the 'White Paper on Energy Policy for the European Union'<sup>52</sup>. According to the White Paper, "energy policy must form part of the general aims of the Community's economic policy based on market integration, deregulation, public intervention limited to what is strictly necessary in order to safeguard the public interest and welfare, sustainable development, consumer protection and economic and social cohesion. However, beyond those general aims energy policy must pursue particular aims (in the energy sector) that reconcile competitiveness, security of supply and protection of the environment ...".

The EU countries are heavily dependent on oil. Energy import dependence is about 50% and active policies have to be adopted in the near future in order to reduce the importance of imports.

As instruments to deal with the security of energy supply, energy efficiency in the consuming sectors and the increasing role of renewable energy sources are being promoted. ALTENER, SAVE and Joule programmes have been important instruments to promote technologies, good practices and institutional reforms in the energy fields. These programs have also had important impacts at local and transnational level by the support to the creation of energy agencies and multinational co-operation projects.

The 2000 Green Paper "Towards a European strategy for the security of energy supply" discusses the Europe's structural weaknesses: high growth rates for energy consumption and increasing dependency on external sources of energy, while there are strict targets on CO<sub>2</sub> emissions according to the Kyoto Protocol negotiations.

The mentioned Green Paper proposes a strategy to diversify energy imports and to reduce energy consumption through improved energy efficiency and a higher use of renewable energy sources. The promotion of local initiatives has been considered as an instrument for reaching the targets set out in the Green Paper. The support to local energy agencies has been fundamental in this strategy.

Local and regional energy agencies have an important role and influence on local energy policy and decision making. They contribute to the sustainability

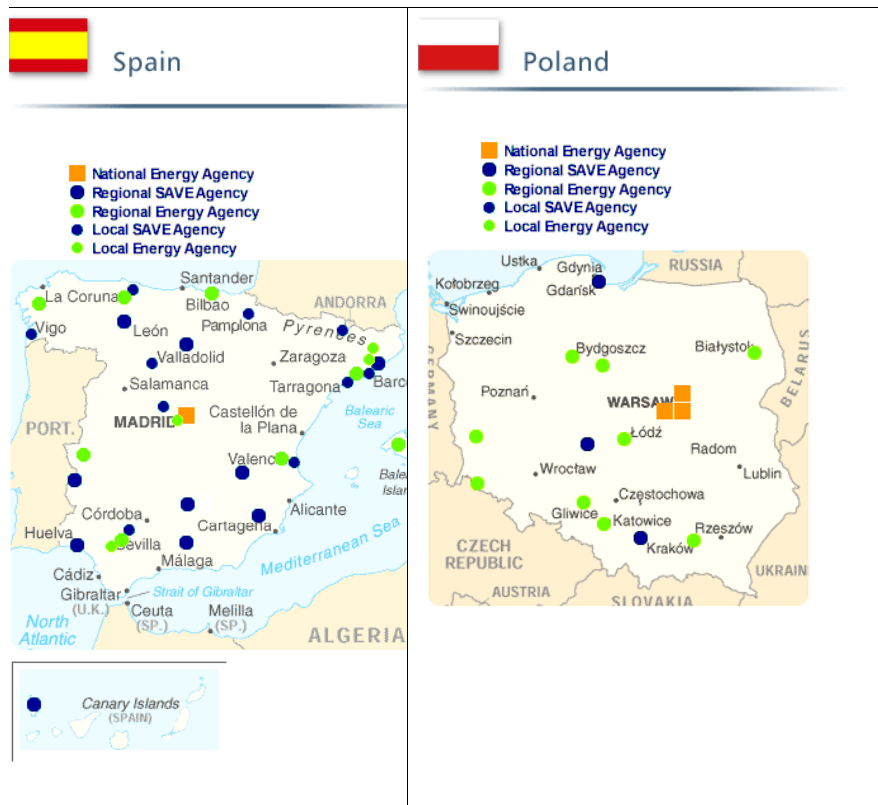
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<sup>52</sup> (COM (95)682) [http://www.europarl.eu.int/factsheets/4\\_12\\_0\\_en.htm](http://www.europarl.eu.int/factsheets/4_12_0_en.htm) - note1#note1



of regions by introducing good practices in energy management and by focusing a considerable effort in the promotion of local energy resources. Hundreds of such agencies are now established in all the EU countries, as exemplified in Fig. 1 for Spain and Poland.

**Figure 71 Local energy agencies in Spain and Poland**



Renewables and distributed generation are energy supply technologies that are expected to have a high contribution to local development, by promoting endogenous resources and creating opportunities for new economic activities. The White Paper "Renewable energy: White Paper laying down a Community strategy and action plan" has as objective to attain, by 2010, a minimum penetration of 12% of renewable energy sources in the European Union. A Directive on the "Promotion of production of electricity from renewable energy sources" (Directive 2001/77/EC) confirmed the target of 12% of renewables in the EU energy systems while fixing a target of 22,1% of electricity produced from renewable sources. This target will impact positively on security of supply, environment and social and economic cohesion. This directive also constitutes an important item of the package of measures needed to comply with the commitments made by EU under the Kyoto Protocol.



The creation of a single market for energy is also a part of the EU energy policy. Directives adopting common rules for electricity (Council Directive 90/547/EEC of 29 October 1990) and gas (Council Directive 91/296/EEC of 31 May 1991) aiming to the free transit and market transparency are nowadays part of the *acquis-communautaire*.

The development of trans-European networks is also part of the strategy to accomplish the internal market for energy. The Council Decision 96/391/EC of 28 March 1996 lays down a series of measures aimed at creating a more favourable context for the development of trans-European networks in the energy sector, thus creating the conditions for the development of co-operation projects within regions in different continents (mainly Europe, Africa and Asia). In this context some 74 projects of common interest have been identified.

The transport sector has a key role in the interface with the energy sector. About 40% of the final energy demand is consumed in the transport sector of which 98% are oil products. Future developments of the sector will consider diversification to other less polluting sources like electricity, gas and biofuels. To encourage diversification fiscal measures as well as the introduction of biofuels are part of the policies being adopted by the EU countries.

EU Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport was adopted in 2003. The Directive aims to promote the use of biofuels or other renewable fuels as a substitute for petrol or diesel in the transport sector.

It requires Member States to take account of the reference values prescribed in Article 3(1) in setting their national indicative targets. These reference values are:

- 2 percent, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2005.
- 5.75 percent, calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on their markets by 31 December 2010.

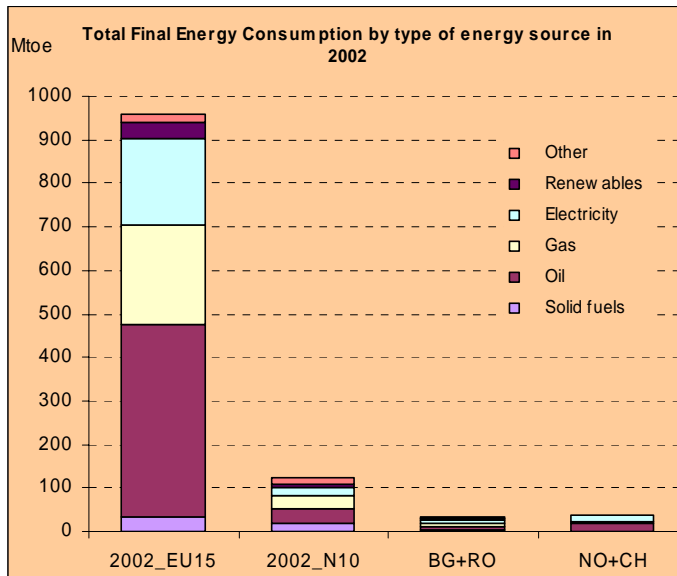
Biofuel policy for the transport sector is expected to have a high impact on regional development, mainly in agricultural regions where the negative impacts of the Common Agriculture Policy can be reversed by the new opportunities created for energy crops.

Nuclear energy is nowadays a very sensitive aspect in the energy debate. It is a clean technology in what greenhouse gases are concerned but security, deposits of radioactive residues and power stations dismantlement are still important barriers to the development of this energy carrier. The fusion technology is still far from the market and notwithstanding the huge sums of resources devoted to research it is not expected to become competitive in the next 30-40 years.

Comparing the European Union countries with the accession countries in terms of total final energy demand the main energy systems differences come as follows:

- EU countries rely less on solid fuels and more on natural gas;
- Coal is still very important in the accession countries because of the important endogenous proven reserves. Some capacity has been dismantled, because of the huge environmental problems (CO<sub>2</sub> emissions and acid rains) while the productivity has been improved in the coal mines of certain countries;
- There is a substitution movement from coal to natural gas for electricity production;
- Industry as an energy consuming sector has lost importance because of the structural political and economic reforms experienced in these countries during the nineties;
- The nuclear power stations in some countries have severe security problems and negotiations are or have been done with EU along the negotiations process in order to close some of the most sensitive reactors;
- Renewable energy sources other than hydro have some important barriers in the accession countries. Excess electricity generation capacity in some countries, still subsidized prices and lack of financial incentives are among some of the most relevant barriers.
- The energy market reforms are still being conducted and will approach the *acquis communautaire* in a near future. The public ownership of energy utilities is still very important in some countries.
- Huge investments in the energy sector are necessary to increase competitiveness and improve the energy services quality.

**Figure 72 Total final energy demand by type of energy in 2002**



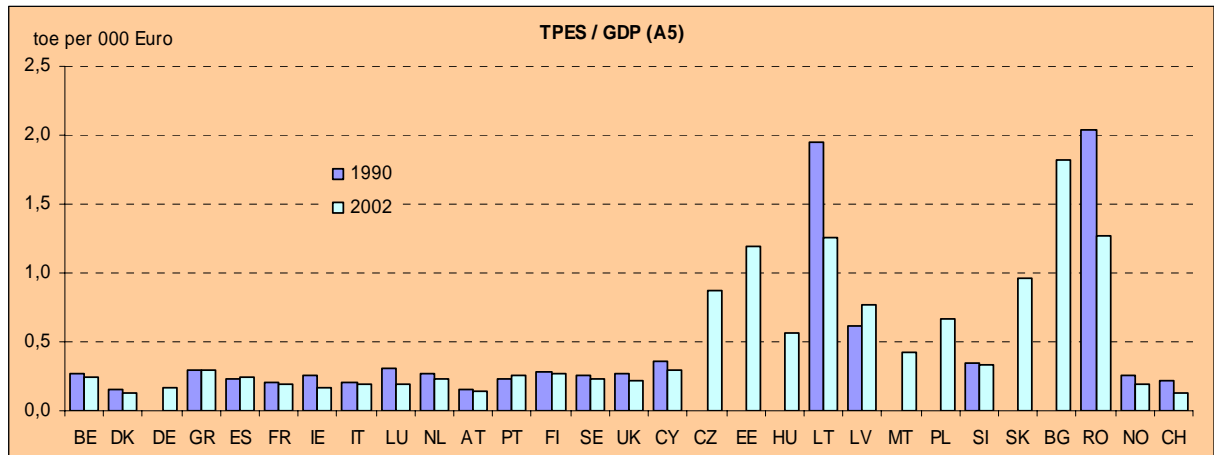
Source: Eurostat.

Four main pillars of the European Union energy strategy have been outlined in the European Commission Green Paper on Energy Security (November 2000): (i) security of supply, (ii) completion of the internal market, (iii) environmental challenge and (iv) promotion of renewable energy and demand management.

The enlargement of EU with the accession of a number of Central and Eastern European states will confirm the current trends that can be observed in the EU15: increasing energy demand, relying mainly on imported fossil fuels, which will ask for new investments in gas, oil and electricity networks.

The accession countries will induce more pressure on security of supply, because of the dependence on oil, of the low energy efficiency, of the different legal and regulatory frameworks and of the expected increased demand associated to new development patterns. These countries must also conduct energy market reforms which can induce increasing energy prices necessary to finance modernization investments (in renewables and in rational use of energy across the economy).

**Figure 73 Energy intensity for the enlarged Europe between 1990/2002**



Source: DGET and Eurostat.

The energy intensity measured as total energy demand per unit of GDP shows clearly the huge investments that have to be done in the accession countries in energy efficiency. If we take into account the tendency for increasing prices in the candidate countries, as a consequence of liberalization of the markets and elimination of subsidies prices, we can imagine how important rational use of energy is for competitiveness.

In the candidate countries energy at local level has an important role as a source of heat for space heating. District heating infrastructures have in general to be refurbished for efficiency reasons. Small installations for distributed generation of electricity and heat are appropriate and in the rural areas there is a market to be developed for biomass as a fuel for district heating.

**Figure 74 Final energy consumption between 1990/1995/2000**



Source DGET and Eurostat.

Among the main challenges facing the European Union countries we must point out Kyoto targets for greenhouse gas emissions and ceilings for the acidification gases (Gothenburg agreements), implying strong actions on rational use of energy, renewables development, changing the energy mix towards less oil products and coal and more natural gas.

In the framework of the Kyoto protocol there is space for project co-operation among countries. Joint Implementation projects can be an efficient instrument for the transfer of technology for the candidate countries. Renewable sources development is among the more promising fields for investment, with a huge impact in local development. Wind and biomass for energy production are natural candidates.

Figures 4 and 5 illustrate clearly the potential for emissions trading benefits in the accession countries and for business co-operation, including foreign investment in the energy intensive industries owing to weaker restrictions in what greenhouse gases are concerned.

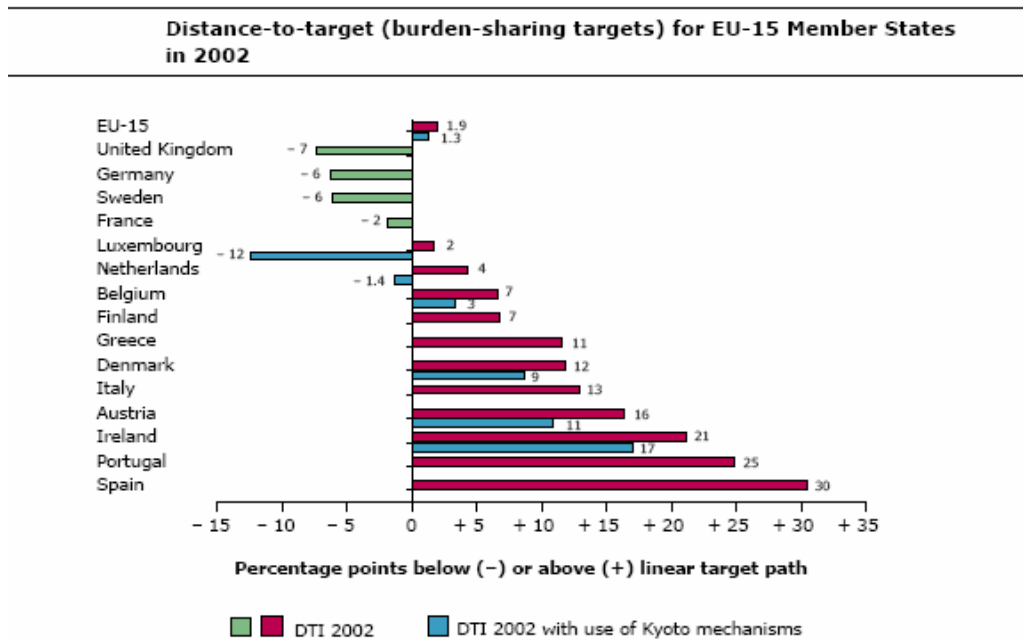
With the enlargement new advantages will emerge in terms of new markets and new opportunities for investment. The Energy Charter Treaty<sup>53</sup> has opened an opportunity window for political commitment in East-West energy co-operation. The enlarged market will create additional needs for interconnection in order to solve some critical interconnection weaknesses in free energy transit which are identified in EURELECTRIC & UCTE (2002)<sup>54</sup> for the European grid. In fact the European Directive 96/920EC has contributed to important improvements in the transnational networks. However we are still far from a single market and even for EU15 the demand is much higher than the offer, which implies some congestion management. The situation will be much worse if we consider EU25.

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<sup>53</sup> The Energy Charter Treaty of 17 December 1994 OJ N° L 69 of 9 March 1998

<sup>54</sup> European Interconnection: State of the Art 2002

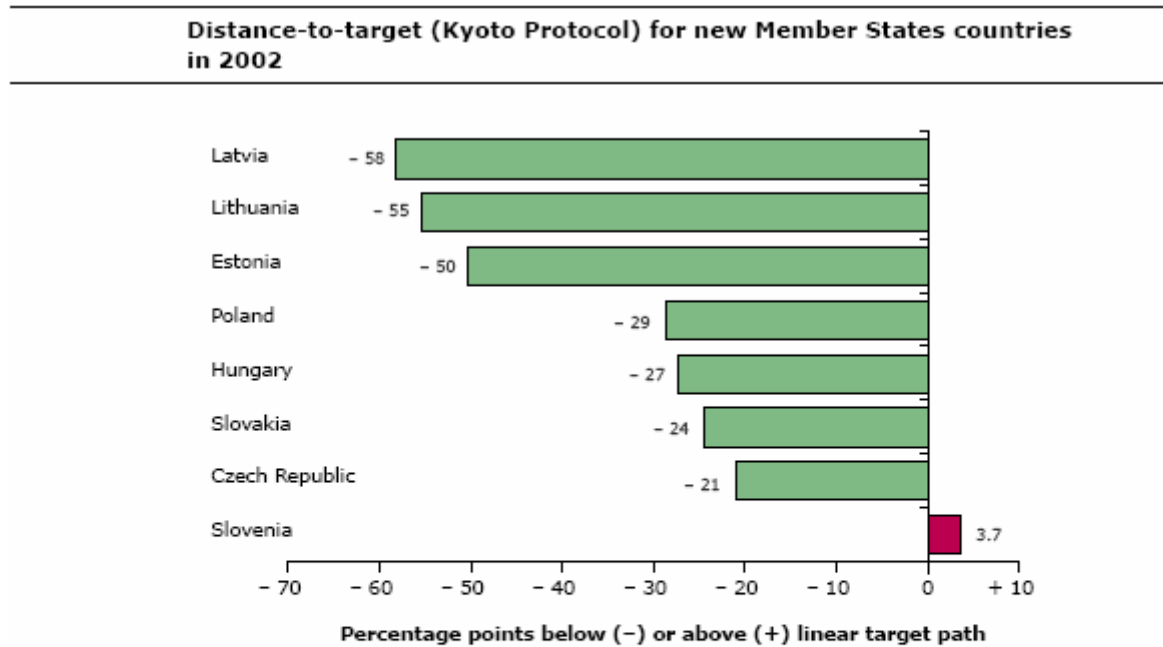
**Figure 75 Distance to target indicators for the Kyoto Protocol**



**Note:** The distance-to-target indicator (DTI) measures the deviation of actual emissions in 2002 from a (hypothetical) linear path between base-year emissions and the burden-sharing target for 2010. A positive value suggests an under-achievement and a negative value an over-achievement by 2002. The DTI is used as an early indication of progress towards the Kyoto and Member States' burden-sharing targets. It assumes that the Member States meet their targets entirely on the basis of domestic policies and measures. Therefore, for those Member States in an advanced stage of implementing Kyoto mechanisms a second DTI estimate is presented, showing the additional effects of the use of these mechanisms in 2002.

(Source: EEA (2004), "Greenhouse gas emission trends in Europe",

**Figure 76 Greenhouse gas emissions of 10 candidate countries compared with their Kyoto Protocol**



**Note:** The distance-to-target indicator (DTI) measures the deviation of actual emissions in 2002 from a (hypothetical) linear target path between 1990 and 2010. A positive value suggests an under-achievement by 2002 and a negative value an over-achievement in 2002. The DTI is used as an early indication of progress towards the Kyoto targets. It assumes that the countries meet their targets entirely on the basis of domestic policies and measures. Countries with base-years other than 1990 are Hungary (average 1985–87), Poland (1988) and Slovenia (1986). Due to lack of more recent data, for Poland the DTI refers to 2001.

(Source: EEA (2004), "Greenhouse gas emission trends in Europe",

Renewable Energy Sources can play a major role in contributing to a wide range of EU policy goals. The development of a successful EU renewables sector would make a useful long-term contribution to diversity, security and self-sufficiency of energy supply, both at national and local level. As low environmental impacts is one of their main benefits, RES could play a leading role in mitigating the environmental negative effects of energy use, since almost all the RES technologies offer major reductions in harmful emissions when compared with fossil fuels. Furthermore, exploitation of RES would create employment (particularly amongst SME), increase exportations if technology development is pursued, and promote social and economic cohesion, particularly in remote and rural regions.



Many of the RES technologies are well suited for application in remote rural areas (e.g. solar, wind power and biomass, including biofuels production) and have the additional benefit that they create local employment. It is therefore clear that an increase in the deployment of RES technologies would provide new opportunities for the populations of the less developed regions. The higher availability of some RES such as wind, solar and geothermal in such regions is also likely to encourage the larger industries to create local jobs and thus to build closer working relationships and strengthen cohesion across the EU.

A study<sup>55</sup> calculating the effects of renewable energy on EU employment shows that:

- An increase in energy provided from RES can result in the creation of over 900,000 new jobs by 2020, 385,000 jobs are predicted to be created by 2020 from provision of renewable energy, and a further 515,000 jobs from biomass fuel production. This increase takes account of the direct, indirect and subsidy effects on employment and jobs displaced from conventional energy technologies.
- Jobs gains are greatest from biomass technologies - both in the biomass energy industry and in fuel supply - however all technologies show long-term net job creation.
- Renewable energy technologies are in general more labour intensive than conventional energy technologies, in delivering the same amount of energy output.
- Jobs displaced as a result of subsidies to support renewable energy deployment are significantly less than corresponding job gains (both direct and indirect impacts) elsewhere in the economy.
- Job gains are greatest in the agriculture and manufacturing industrial sectors. The conventional energy supply industry is predicted to lose less than 2% of its work force by 2020 as a consequence of the shift to a greater use of energy from renewable sources.
- Employment creation occurs in all Member States.

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<sup>55</sup> The impact of renewables on employment and economic growth (1999). Internet site: <http://www.eufores.org/Employment.htm>

### 3.1 Major EU Energy policy headlines and its territorial impact factors.

As discussed in the previous reports, energy's importance to regional development has not deserved enough attention. The traditional framework of spatial reference – made up of national territories – and the fact that electricity can be transported at relatively low cost - and its prices should not show significant differences - led observers to view energy as something ubiquitous, with no major impact on decisions regarding business location and conditions of competitiveness.

One can identify different types of energy territorial impacts: employment and GDP, location as a competitiveness factor, income transfer, household behaviour and quality of life and environment as discussed before.

In the following section it is done a more focused analysis on the main headline energy policies on the current EU Agenda and its territorial impact. An assessment of the major headlines based on its objectives and supporting documents and their potential territorial impact is shown.

Following this overview of the EU energy policy a survey is done on each country's energy policy and developments.

## 1. SECURITY OF ENERGY SUPPLY

### SUPPORTING DOCUMENTS AND ISSUES

- Green Paper;
- Minimum stock levels of crude oil and/or petroleum products;
- Security of supply of natural gas;
- Security of supply for petroleum products.

### OBJECTIVES

To ensure, for the well-being of its citizens and for the proper functioning of the economy, the uninterrupted physical availability of energy products on the market at an affordable price for all consumers, whilst respecting environmental concerns and looking towards sustainable development.

Rebalance its supply policy by clear action in favour of a demand policy.

Undertake an analysis of the contribution of nuclear energy in the middle term.

Provide a stronger mechanism to build up strategic stocks and to foresee new import routes for increasing amounts of oil and gas.

### POTENTIAL TERRITORIAL IMPACT FACTORS

- Environmental concerns influencing energy choices - the action to combat against climate change will promote the use of local energy sources as well as energy efficient technologies. Technological development, job creation and reinforcement of other infra-structures: telecommunications, transports, health and education.
- Possible new infrastructure on electricity generation: both centralized and decentralized and corresponding further income for local authorities.
- Reduction of environmental impacts: air quality, water quality and resource management, soils conservation, noise reduction, biodiversity protection, etc.
- Renewable energy projects normally bring further income to local authorities.
- Major concern on security of supply either by the use of decentralized generation (renewables and CHP), as well as further energy reserves improves the avoidance of blackout happenings with its known consequences as well as major effects of terrorist attacks.
- Development of the internal market has given both a new place and role to energy demand which could lead to political tension, e.g. the fall in prices could thwart the action to combat climate change. It is up to the societies themselves to find satisfactory compromises.

## 2. INTERNAL MARKET IN ENERGY

### SUPPORTING DOCUMENTS AND ISSUES

- Price transparency;
- Transit of electricity through transmission grids;
- Transit of natural gas through transmission grids;
- Coordination of procurement procedures of entities operating in the water, energy, transport and telecommunications sectors;
- Common rules for the internal market in electricity;
- Common rules for the internal market in natural gas;
- Conditions for granting and using authorizations for the prospection, exploration and production of hydrocarbons;
- Completing the internal energy market;
- Completing the internal energy market: revision of the Directives concerning common rules for the internal market in electricity and natural gas;
- Completing the internal energy market: cross-border exchanges in electricity.

### OBJECTIVES

Creation of one truly integrated single market for energy which would provide the European Union with a competitive market and a secure energy supply.

Appropriate rules with respect to the pricing of cross-border trade; rules for allocation and management of scarce interconnection capacity; and where economically justified, the increase of existing physical interconnection capacity.

### POTENTIAL TERRITORIAL IMPACT FACTORS

- Changes in taxes for cross-border trade.
- Development of actions for congestion management.
- New industry placements by the expansion of the natural gas and electricity grids.
- Lower price disparities and reduction of the weight of energy in location decisions.
- Supply more responsive to the market: risk of minor interest in supplying less developed and isolated regions.
- Creation of a local R&D technology base.
- Development of physical infrastructure both in energy and other satellite sectors. Expansion of multi-product companies (e.g. metallurgy), better competition conditions and creation of alternative markets. Creation of regional utilities (gas and electricity).
- Public service objectives right of households to receive an electricity supply on reasonable terms, the protection of vulnerable consumers and environmental protection.
- Positive influence on both quantitative and qualitative aspects of employment.

### 3. ENERGY AND SUSTAINABLE DEVELOPMENT

#### SUPPORTING DOCUMENTS AND ISSUES

- Global partnership for sustainable development;
- Strategy for sustainable development;
- Integrating of environmental considerations in Community energy policy;
- The energy dimension of climate change.

#### OBJECTIVES

Incorporate the environmental dimension into its objectives and actions while developing a sustainable energy policy.

#### POTENTIAL TERRITORIAL IMPACT FACTORS

- On large combustion plants there might be possible decommissions (e.g. old coal power plants or the disposal of disused offshore oil and gas installations).
- Combined heat and power production and renewable energies development. Soil occupation by these investment projects might bring further income to local authorities. These additional incomes might allow local authorities to invest in further basic infrastructures: telecommunications, health, transport, education, etc.
- In addition, new legislative measures had been proposed concerning the taxation of energy products representing further income to local authorities.
- Waste incineration and polluting emissions from motor vehicles controlled and local environment benefits.
- Improvements in the industrial tissue, by the use of more efficient and less consuming technologies.
- Possibilities of new agricultural (energy) productions and renewed opportunities for rural areas.

## 4. ENERGY EFFICIENCY

### SUPPORTING DOCUMENTS AND ISSUES

- Towards a strategy for the rational use of energy
- Energy **efficiency requirements**:
  - Energy performance of buildings;
  - Energy certification of buildings;
  - Ballasts for fluorescent lighting;
  - Energy efficiency for refrigerators;
  - Energy efficiency for hot-water boilers.
- Labelling of **energy efficient products**:
  - Household appliances;
  - Office appliances: Energy Star programme;
  - Cogeneration.

### OBJECTIVES

To prepare the ground for common policies and actions in line with the Kyoto commitments.

### POTENTIAL TERRITORIAL IMPACT FACTORS

- Energy efficient buildings;
- Limit carbon dioxide emissions;
- Energy-efficient household appliances and other end-use equipment;
- Wider use of negotiated and long-term agreements on minimum efficiency requirements;
- Energy efficiency in the electricity and gas sectors and combined heat and power (CHP);
- Energy management and public and cooperative technology procurement.
- Better living conditions (air quality, lighting and thermal comfort in buildings accompanied by general economic savings.
- Development of decentralised generation and blackout and terrorist avoidance.
- Creation of a local R&D technological basis.
- Wise management of mobility systems and new concepts for urban development.

## 5. RENEWABLE ENERGY SOURCES

### SUPPORTING DOCUMENTS AND ISSUES

- White Paper laying down a Community strategy and action plan;
- Promotion of electricity from renewable energy sources;
- Promotion of biofuels use in transport;
- Programme "Intelligent Energy – Europe" (2003-2006);
- 6th Framework Programme on Research, Technology Development and Demonstration (2002-2006).

### OBJECTIVES

To give a boost to stepping up the contribution of these energies while respecting the principles of the internal market.

### POTENTIAL TERRITORIAL IMPACT FACTORS

- Make greater use of the potential available;
- Help further cut CO2 levels;
- Reduce energy dependence;
- Develop the national industry;
- Create jobs.
- Development of agriculture through expansion of energy for pumping and irrigation;
- Better regulation of hydrological flows (small and micro hydro power);
- Better use of local agricultural and animal breeding residues, implying less soil contamination, and additional energy sources (biogas and other agricultural residues);
- Economic savings,
- creation of additional green areas,
- creation of new factories: e.g. biofuels production, and other local activities (alternative agricultural use of soils, collection and distribution of materials)
- Alternative to traditional agriculture – biofuels
- By the use of forest residues, improvement of forest cleaning and reduction of potential forest fires,
- Improvement of local environment: quality of soil, water, air and noise.

## 6. TAXATION OF ENERGY PRODUCTS

### SUPPORTING DOCUMENTS AND ISSUES

- Community framework for the taxation of energy products
- Tax on carbon dioxide emissions and energy

### OBJECTIVES

To determine an overall tax system for the taxation of energy products, with a view to improving the functioning of the internal market, encouraging behaviour conducive to protection of the environment and promoting the greater use of the factor labour.

To limit the emission of greenhouse gases and promote efficient use of energy by introducing in the Member States, an additional harmonized tax on carbon dioxide emissions and energy content.

### POTENTIAL TERRITORIAL IMPACT FACTORS

- Agricultural, horticultural or fish farming works, and forestry;
- Improvements in:
  - stationary motors;
  - plant and machinery used in construction, civil engineering and public works;
  - vehicles intended for use off the public roadway;
  - passenger transport and captive fleets which provide services to public bodies.
- Improvement in traffic at city centres and improvement of conditions for tourism and other tertiary sector activities.
- The situation of energy-intensive firms by including additional provisions (reductions and exemptions) in order to safeguard the competitiveness of industry.
- The need to save energy and reduce carbon gas emissions by allowing Member States to introduce, subject to Community competition rules, tax incentives for new investment in this field.



## 7. NUCLEAR ENERGY

### SUPPORTING DOCUMENTS AND ISSUES

SURE programme: nuclear safety.

- Nuclear safety in the Newly Independent States and Central and Eastern Europe;
- Dangers arising from ionising radiation;
- Waste
- Shipments of radioactive substances between Member States;
- Transfer of radioactive waste: supervision and control.

### OBJECTIVES

To improve the safe transport of radioactive materials in the European Union and the safety of nuclear installations in countries participating in the TACIS programme by means of increased cooperation in the field of safeguards and industrial cooperation.

### POTENTIAL TERRITORIAL IMPACT FACTORS

- Reduction of incidents which have occurred during transport;
- Cooperating with the TACIS countries on safe transport;
- Improvements of nuclear safeguards;
- The development of modern logistical, evaluation and control equipment and the relevant training;
- Development and transfer of European technologies by means of cooperation in industry and between regulatory bodies;
- Promoting cooperation between partners from the Community and the TACIS countries (e.g. in the form of joint industrial projects).

## 8. TRANS-EUROPEAN NETWORKS

### SUPPORTING DOCUMENTS AND ISSUES

- Declaration of interest concerning the transmission of electricity and natural gas;
- General rules for the granting of Community financial aid in the field of trans-European networks;
- Guidelines on trans-European energy networks;
- Set of actions relating to trans-European networks in the energy sector;
- The external dimension of trans-European energy networks.

### OBJECTIVES

Granting to facilitate private financing of the projects

### POTENTIAL TERRITORIAL IMPACT FACTORS

- Promote cross-border projects;
- Promotion of employment creation;
- Development of international cooperation and local development;
- Reinforce the security of the Community's energy supplies.
- Connection of isolated electricity networks to the interconnected European networks;
- Improvement of the reliability and security of the Community's electricity supply networks or to supplying the Community with electricity.
- Introduction of natural gas into new regions;
- Increase the transmission, reception and storage capacities (needed to satisfy demand) and diversification of supply sources and routes for natural gas

## 9. COOPERATION WITH THIRD COUNTRIES

### SUPPORTING DOCUMENTS AND ISSUES

European Energy Charter

- The Northern Dimension of the European energy policy
- Euro-Mediterranean Cooperation
- Cooperation between the United States and Euratom in the field of fusion energy

### OBJECTIVES

The promotion of energy efficiency policies consistent with sustainable development;

### POTENTIAL TERRITORIAL IMPACT FACTORS

- The creation of conditions which induce producers and consumers to use energy as economically, efficiently and environmentally soundly as possible;
- The fostering of cooperation in the field of energy efficiency.

#### NOTE:

Please see annex 9 - EU Energy policy documents for further details on the EU Energy Policy.

## 3.2 Potential policy territorial impacts

Links between energy policy and territory have three basic drivers: investment, prices and income transfer. Impacts of energy policy can then be measured in terms of industry development, welfare and environment.

In this section our aim is to briefly discuss potential impacts of European energy policy headlines on territorial development.

Firstly we will set out what we meant by each of the impact carriers quoted above.

**Investment** means in this context all energy infra-structure development, led by public or private financing. These could be related to the commissioning of energy production facilities, grid construction or improvement, etc. There are in a larger or lesser extent exploitation expenses and revenues associated to every energy investment. This will be considered in our assessment associated under the same heading.

Investment effects are, per se, positives in principle, the better if they are applied in less developed or remote regions, either from the infra-structure development itself, or from the exploitation effects. It must be emphasized anyway, that a minimum level of socio-economic fabric density is required to allow those regions to capture significant shares of potential benefits.

**Prices** reflect changes in the costs of energy either in production, distribution or consumption that may change the behaviour of producers, distributors or consumers. These can derive from taxation or energy sector (production, distribution and consumption) factors.

We assume that price changes have two levels of impact. One, that we may call for simplicity an income effect, where price level changes have direct impact on the economy pushing on the opposite direction of the price movement (an increase in prices pressing for a reduction on total economic activity, and a decrease acting in the reverse direction). Ahead in this report we provide evidence that these forces can be considered important, at least on the short run. A second effect, that we may call the structural effect can induce technological changes to accommodate price increases (or delay it if energy prices are reduced) or at a limit situation force relocation of industrial facilities. As it is also said ahead, relocation would hardly be derived from energy price effects alone.

**Income transfer** effects aim to capture the effects associated with the fiscal redistribution, changes on the location of energy production facilities or redistribution of energy production ownership.

Under this heading we are then considering existing possibilities of taxation revenue derived from energy policies as the more obvious effect. If a tax is levied (or raised) on energy products its revenue can be used to improve the living conditions or the economic infra-structures of less developed regions, thus improving competitiveness for the benefited territories.

But energy policy can also provide a change in the balance of the energy producing regions. Renewables are much likely to be established in less developed or remote regions, thus transforming a traditionally depleted area in an energy exporter. This could mean that income is transferred from consuming areas towards the new producing areas.

But this reasoning is not fully achieved unless the ownership of producing facilities and distribution companies is considered. The internal market (and privatization) can mean, in the end, that the ownership of energy companies and producing facilities are located outside production or consuming territories, thus inducing income transfers hard to trace.

A third line of potential income transfers can be obtained via emission rights market.

Assuming the aforementioned potential territorial impact factors we may assume an impact chart like follows.

**Table 5      Table 1 – Potential territorial impacts of energy policies**

Policy headlines	Impact carriers		
	Investment	Prices	Income transfer
Security of energy supply			
Internal market in energy			
Energy and sustainable development			
Energy efficiency			
Renewable energy development			
Taxation of energy products			
Trans-european networks			

- relevant impacts expected  
 - some impacts expected  
 - diffuse impacts expected

Some comments are required on the chart to make clear our assumptions.

We must accept that there are interconnections among the proposed policy headlines, on the one hand, and that carriers themselves, do not act independently. So some simplification is required in order to identify impacts.

*Investment effects* are more likely to be originated by security of supply (and associated TEN measures) and renewable development policies. All assessments of these policies seem to point out to important effects on less developed regions.

The *price effects* are markedly framed by two opposed development vectors. On the one hand, internal market and liberalization are aimed to reduce energy prices by increased competition. This would mean a push towards an increase on economic activity and an increase on the welfare of the families (either by availability of income for an extra expenditure on energy as a mean for household comfort, or by freeing resources for other forms of consumption and savings). At the same time that could mean a pull towards slower technological development, at least towards less energy efficient equipments and buildings.

But on the other hand consideration of environmental externalities on prices and the cost of emissions rights may push prices upwards, inducing a negative income effect and as positive incentive for more efficient equipments and buildings.

*Income transfer effects* may be harder to evaluate and, even if the potential seems clear, we may not be able to see much of these out of a case study framework. Fiscal effects are subject to national macroeconomic and regional development policies. Private sector transfers could hardly be statistically measured.

### 3.3 Summary

The following tables present a summary of main energy features for Member States.

**Table 6 Summary of main energy features for EU15**

Country	Energy market opening (electricity + gas) <sup>56</sup>	Main energy investments planned	Kyoto commitment by 2008-2012 <sup>57</sup>	Renewables target Directive 2010 <sup>58</sup>	Obs.
Austria	100%	Gas storage facilities; Renewables	-13%	78,1%	Austria is a carrier of substantial international energy trade.
Belgium	Not yet completed	Renewables & CHP	-8%	6%	Belgium is committed to phase out nuclear power. Importance of electricity & gas cross-border trade.
Denmark	Not yet completed (gas)	Renewables: geothermal, wind & biomass; Energy efficiency	-21%	29%	Introduction of “green certificates” system
Finland	100%	New nuclear energy power. Extend cross-border grids and networks.	0	31,5%	There is much electricity trade between other Nordic countries and eastern countries.
France	Not yet completed	Renewables	0	21%	Highest nuclear share in electricity production. Reduction of coal use.
Germany	100%	Renewables, CHP & Energy efficiency	-21%	12,5%	Phase out nuclear by 2005. Largest electricity market in Europe. Declining coal subsidies.
Greece	Not yet completed	Natural gas for power generation; Energy saving & efficiency & renewables	25%	20,1%	Expansion of natural gas use: power generation & other.
Ireland	Not yet completed	Strengthen transmission grids; new sub-sea natural gas pipeline to UK; renewables, fuel switch on coal power plants.	13%	13,2%	Small market. Coal & peat play important role on energy mix but are high CO2 emitters. Shut down of fuel switch coal plants.
Italy	Not yet completed	Fuel switch from coal and oil to natural gas. Renewables.	-7%	25%	Strong differences between the north and south of the country.
Luxembourg	Not yet completed	Renewables & CHP	-28%	5,7%	Strong importance of iron & steel industry -> high energy consumption per inhabitant. Very small market.
Netherlands	Not yet completed	Grid reinforcement. Renewables	-6%	9%	Nuclear to be phased out.
Portugal	Not yet completed	Natural gas grid expansion LNG terminal; reinforcement of electricity grid; renewables, energy efficiency & CHP	27%	39%	In process of creation of an Iberian Electricity Market.
Spain	Not yet completed	Expansion of connections to EU natural and electricity grids. Renewables & CHP, energy efficiency.	15%	29,4%	One of the most important European wind energy markets.
Sweden	Gas not yet completed. Electricity completed	Natural gas, renewables & CHP.	4%	60%	Electricity market in cooperation with Baltic countries under study. Phase out all nuclear plants.
UK	100% completed	New gas pipelines; Renewables, energy efficiency and CHP	-13%	10%	One of the largest energy markets in Europe.

<sup>56</sup> According to the level of implementation of the Directives of Electricity and Gas. European Commission; Implementing the Internal Energy Market – First Benchmarking Report. European Communities, Belgium, 2002.

<sup>57</sup> Negative means reduction of emissions and positive means maximum threshold allowed. IEA country reports.

<sup>58</sup> Amount of electricity generated by renewable energy sources by 2010, according to the Renewable Energies Directive. IEA country reports.

**Table 7 Summary of main energy features for new Member States countries**

Country	Energy market opening (electricity + gas) <sup>59</sup>	Main energy investments planned	Kyoto commitment by 2008-2012 <sup>60</sup>	Renewables target Directive 2010 <sup>61</sup>	Obs.
Cyprus	Acquis Communautaire.	Renewables	-13%	6,0%	Energy imports represented 70% of the export value.
Czech Republic	Strong effort towards liberalization	New nuclear power plant is in the pipeline. Plans to improve the refineries and to invest in oil production	-8%	8,0%	High dependence on coal (50% of TPES in 1998). Net exporter of electricity.
Estonia	Liberalization is being done	Natural gas system	-8%	5,1%	High dependence on shale oil (near 75% of TPES)
Hungary	Strong effort towards liberalization	Combined cycle gas turbines	-6%	3,6%	Fossil fuel resources
Latvia	Strong effort towards liberalization		-8%	49,3%	No refining capacity; net importer of electricity
Lithuania	Some energy sectors have been privatized	New power capacity to substitute 3 000 MWe nuclear.	-8%	7,0%	Nuclear power is the main source for electricity production, net exporter of electricity
Malta				5,0%	Fuel switch from coal to oil
Poland	Liberalization in the political agenda	Refining system and power production.	-6%	7,5%	Heavy dependence on coal; exporter of coal and net exporter of electricity
Slovakia	Liberalized market	Electricity grid	-8%	31,0%	High dependence on fossil fuels imports; net exporter of electricity
Slovenia	100%	Natural gas power plants and hydro power plants (repowering and refurbishment)	-8%	33,6%	Net exporter of electricity. Lack of oil storage capacity.
EU25				21,0%	

<sup>59</sup> According to the level of implementation of the Directives of Electricity and Gas.

<sup>60</sup> Negative means reduction of emissions and positive means maximum threshold allowed. IEA country reports.

<sup>61</sup> Amount of electricity generated by renewable energy sources by 2010, according to the Renewable Energies Directive. IEA country reports.

### 3.4 Opportunities for energy

Energy and Transport DG of the European Commission supports the creation of regional and local energy agencies through the Save Program. These agencies have as main objective to advise local decision makers on local energy policy.

There are now 178 such agencies<sup>62</sup> established and developing action on good energy management practices, sustainability at local level, information and guidance to the public and other specific services.

The existence of such expertise is of great value for the implementation of policies that can have an impact on the welfare of the population and on the use of local energy resources.

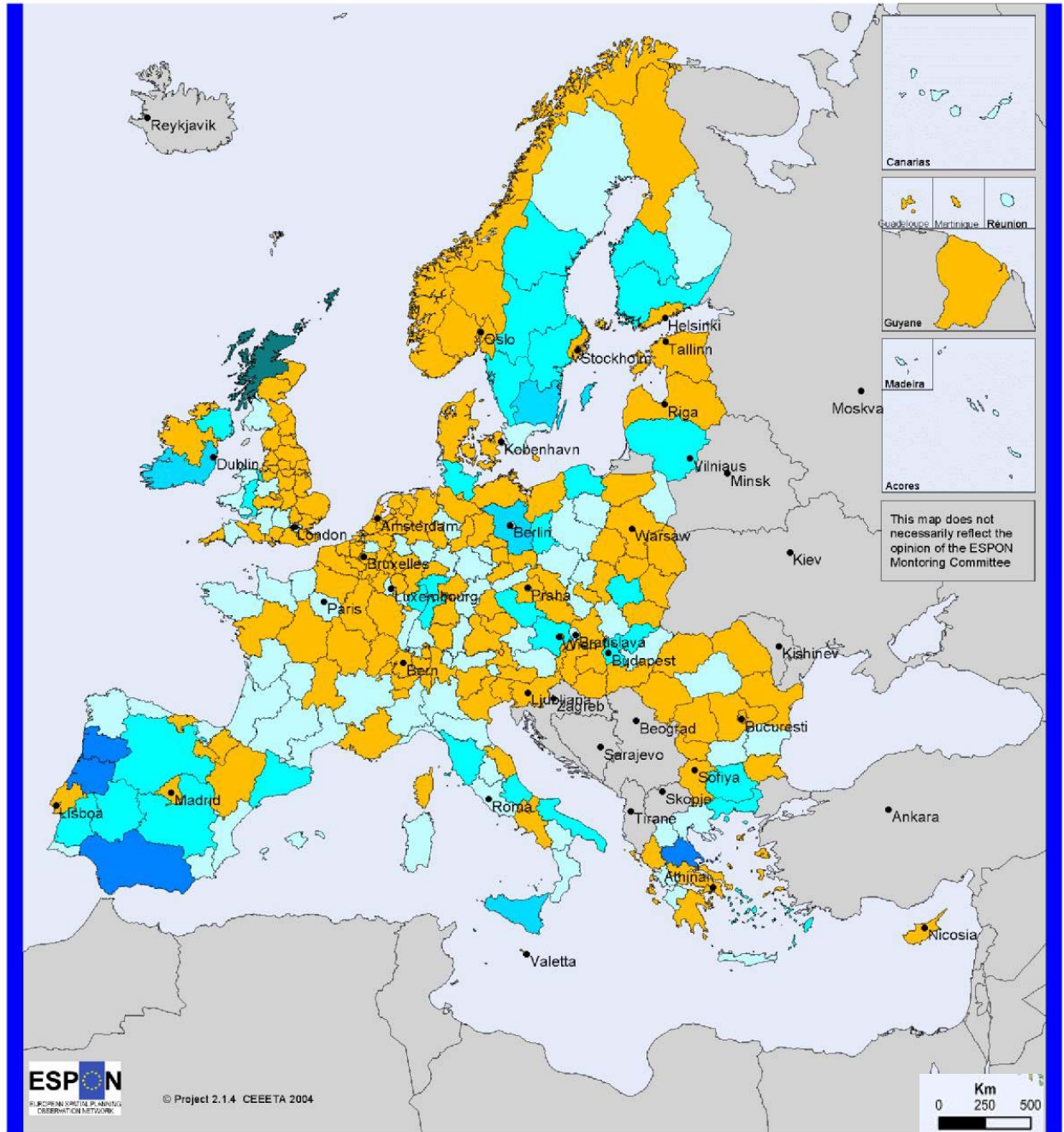
A map with the NUTS 2 regions that can benefit from the regional agencies activities is presented below.

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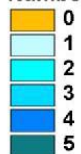
<sup>62</sup> <http://www.managenergy.net>



**Map 34 Number of Regional Energy Agency by NUTS 2**



**Number of Regional Energy Agencies**



© EuroGeographics Association for the administrative boundaries

**Source: European Commission  
 ManagEnergy Initiative**

## 4 Typologies

This section of the report presents the typologies developed in the project. Developing methodologies was aimed at establishing relations among energy indicators, territorial development and energy policy, in a way that these would be “easy to use” indicators that may help to define policy orientations. In the case of project 214, not having basic indicators below NUTS 0 level, was, from the beginning a major problem for this exercise. But, even if those indicators were available, energy issues are, most of them placed at the national level or, sometimes even at European level. Thus trying to discuss the local level in this framework would be most of the times unfruitful, if not misleading.

From what has been said before, major problems and objectives on energy sector in Europe can be framed within four major issues about energy:

1. The high level of dependency of Europe from oil to satisfy its energy needs;
2. The pressure placed on GHG emissions by the high share of fossil energy sources (oil, natural gas and coal) on primary energy supply;
3. The opportunities for less dependence and less GHG emissions based on renewable energy sources;
4. The link between energy and territorial development being only established by energy prices (income effect and competitiveness) and renewable energy sources (income and employment);

From this standing point, our efforts have been to provide typologies that would be able to provide highlights about these 4 issues.

The proposed typologies are, then:

- a) Level of energy self-sufficiency;
- b) Pressure on GHG (derived from the share of fossil primary energy in TPES);
- c) Potential share of electricity consumption replaceable by renewable energy sources;
- d) Level of sensibility to energy price changes by regions (NUTS 2);

- e) Sensibility of regions to energy price changes and country energy self-sufficiency;
- f) Sensibility of regions to energy price changes and country pressure on GHG emissions.

#### 4.1.1 Level of energy self-sufficiency

The level of self-sufficiency (or the low level of it) is a key trait of Europe's energy sector, and a major challenge for its sustainable development.

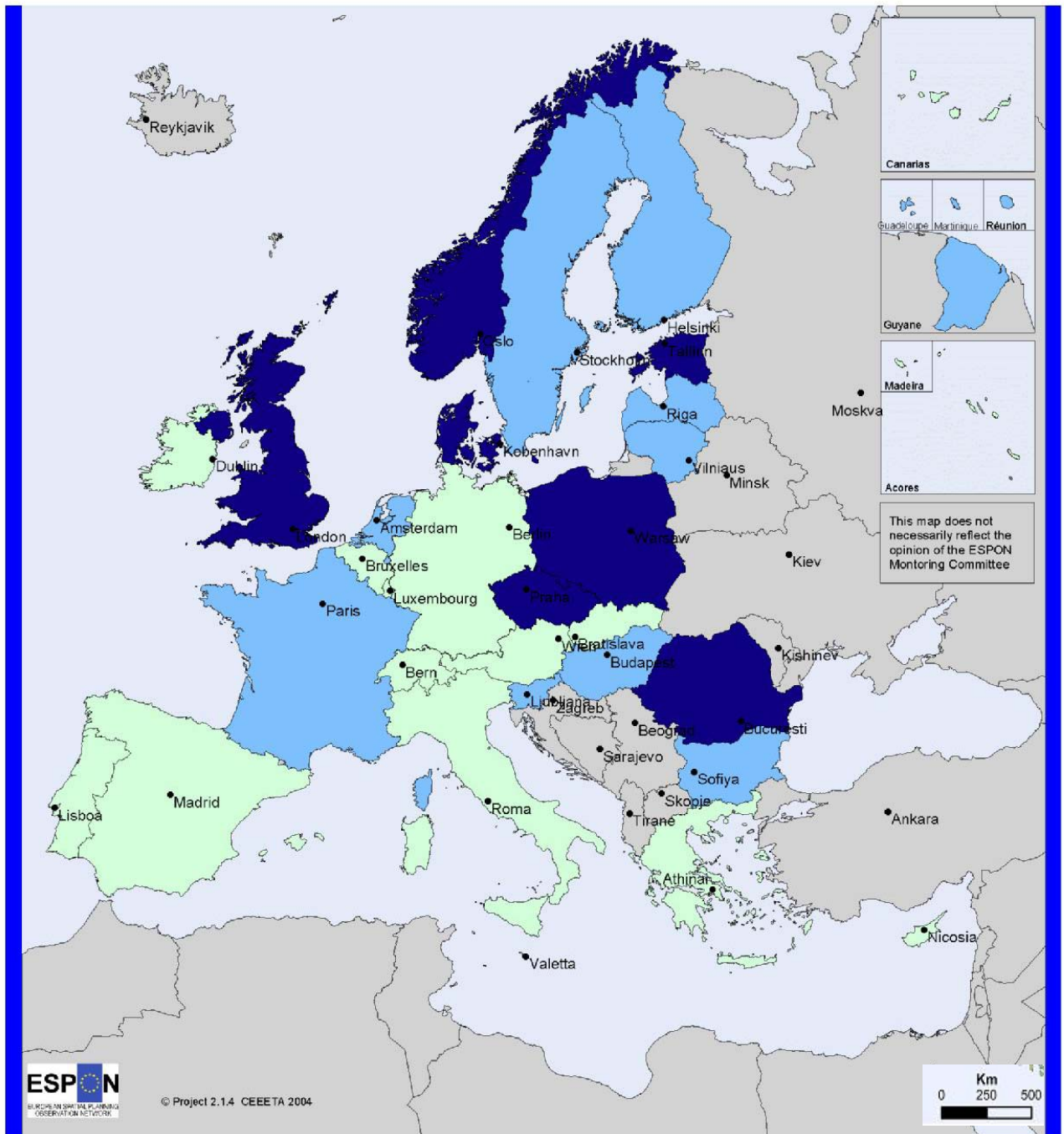
Having a low level of energy self-sufficiency is a threat to development, by the exposition to energy shocks like those that have been seen since the 70's.

Also the exposition to external energy sources (from those the oil being the most relevant) is a major problem for the security of supply, allowing for severe shortage scenarios in worst case events in the producing areas.

So it is an objective, per se, to increase the self-sufficiency, either by developing new energy sources or by placing a stronger emphasis in more efficient use of energy resources.

The image is very clear when boundaries are set trying to highlight groups of countries with different energetic resources capabilities.

Map 35 Typology of self-sufficiency of European countries in energy resources



**Level of energy self-sufficiency**

- Low
- Medium
- High

© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat

Countries with less endogenous resources for mainstream energy sources (oil, coal, large hydro) should reinforce their means of getting access to new forms of producing energy. The most important cases in this situation are Ireland, Germany, Austria, Slovakia, Italy, Portugal, Spain, Greece, Cyprus and Malta.

This is a task that can be dealt at European level (reinforcing interlinks), but can be obtained at national level, by means of diversification of sources, especially by boosting renewal sources (wind, biomass and solar) that are available in larger or lesser extent to all of them.

On the other end of the scale, Norway, UK and Denmark (net oil exporters) and Estonia, Poland, Czech Republic and Romania are well equipped countries to better satisfy their energy needs.

#### 4.1.2 Pressure on GHG

But self-sufficiency can not be considered per se, when designing energy policies. The extensive use of fossil energy sources is another issue and another problem in Europe's energy sector.

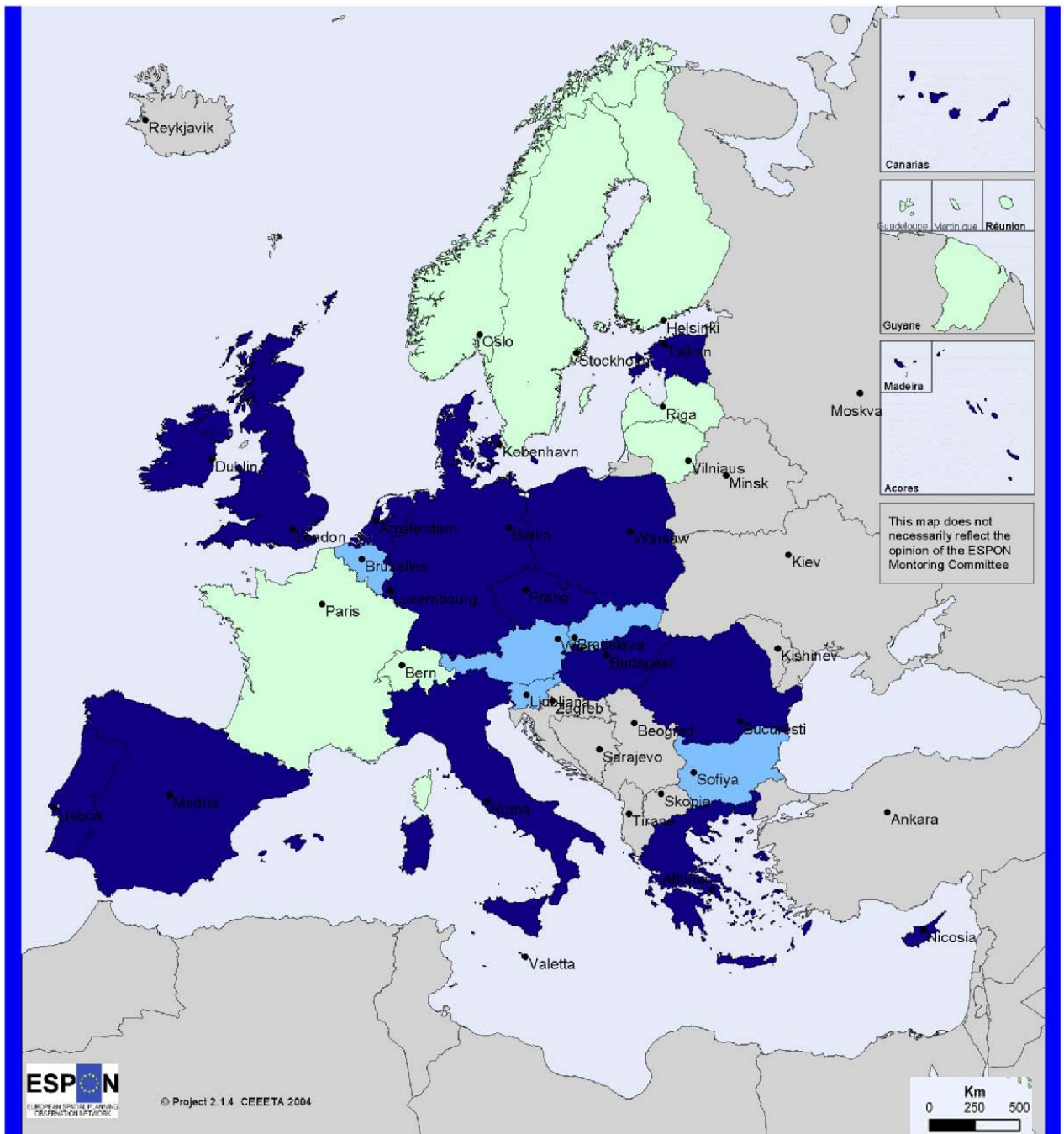
In fact, most of Europe's energy production infra-structure is based on fossil primary sources (oil, coal and natural gas). All these sources produce considerable amounts of GHG, which in turn are a problem to be faced. All the European countries have specific GHG emission targets for 2008-2012, in the framework of the Kyoto Protocol.

Although very different profiles and trends of GHG emissions can be found around Europe, a common trait of all countries is the very high use of fossil energy sources in primary energy production.

Moving away from these energy sources is a policy issue that needs to be faced by all European countries in the near future and that poses very complex problems and difficult decisions to be met.



**Map 36 Pressure on GHG emissions from the share of fossil fuels in total primary energy supply**



**Pressure on GHG (share of fossiles in TPES)**

- Low
- Medium
- High

© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat

Once again, although important differences can be found among countries, the majority of Europe is under the menace of GHG emissions on growth. The degree of pressure on fossil fuels is a proxy for GHG emissions. However it must be pointed out that the results pictured in map 2 are not coincident with the actual situation regarding the distance to Kyoto and burden sharing agreements. This situation depends on the target that has been fixed, on the growth rates of the economies and on the success on implementing domestic policies and measures to deal with GHG emissions. As an example, the UK is in line with its target notwithstanding the high level of dependence on fossil fuels.

The answer for the challenges can be found in increased efficiency and renewable sources development.

Exceptions are France (in large part due to its nuclear capabilities), and the Scandinavian countries.

#### 4.1.3 Potential for renewables development

Some good news can be found on the availability of renewable resources (wind, biomass, solar, geothermic resources) that can be used to increase self-sufficiency and reduce GHG emissions.

The typology pictured in the following map provides clusters of countries according to their capability to replace fossil sources by renewable ones in the production of electricity. What is presented is the share of electricity consumption that could be replaced by a full usage of renewables potential.

Note must be taken, that, according to the state of the art in energy technology it would be impossible to use the full potential of renewable sources, thus this being an issue for the agenda of R&D in the field of energy.

If we look at the potential of wind and biomass (see chapter 1 of this part of the report), we must be aware that complementarities can be found among the different sources, meaning that for some countries and regions major efforts are to be placed in wind, whereas for others biomass are the most advantageous source, and for others even the incipient solar solutions can be one promising road to be followed.

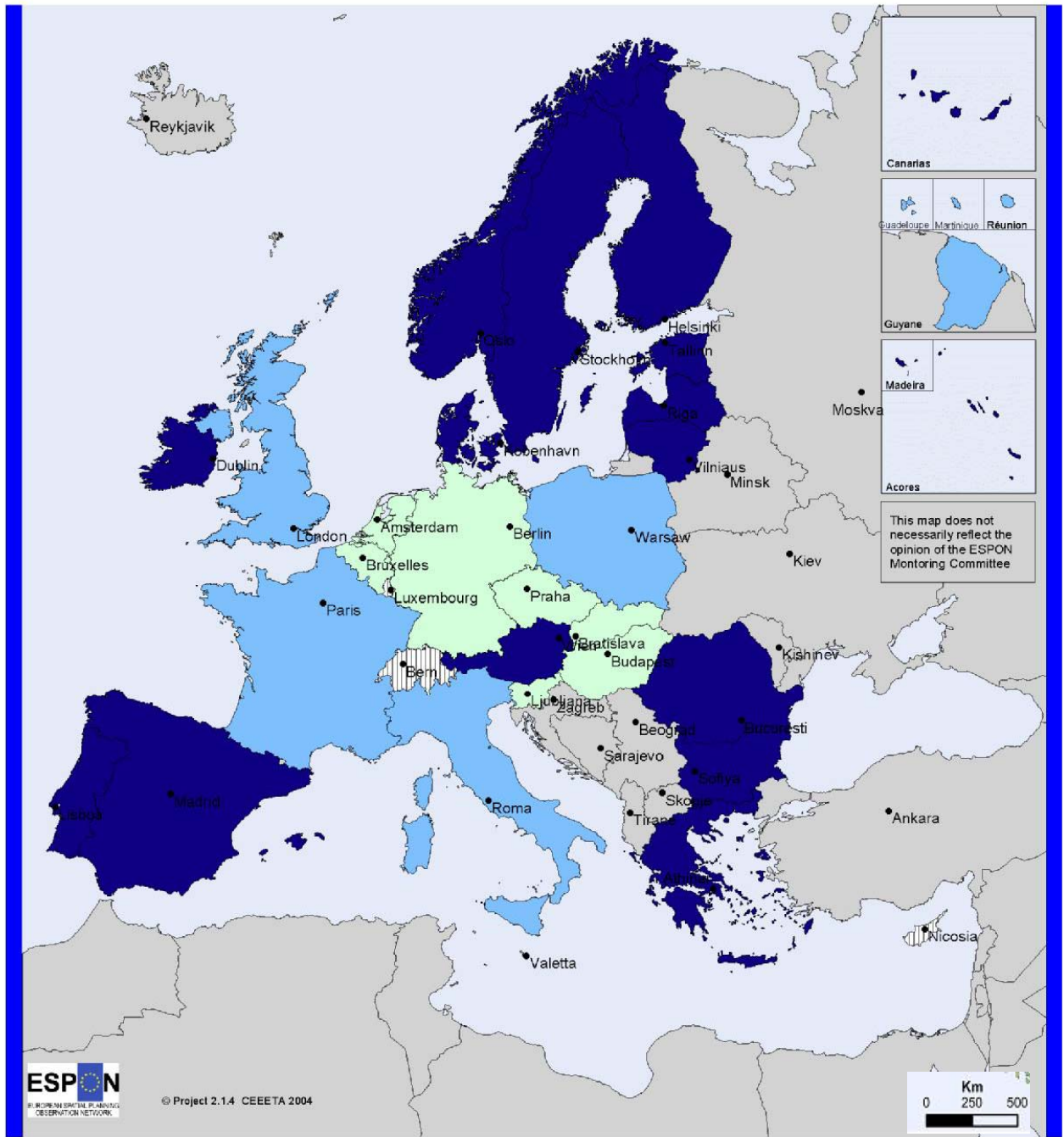
Altogether, renewable sources of energy would be a possible provision of substantial part of electricity needs (even if biomass can provide other sorts of uses like biofuels and derived heating, in this last case with substantial gains in energy efficiency of the production processes).

None in this movement is new in most European countries, but one must acknowledge that reality is very much behind potential.

With the pictured typology it becomes obvious that all the countries in Europe can boost their renewable programs and this could be a line to be reinforced in European support policies for the energy sector.



**Map 37 Share of electricity consumption that can be replaced by the potential use of renewable resources**



Potential share of renewables in total final electricity consumption

- Low
- Medium
- High
- No Data

© EuroGeographics Association for the administrative boundaries

Source: DGET, Eurostat, EWEA,  
 "Biomass availability in Europe" 2003

It must be highlighted that data collected in our research strongly supports the evidence that renewable development can also have relevant impact in the level of economic activity in less developed regions, by means of new income, new enterprise initiatives and new employment opportunities.

The capabilities of countries such as the Scandinavian and Baltic, Iberian, Ireland, Austria, Romania, Bulgaria and Greece, deserve a special note.

Central Europe countries (Germany, Netherlands, Belgium, Hungary, Czech Republic and Slovakia) seem to be better worst endowed for the use of renewable endogenous resources.

#### 4.1.4 Sensibility to energy price changes

But the link between energy policy and local development can also be clearly established with the help of simulation of price changes for energy.

The bad news are that less modern industrial areas can suffer from rises on energy prices and less developed areas can suffer more from changes in prices than more developed ones.

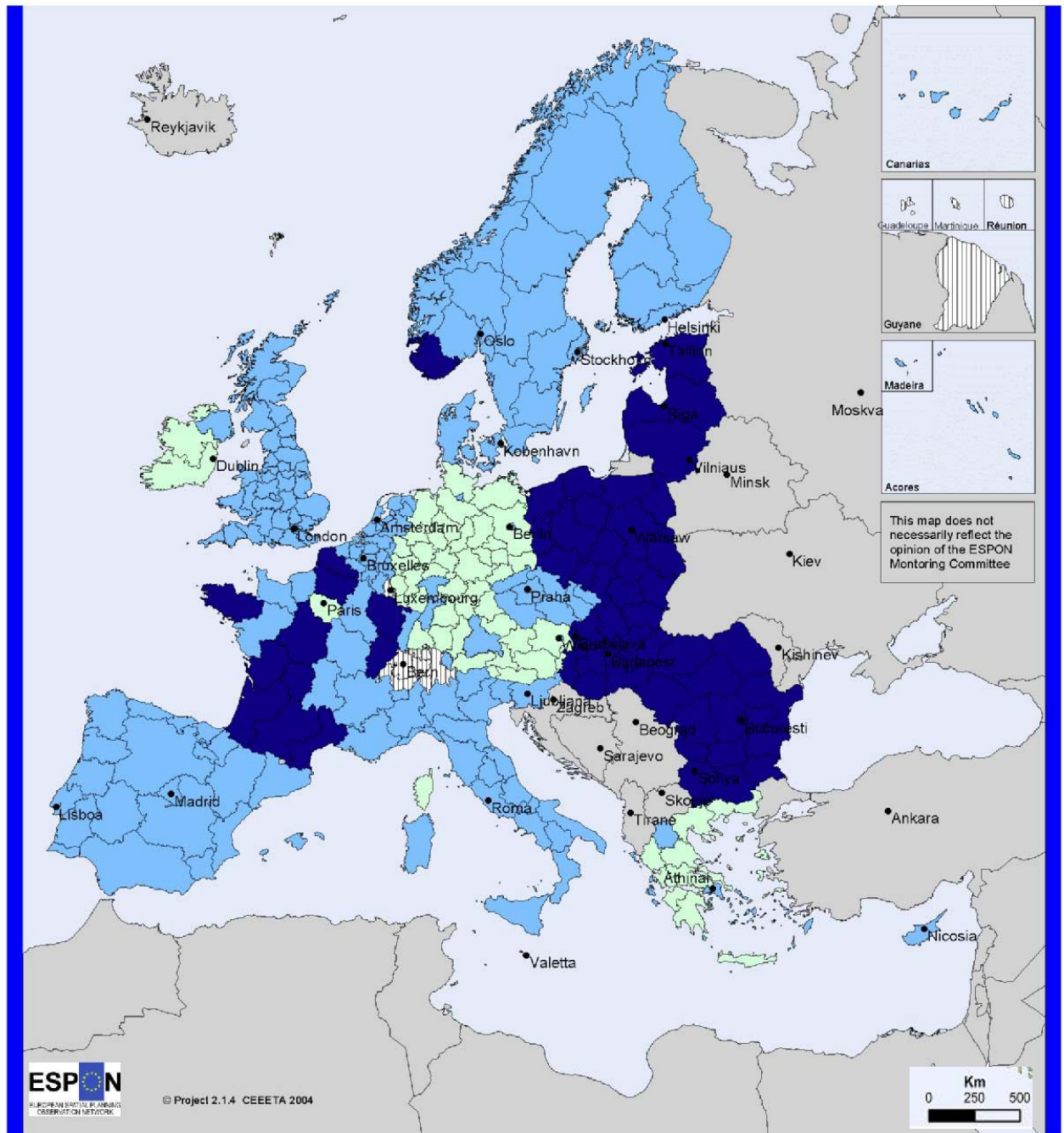
As it is clear from the picture presented in the map that is presented in the following page, N10 countries are, in general more liable to negative impacts from a rise in the prices of energy, mainly due to high energy intensity of their processes. Has said elsewhere in this report EU15 citizens use 50% more energy than N10 inhabitants, but it takes only 30% the energy to produce one Euro of income in EU15 than in N10.

Thus very high emphasis in energy efficiency policy must be developed in New Member States in order to lessen the exposition of those economies to energy shocks.

But we must, again say, that the data provided (with few exceptions from Belgian and French regions) energy trends are mostly country issues, and regional analysis do not provide especially interesting insights.

Germany, Austria, Ireland and Greece, seem to be well placed regarding energy price shocks, despite the reasons for that can be substantially different: climate and light industry for Greece, energy efficient use, for the others.

**Map 38 Sensibility of the NUTS2 regions to changes in the prices of energy**



**Sensibility to variations on energy prices**

- Low
- Medium
- High
- No Data

© EuroGeographics Association for the administrative boundaries  
 Source: Eurostat,  
 National Statistics

#### 4.1.5 Energy price changes and energy self-sufficiency

Given this dependency of regions on country energy structure, we provide two other forms of getting some insights on the subject.

The first is relating the sensibility to price change and energy self-sufficiency.

The rationale behind this typology is that achieving a higher degree of self-sufficiency has a price tag on it. Energy could become more expensive if less obvious energy sources are used.

But the less self-sufficient a country is, the more costly it could be the change.

Classifying regions by having a sensibility to price change above (high) or below (low) European average, and classifying regions in highly self-sufficient (above average) and lowly self-sufficient (below average), we have a fourfold typology that may be helpful designing dependency policies.

The results are presented in the following map.

Regions with low price sensibility and high national self-sufficiency (pictured light green) are the ones that may have fewer problems deepening their energy self-reliance, and are regions that may contribute positively for the development of other European regions, not so well suited. These regions are located in the UK, Denmark and Norway, not surprisingly countries that are actually net exporters of oil.

In the other extreme we can find regions that are simultaneously highly sensible to price change, and are located in countries that have a low level of self-sufficiency. These are problem regions and are located in Latvia, Lithuania, Hungary, Slovenia, Cyprus, and (to some extent surprisingly) parts of France and Italy.

The remaining two sets of countries deserve different energy policy priorities.

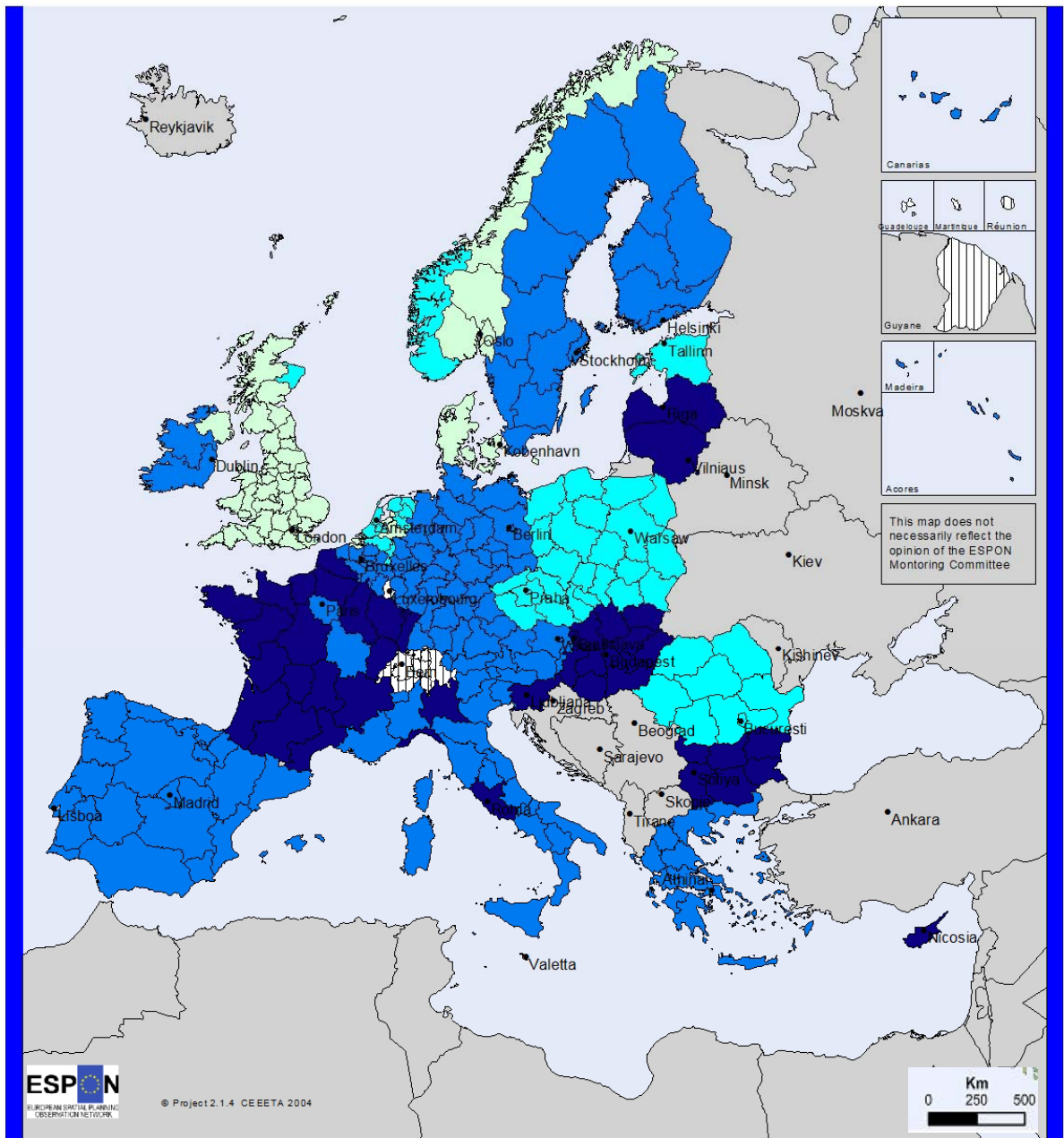
The most important part of EU 15 (all regions of Portugal, Spain, Ireland, Sweden, Finland, Germany, Austria, Belgium, most of Italy, parts of France, all Greece) are regions that have a relative low sensibility to price changes, and have low self-sufficiency.

For these cases, investing in renewables can be a reasonable way of achieving more self-sufficient and reliable energy supply, without facing excessive problems in the economy.

The third group of regions (mainly from Poland, Czech Republic, Romania, Estonia) are characterized by low dependency, but high sensibility to price shocks. In this case the recommended policies should focus on energy efficiency as the key policy target, before important change can be obtained into renewable development, since price is an important issue.



**Map 39 Sensibility to variations on energy prices and energy self-sufficiency**



**Sensibility to variations on energy prices and energy self-sufficiency** © EuroGeographics Association for the administrative boundaries

- Low Sensibility and High Self-sufficiency
- High Sensibility and High Self-sufficiency
- Low Sensibility and Low Self-sufficiency
- High Sensibility and Low Self-sufficiency
- No Data

Source: Eurostat,  
National Statistics

#### 4.1.6 Energy price changes and country pressure on GHG emissions

Another issue in the same direction of rationale is the relation among GHG objectives and local impacts.

We intend to measure the tension between environment and competitiveness in the following typology that crosses region behaviour in what regard sensibility towards price change and pressure on GHG emissions by the share of fossil energy sources on total primary energy supply.

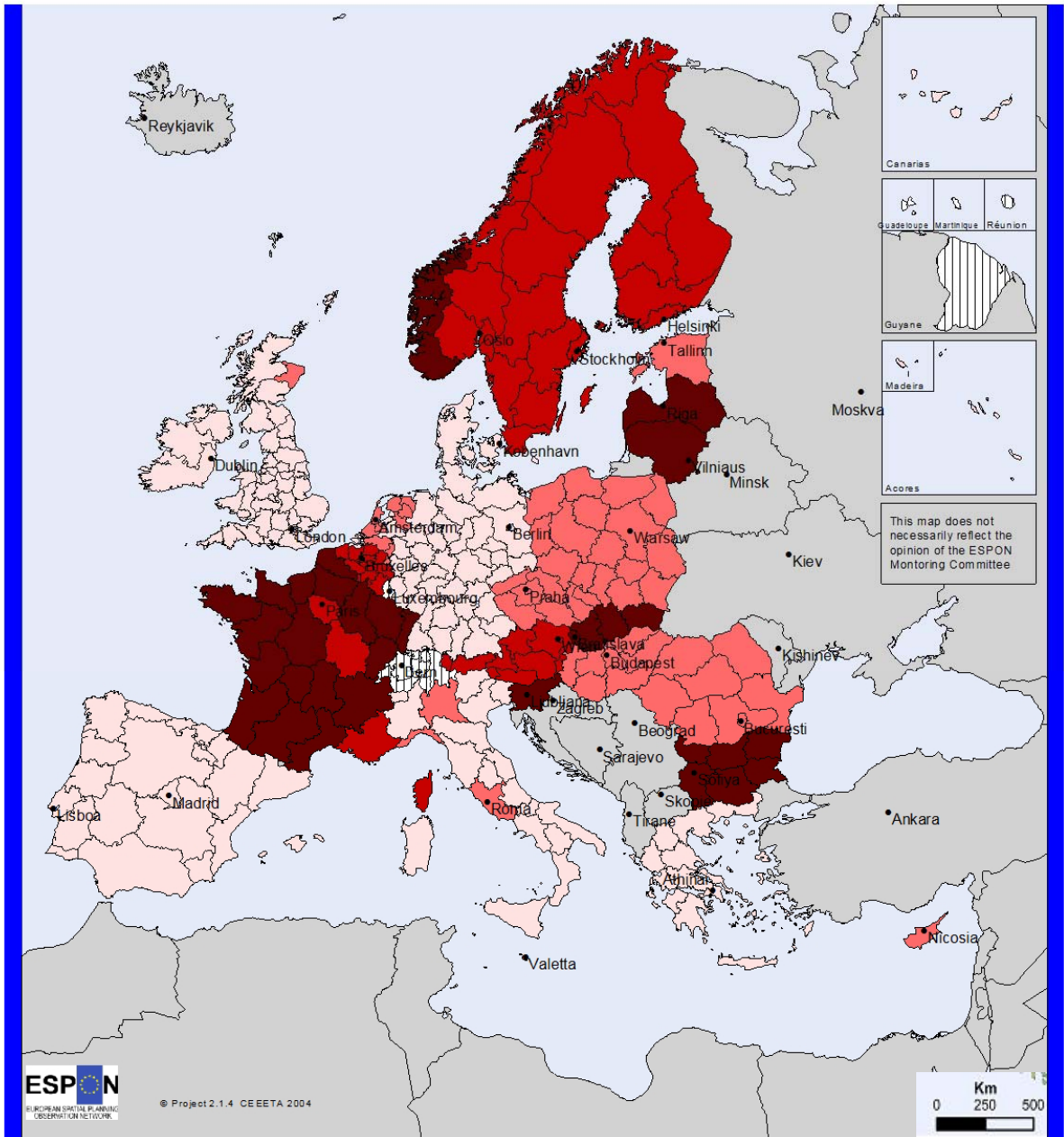
Classifying regions and countries as high and low according to their position above or below European averages, we have again a fourfold typology that is presented in the next map.

Most of EU 15 (all of Portugal, Spain, Ireland, Denmark, Greece, almost all of the UK, most of Germany, Austria and Italy) are regions that have high GHG pressure, by the extensive use of fossil energy sources, but that are less sensible to price changes than average. In these regions, adjustments can be made, via more efficient energy use and promotion of renewables, in order to provide a better framework to achieve Kyoto targets.

At the other end, problem regions are mostly located in N10 countries. For these regions special care must be placed when dealing with emissions control, since these could be damaged by eventual price impacts.

Middle cases are those regions with high price sensibility but low GHG pressure (mostly regions from France, Bulgaria, part of Norway, Slovakia and Slovenia). The no problem areas (so to say) are parts of France, Belgium Austria, Sweden, Finland and most of Norway.

Map 40 Sensibility to variations on energy prices and GHG pressure



**Sensibility to variations on energy prices and GHG pressure**

- Low Sensibility and High GHG Pressure
- High Sensibility and High GHG Pressure
- Low Sensibility and Low GHG Pressure
- High Sensibility and Low GHG Pressure
- No Data

© EuroGeographics Association for the administrative boundaries

Source: Eurostat,  
 National Statistics



## 5 Case Studies

The lack of statistical data has not enabled us to go deeper on the study of the relationship between energy policies and measures and its territorial impact analysis. In order to collect further evidence of the impact of energy policies on local development we have launched several case studies covering important aspects of the energy policy:

- solar thermal development (Denmark)
- biomass development for heating purposes (Poland)
- introduction of an autonomous local unit for natural gas distribution in a medium size town (Portugal)
- the local impact of a big coal power plant (640 MW) in a depressed region (Portugal)
- the impact and uncertainties with market integration (Iberian Peninsula)

Some of these case studies are still under review and being finalized.

The decentralized nature and the scale of renewable energy have important consequences in terms of job creation. With the actual technology in the market, solar thermal, biomass for heating and electricity production, wind power and biofuels to substitute petrol and diesel offer a range of cost effective projects. In very limited regions geothermal energy is also being exploited for heating and electricity generation.

All these technologies and the projects associated rely on European or national technology and expertise and endogenous energy resources. The European Union policies on renewables and greenhouse gases have been adopted by the European Union countries and a huge development is expected till 2010 in order to meet the defined targets at country level.

The case studies have different scope in terms of territory covered:

- All the country (Solar thermal in Denmark)
- A specific region (Biomass in Poland and the two Portuguese case studies)
- More than one country (market integration)

In what follows we highlight some relevant aspects of the case studies and expected results after completion.

## 5.1 Solar thermal development in Denmark

The majority of EU countries have launched policy programmes in favour of renewable energy sources like solar for thermal purposes. These programs are proposed mainly after the increase in oil prices resulting from the oil crisis. Nowadays global warming is a new argument in favour of renewable energy sources.

Solar energy as a decentralized energy carrier has strong effects in terms of job creation, mainly if there is an industrial project associated.

Manufacturers, sellers, architects, installers, researchers, are among some of the direct agents involved.

From 1978 till 2002 Denmark put in place an active policy for thermal solar development. As a result 12 manufacturers have been actively involved in the program, about 1000 installers have been certified and 260 000 m<sup>2</sup> of solar collectors have been installed.

Being difficult to assess the impact of a solar program development at territorial level we can conclude however that the multiplier effects of such a program are enormous. We must add also the externalities involved: substitution of fossil fuels, diversification of energy sources, less emissions of greenhouse and acidification gases.

## 5.2 Biomass development for heating purposes in Poland

Poland has very high unemployment rates in rural areas (20%). The unemployment could be partially overcome by an active policy for biomass development. Biomass development could also have important impacts at the level of gaseous emissions, considering that Poland rely mainly on domestic coal as a source of primary energy.

Meanwhile the responsibility for preparing energy plans to secure energy supplies to the local residents and industries were made the responsibility of the lowest administration units (gminas), which is favourable to renewables development and use of endogenous resources.

If a biomass policy is successfully developed it should be noted that the biomass fuel would be locally produced (mostly auto-produced). This will:

- lower the energy bills of the users
- create local jobs as installation and maintenance is left to local companies

- boost countrywide the SME businesses involved in boiler manufacturing, especially if the “400000 boilers program” is launched successfully.

However some barriers to the development of biomass for heating purposes have to be considered:

- lack of expertise at local level to conduct sustainable energy projects;
- lack of financial resources to upgrade the inefficient heating systems now in place;
- scarcity of financial resources in the municipalities for renewable energy projects support.

With the present administrative structure, the most appropriate level for renewables development seems to be the level of powiats (counties) or groups of several neighbouring ones with similar or complementary characteristics. Such a scale of planning of the use of RES would, in particular, facilitate the cost-effective allocation of surplus biomass from the production area to the communes where the demand is higher than the existing potential. Thus the effective solution would be to bring the co-ordination down to the county or NUTS3 level (groups of counties).

At the same time, the arguments that the introduction of the mandatory admixtures of bio-components to fossil fuels for motor vehicles - apart from the global impact - would greatly help the troubled Polish agricultural sector and, by this virtue, Poland’s economy at large were played down. Other arguments were overshadowed as well (energy security of the country, improved trade balance, increased volume of Poland’s GHG emission credits). Job creation in unemployment-ridden areas would be a significant effect; according to government estimates ca. 100 thousand people would find employment in the biofuel sector by 2005. The same source estimated the farmers’ revenues total revenue from rape-for-biodiesel production alone at 46, 126, 219 and 328 mEURO in 2002, 2003, 2005 and 2007, respectively. These are – as it looks now – lost opportunities. No doubt, the cancellation of the Act will benefit the (fossil) oil lobby instead.

### 5.3 Impact of an autonomous local unit for natural gas distribution

In Portugal the main pipeline for natural gas distribution goes from south (Sines) to North, along the territory near the coast. The interior of the country has some small towns with reduced economic activity apart from the

services and agriculture. Energy infrastructures and reliable energy supply are an important location factor for economic activities. Small autonomous units using liquefied natural gas can be used where the market exists but it is not cost effective to invest in the connection to the main pipeline. This is the case with Vila Real, an interior town in the North of Portugal, with 50 000 inhabitants. Besides a dynamic university, which has given new life to the region, in itself the region is lacking of a diversified economic tissue.

With the availability of natural gas it is expected that new activities will come and additional arguments for choosing location can be offered to the firms looking for reliable sites in terms of infrastructures availability.

The autonomous unit has been installed in 2000 and in 2001 a duplication of its capacity was already in place, which shows the enormous interest from the consumers for a clean and reliable energy source.

The town is now experiencing a dynamic development process, based on modern communication infrastructures, availability of skilled labour, diversified energy sources.

#### 5.4 Impact of a big coal power plant (640 MW) in a depressed region

Moving along the Tejo Valley to the East we enter into more and more depressed areas, with agriculture and forestry being the main economic activity. Sites for coal power plants are not easy to find because of the opposition of populations. Local impacts on the environment are the main argument against such projects (particulates, acidification emissions, among others).

Such a power plant needs water for refrigeration and a location near the Tejo River could be eligible. During the negotiations with the local authorities of the candidate locations the development impact in the regions in terms of job creation, municipal revenues and other policies aiming to improve the welfare of the population are of a crucial importance.

The site selected is located in one of the poorest villages in the Abrantes municipality, implying the transportation by rail of imported coal from Sines harbour, about 320 km Southwest on the Atlantic coast.

Some summary measures of the impact of the installation of the Pego coal power plant (640MW) come as follows:

- The income tax (IRC) is about 20 million euros, which represents 26 percent of the total IRC in Santarém district and 80 percent of total IRC in Abrantes municipality;
- The annual direct labour requirements amount to 284 jobs equivalent per year and the impact in terms of indirect labour requirements is 33.486 jobs equivalent per year;
- The installation of the Pego power station induced an intense demand for construction materials, services (ceramic, hardened, inert, wood, transports, tourism, etc.), and workforce at local level;
- During the construction the number of jobs was increasing until the 3rd year of construction, reaching a maximum that exceeded the 2.000 workers, having in consideration the staff of the contractors and sub-contractors;
- After the power station began its exploration, the public investment in Abrantes municipality increased around 160% in the period 1995-1998 and direct taxes increased by 80%.

Besides the main activity the Pego investors are nowadays important supporters of some social initiatives in the area having as targets the less favoured people (care centers for elder people and children, cooperation with the schools for student's visits, among others).

The power station has conducted important initiatives in the environment field, having adopted modern regulations in terms of certification.

## 5.5 Impact and uncertainties with market integration (Iberian Peninsula)

Portugal and Spain are in the process of negotiating the implementation of the Iberian Market for Electricity, which is expected to enter into force next year. According to what has happened in similar situations, the completion of the liberalized market will take several years. Meanwhile we will have a mix of competitive and oligopolistic markets, calling for a more or less degree of regulation.

With integration of markets and increased competition it is expected a reduction in the electricity market price, which would be a positive outcome. However the final result of the integration of the two markets is uncertain, depending on the market power of the main producers.

Integration will imply additional investments on high voltage transmission lines in order to eliminate barriers actually in place for the electricity transit. Besides the expected impact on electricity prices the integration of the two markets will have important consequences at the level of security of supply, thus reducing the probability of shortfalls.

## 5.6 Final Considerations

The case studies approach to study the territorial impact of energy policies and measures can help the researcher to understand the main movements and impacts of decisions, investments and energy use that can be registered in some countries and regions, at certain moments. Some of the impacts are qualitative, such as the impact on welfare of the population from energy availability at low prices. Others being quantitative depend on the region where the phenomenon we want to measure happens. For instance, different per capita electricity consumption can depend on the climate of the region, the structure of the economic tissue, the price, the lack of alternative energy sources.

To the complexities mentioned we can add fundamental questions for which the answer is not clear and with unknown or uncertain impacts:

- will the price of oil follow old patterns or are we approaching a non return period of high prices?
- will a new technology be mature in due time to replace oil?
- what will be the role for renewable energy sources?
- from the on going debate will nuclear power emerge as a winner?
- what will be the evolution towards distributed energy (micro generation of electricity, cogeneration ...)?
- will the Kyoto protocol enter into force?
- what will be the role for biofuels in the transport sector?

The lesson to extract from these questions is that a set of uncertainties exist that will prevent us from extracting definitive conclusions for the medium and long term from historic data. We need to be prepared to react in real time to the important challenges faced by the energy sector and the energy consumers. The evidence collected in this study is of great value to

understand the complexities of the energy sector and its connection with the territory and with the consumers.

# **Territorial trends of energy services and networks and territorial impact of EU energy policy**

## **Part Three: Annexes**

- Annex 1: List of indicators developed and datasets provided to the ESPON Database
- Annex 2: List of maps, tables and figures
- Annex 3: List of missing data
- Annex 4: List of abbreviations and glossary
- Annex 5: List of references, including the use of results from projects outside the ESPON programme
- Annex 6: List of publications of the TPG members resulting from the research undertaken
- Annex 7: Indication of performance indicators achieved
- Annex 8: Additional maps and tables
- Annex 9: EU energy policy
- Annex 10: Country's energy policy guidelines
- Annex 11: Case studies of the project in brief
- Annex 12: Bibliography



## Annex 1: List of indicators developed and datasets provided to the ESPON Database

For the final report the dataset was updated with the latest information available. The dataset is accompanied by proper Metadata description. (see excel file).

The project team decided to collect selected data mainly from Eurostat related to three core indicators to be included in the common ESPON database:

- **Core Indicator 1** – Electricity Production
- **Core Indicator 2** – Final Energy Consumption by source and sector
- **Core Indicator 3** – Energy Price for industry (tax included)

The project started the work with an extensive and detailed list of indicators that were judged as capable for the identification of the energy sector. The pool of indicators was divided in four dimensions A, B, C, D.

**Table 1 Indicator List of ESPON 2.1.4 in December 2004 at NUTS 0 level**

### Indicators A. Economy, society and energy

Indicator	Why is this indicator important?	What are the links with other indicators?
<b>A.1 TPES / Population</b> (toe per capita)	Primary energy supply to the economy depends on final energy demand, on the endogenous resources, on the energy carriers to transform energy. Primary energy relies on fossil fuels for most countries. This ratio and the messages embodied deserve a complementary analysis because it can translate welfare of the population, the way energy is used (degree of efficiency), the importance and structure of the industrial sector versus service sector.	As a high level indicator there are direct or indirect links between energy supply and virtually all the other indicators in this set. <u>Direct links</u> are with indicators on emissions of GHG, Eco-efficiency indicators and uptake of energy efficiency measures. <u>Indirectly</u> the energy efficiency of the economy is linked closely to total material requirement, distance travelled (and therefore ability to achieve access without using cars).
<b>A.2 FEC/ Population</b> (toe per capita)	Final energy represents the energy consumed in the last stage, meaning that there are no more transformations into other energy forms. It is independent of the efficiency of technology conversions from primary to final energy. It reflects the efficiency of the end use equipments, the welfare of the population and the structure of the economy in terms of sectors.	As a high level indicator there are direct or indirect links between energy supply and virtually all the other indicators in this set. <u>Direct links</u> are with indicators on emissions of GHG, Eco-efficiency indicators and uptake of energy efficiency measures.
<b>A.3 FEC service and residential sector / FEC total (%)</b>	Developed economies have usually a strong service sector (high percentage in the ratio). This indicator is a good proxy to classify countries according to their development level.	It is expected that the evolution of this ratio goes in line with the importance of the service sector in terms of GDP.

Indicator	Why is this indicator important?	What are the links with other indicators?
<b>A.4 Electricity consumption/ Population</b> (kWh per capita)	It is a good proxy to measure the welfare of the population.	The evolution of this indicator follows the evolution of A.3.
<b>A.5 TPES / GDP</b> (toe per 000 Euro)	It shows the efficiency in using energy when comparing countries with the same sector structure. However the magnitude depends on the structure of the economic activity and also of the efficiency in using energy.	As a high level indicator there are direct or indirect links between energy supply and virtually all the other indicators in this set. <u>Direct links</u> are with indicators on emissions of GHG, Eco-efficiency indicators and uptake of energy efficiency measures. <u>Indirectly</u> the energy efficiency of the economy is linked closely to total material requirement, distance travelled (and therefore ability to achieve access without using cars).
<b>A.6 FEC / GDP</b> (toe per 000 Euro)	Final energy represents the energy consumed in the last stage, meaning that there are no more transformations into other energy forms. It is independent of the efficiency of technology conversions from primary to final energy. It reflects the efficiency of the equipments in the economy and the structure of the economy.	It is the inverse of the energy productivity in terms of value added (see A7)
<b>A.7 GDP / FEC</b> (000 Euro per toe)	When comparing countries it shows those which are more or less dependent in final energy in the productive process. We must have in mind that the indicator can be influenced by the relative weight of the economic sectors (for instance, service sectors are in general terms less intensive than manufacturing sectors).	It is the inverse of A6.
<b>A.8 Electricity consumption/ GDP</b> (kWh per 000 Euro)	It measures the degree of dependence of the economy from electricity.	The inverse (see A.9) measures the productivity of electricity in terms of GDP.
<b>A.9 GDP / Electricity consumption</b> (Euro per kWh)	It measures the relative efficiency in using electricity.	The inverse (see A.8) measures intensity of electricity in GDP.
<b>A.10 Households energy use</b> (toe per capita)	It enables the comparison of countries in terms of welfare of the population.	It gives the same information of A.2

### Indicators B. Reliable supplies of energy

Indicator	Why is this indicator important?	What are the links with other indicators?
<b>B.1 Average load factor</b> (%)	It is a measure of the demand pressure under the electric sector and of the failures risk.	
<b>B.2 Proportion of electricity generated by renewables</b> (%)	It enables the assessment of the weight of renewables in electricity generation and to which degree the country is achieving the indicative target of the Directive on electricity production from energy sources.	It is complementary of the B.3, B.4 and B.5 ratios
<b>B.3 Proportion of electricity generated by liquid fossil fuels</b> (%)	It enables the assessment of the weight of liquid fossil fuels in electricity generation.	It is complementary of the B.2, B.4 and B.5 ratios
<b>B.4 Proportion of electricity generated by solid fossil fuels</b> (%)	It enables the assessment of the weight of solid fossil fuels in electricity generation.	It is complementary of the B.2, B.3 and B.5 ratios

Indicator	Why is this indicator important?	What are the links with other indicators?
<b>B.5</b> Proportion of electricity generated by natural gas (%)	It enables the assessment of the weigh of natural gas in electricity generation.	It is complementary of the B.2, B.3 and B.4 ratios
<b>B.6</b> Shares and diversity of fuels used for electricity generation	It enables the classification of the countries and regions energy systems according to the more or less dependence on a reduced number of energy products. ( <i>Shannon-Weiner measure<sup>1</sup></i> )	As a summary measure it sums up information given by indicators B.2 to B.5.
<b>B.8</b> Ratio of energy production to primary energy consumption	It gives a good measure of security of supply in terms of primary energy consumption.	
<b>B.9</b> Fossil fuels dependency (%)	It is an indicator which can be used to compare countries in terms of greenhouse gases emissions.	
<b>B.10</b> Annual electricity failures (minutes/year)	It is a measure of the quality of the service of the electricity distribution utilities.	
<b>B.11</b> Crude oil refined/fossil fuels primary consumption (%)	Importance of refinery in fossil fuels primary consumption	

### Indicators C. Competitive energy markets

Indicator	Description	Why is this indicator important?
<b>C.1</b> Fuel price indices for the industrial sector (natural gas, electricity)	It enables the visualization of the evolution of relative price indices of energy used by industry. As a basis for comparison the German price will be considered (it is the larger consumer of the countries considered).	It enables the assessment of relative competitiveness among countries.
<b>C.2</b> Fuel price indices for the domestic sector (natural gas, electricity)	It enables the visualization of the evolution of relative price indices of gas and electricity as the main energy sources used by the residential sector. As a basis for comparison the German price will be considered (it is the larger consumer of the countries considered).	It enables the assessment of relative competitiveness and welfare of the population among countries.
<b>C.3</b> Fuel price indices for the transport sector (gasoline and diesel)	It enables the visualization of the evolution of relative price indices of petrol and gasoil sources used by the transport sector. As a basis for comparison the German price will be considered (it is the larger consumer of the countries considered).	It enables the assessment of relative competitiveness and welfare of the population among countries.

### Indicators D. Environmental objectives

Indicator	Description	Why is this indicator important?
<b>D.1 Greenhouse gas emissions</b> (Mio tonnes CO2 equivalent)	The amount of CO2 equivalent released to the atmosphere.	This indicator will help to monitor the Kyoto targets or the burden sharing targets.
<b>D.2 Acidification gas emissions</b> (Acidifying Potential (kt))	The amount of acidification gases released to the atmosphere.	This indicator will help to monitor the existing targets for acidification gases.

<sup>1</sup> Shannon-Weiner measure =  $-\sum p_i \ln p_i$  over all i  
where  $p_i$  represents the proportion of the total supplied by fuel i.

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<sup>3</sup> Total Primary Energy Supply (TPES) is the energy content of different energy sources as they are offered by nature before they are transformed for use. TPES is made up of domestic production plus imports and minus exports, international marine bunkers, and stock changes.

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## Annex 3: List of missing data

Especially data with long time series seemed to be very hard to get, even in the form of national level statistics.

At national level we have some difficulties finding data for:

- Core Indicator 3 for new member states - Energy Price for industry
- Indicator B7 - Gas capacity (kWh/day)<sup>4</sup>
- Indicator B10 - Annual electricity failures
- Indicator B12 - Grid density (high and medium voltage) (kWh/day)<sup>5</sup>
- Indicator C4 - Competition in electricity generation<sup>6, 7</sup>

The data collected at regional level (NUTS level 2) included several data gaps and restrictions in comparability.

Main missing data sets, which would have allowed for a more comprehensive analysis are:

- Energy production at regional scale (core indicator 1);
- Final Energy consumption at regional scale (core indicator 2);

The research undertaken along the project was hampered by the regional data gaps for Core Indicator 1 and 2 shown in the next two tables using the Eurostat Newcronos source. It was also an unprofitable work using other sources to complement Eurostat.

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<sup>4</sup> It measures the available capacity for supplying natural gas. Knowing the demand over or underestimation of the capacity can be estimated.

<sup>5</sup> It informs about more or less rarefaction of electricity supply in terms of the grid.

<sup>6</sup> Herfindahl-Herschmann measure = The square of each participant's market share added together across all participants in the market. Values vary between zero, which signifies a perfectly competitive industry, and ten thousand, for a pure monopoly

<sup>7</sup> Measures the degree of concentration in the electricity generation. A better understanding of the behaviour of agents acting in the sector will be achieved.

**Table 8 Data collected for Core Indicator 1 at NUTS 2 (1990-2000)**

**Core Indicator 1 - Electricity Production by power source**

*(installed net capacity production by hydroelectric, nuclear, and thermal power)*

NUTS 2	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
BE	t	t	t	t		n	n	n			
DE											
GR											
ES									n		
FR											
IE											
IT	h,th	h									
NL						n,th	n,th	n	n	n,th	n,th
AT											
PT											
FI											
SE											
UK							n	n	n	n	n
CZ											
HU											
PL	t,h,th	t,h,th	t,h,th	t,h,th	t,h,th	t,h,th					
SK											
BG											
RO											
NO											
CH											

Source: Eurostat Newcronos

Notes: Some regions have only: t - total; n - nuclear; h - hydroelectric; th - thermal  
other cases it means there is data for all power sources

**Table 9 Data collected for Core Indicator 2 at NUTS 2 (1990-2000)**

**Core Indicator 2 - Final Energy Consumption by source and sector**

*(only final electricity consumption by sector)*

NUTS 2	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990
BE	t	t	t	t	t	t	t	t			
DE											
GR											
ES											
FR											
IE											
IT											
NL											
AT					t	t	t				
PT											
FI											
SE											
UK											
CZ				h	h						
HU											
PL											
SK											
BG											
RO											
NO											
CH											

Sources: Eurostat Newcronos, IEA, DGE ( for Portugal) CNE (for Spain)

Notes: t - only total; h - only households

## **Annex 4: List of abbreviations and glossary**

AT	Austria
BE	Belgium
BG	Bulgaria
CEEETA	Research Centre for the Economics of Energy, Transport and the Environment
CH	Switzerland
CO <sub>2</sub>	Carbon Dioxide
CY	Cyprus
CZ	Czech Republic
DE	Germany
DGET	Directorate General for Energy and Transport
DK	Denmark
EE	Estonia
EEA	European Environment Agency
EIA	Energy Information Administration
ES	Spain
ESDP	European Spatial Development Perspective
EWEA	European Wind Energy Association
FEC	Final Energy Consumption
FI	Finland
FR	France
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GR	Greece
GTE	Gas Transmission Europe
HU	Hungary
IE	Ireland

IEA	International Energy Agency
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
N10	Present 10 New Member States
NL	Netherlands
NO	Norway
NUTS	Nomenclature of territorial units for statistics
PL	Poland
PPS	Purchasing Power Standards
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
TEN	Trans European Networks
TIA	Territorial Impact Assessment
TPG	Transnational Project Group
TPES	Total primary energy supply
UCTE	Union for the Co-ordination of Transmission of Electricity
UK	United Kingdom
US DOE	United States Department of Energy Office

## **Annex 5: List of references, including the use of results from projects outside the ESPON programme**

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## **Annex 6: List of publications of the TPG members resulting from the research undertaken**

So far there is no publication of the TPG members resulting from the research undertaken.

## Annex 7: Indication of performance indicators achieved

Along this ESPON project it has been collected, updated and analysed the performance indicators given in the ESPON 2006 programme document. The achievements by our project can be reflected in the table below (accordingly the indications of Lillehammer Guidance Paper).

**Table - Number of performance indicators achieved**

<b>Number of spatial indicators employed in addition to priority 1</b>	
in total	57
covering the EU territory	2
covering more than the EU territory	55
<b>Number of spatial indicators applied</b>	
in total	54
covering the EU territory	2
covering more than the EU territory	52
<b>Number of EU maps produced</b>	<b>44</b>
<b>Number of sector policies fully addressed</b>	<b>4</b>
<b>Number of charts on the institutional structure of sector policies</b>	<b>0</b>
<b>Number of ESDP policy aims mentioned in the ESDP reference made to by sector study</b>	<b>4</b>



## Annex 8: Additional maps and tables

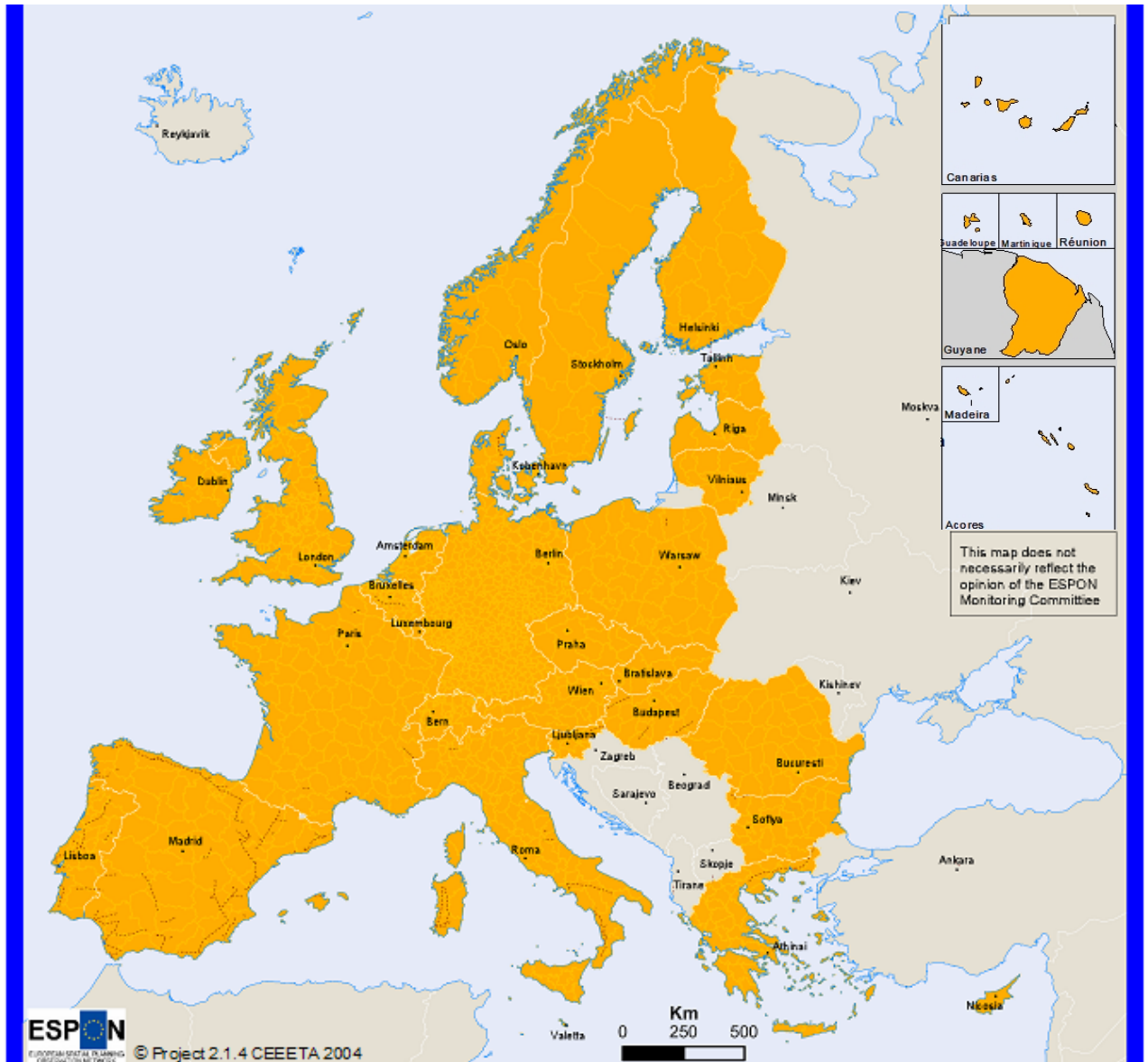
**Table 10 Regional Unplanned Electricity Supply Interruptions in 2001**

	REGIONS	MINUTES LOST PER CUSTUMER	NUMBER OF INTERRUPT, PER CUST,	DISTRIBU TED ENERGY AT MV & LV (TWH)	LENGT H OF MV CIRCUITS (KM)	NUMBER OF LV USERS (MILLIONS )	AREA (KM2)
E	País Vasco	56,40	0,92	n.a.	11,078	1,049	7,234
E	Navarra	59,40	1,16	n.a.	15,266	0,283	10,391
E	La Rioja	66,00	1,5	n.a.	1,264	0,178	5,045
E	Asturias	91,20	1,37	n.a.	9,015	0,589	10,604
E	Madrid	92,40	2,66	n.a.	33,641	2,531	8,028
E	Cantabria	112,20	2,37	n.a.	6,551	0,311	5,321
E	Aragón	112,20	2,5	n.a.	9,214	0,737	47,720
E	Castilla-León	115,20	2,42	n.a.	20,893	0,165	94,223
E	C, Valenciana	145,80	3,78	n.a.	26,742	2,603	23,255
E	Canarias	171,60	4,4	n.a.	8,827	0,825	7,242
E	Murcia	176,40	3,84	n.a.	4,344	0,597	11,313
E	Cast-La Mancha	186,60	4,08	n.a.	27,081	1,054	79,463
E	Extremadura	202,80	4,54	n.a.	6,777	0,555	41,634
E	Andalucia	215,40	3,78	n.a.	38,686	3,621	87,597
E	Cataluña	229,80	3,54	n.a.	55,466	3,705	32,114
E	Galicia	310,20	5,12	n.a.	29,597	1,444	29,574
FIN	Lapland (northern part of Finland)	81,00	2,20	n.a.	10,937	n.a.	93,004
FIN	Coast	307	2,60	n.a.	37,008	n.a.	n.a.
FIN	Inland	506	9,30	n.a.	59,226	n.a.	n.a.
I	Friuli - Venezia Giulia	62,74	1,66	5,23	7,187	0,7	7,844
I	Valle D'Aosta	84,13	1,80	0,55	1,268	0,11	3,264
I	Liguria	89,08	2,46	4,89	6,565	1,21	5,420
I	Lombardia	89,86	1,79	44,22	35,446	5,07	23,872
I	Umbria	90,61	2,26	2,88	7,622	0,48	8,456
I	Marche	102,17	2,46	5,26	10,289	0,82	9,694
I	Trentino Alto Adige	113,25	3,36	2,47	5,362	0,33	13,607
I	Veneto	115,32	2,69	21,38	23,529	2,49	18,364
I	Emilia-Romagna	115,34	2,09	20,06	27,752	2,51	22,123
I	Piemonte	118,81	2,58	17,71	27,096	2,72	25,399
I	Toscana	119,51	3,30	14,58	23,982	2,19	22,993
I	Lazio	143,02	3,44	17,12	26,766	3,11	17,227
I	Molise	161,88	4,02	1,04	3,480	0,2	4,438
I	Abruzzo	180,50	3,39	4,49	9,115	0,78	10,795
I	Mid-western	205	1,52	n.a.	25,478	0,368593	n.a.
I	Northern	229	1,65	n.a.	26,538	0,362114	n.a.
I	Campania	235,91	4,92	12,85	21,647	2,63	13,595
I	Puglia	258,31	3,62	9,41	24,889	2,2	19,362
I	Sicilia	311,48	5,80	11,7	33,216	2,82	25,707
I	Calabria	327,05	8,19	4,18	15,219	1,19	15,080
I	Basilicata	435,03	4,91	1,82	8,831	0,34	9,992
I	Sardegna	486,32	7,37	4,75	14,230	0,94	24,090
IRL	Dublin	133	0,93	n.a.	3,911	0,463853	n.a.
IRL	Southern	238	1,40	n.a.	24,410	0,391795	n.a.
NOR	Oslo (County in the south-east of Norway)	47,00	0,70	9,2	3,552	0,507	454
NOR	Akershus (County in the south-east of Norway)	270,00	2,40	7,1	5,677	0,47	4,916
NOR	Finnmark (County in the north of Norway)	327,00	3,50	1,4	3,488	0,074	48,649
P	Grande Porto	252,83	2,92	n.a.	9,181	0,592	735
P	Península de Setúbal	271,78	6,11	n.a.	5,200	0,407	1,519
P	Grande Lisboa	276,8	3,42	n.a.	7,212	0,82	567
P	Algarve	284,4	5,7	n.a.	8,871	0,318	4,990
P	Beira interior	378,17	8,09	n.a.	8,234	0,269	11,463
P	Trás-os-Montes	440,29	8,34	n.a.	8,980	0,27	11,383
P	Ave-Sousa	507,2	8,18	n.a.	8,124	0,392	3,155
E	Baleares	576,00	4,19	n.a.	8,122	0,533	4,992

	REGIONS	MINUTES LOST PER CUSTOMER	NUMBER OF INTERRUPT, PER CUST,	DISTRIBU TED ENERGY AT MV & LV (TWH)	LENGT H OF MV CIRCUIT S (KM)	NUMBER OF LV USERS (MILLIONS )	AREA (KM2)
P	Alentejo	667,91	10,24	n.a.	7,827	0,227	21,159
P	Minho	685,64	7,36	n.a.	10,491	0,373	3,887
P	Oeste	699,49	9,22	n.a.	3,972	0,347	1,938
P	Litoral Centro	721,21	9,34	n.a.	7,692	0,299	3,833
P	Coimbra	782,3	10,78	n.a.	8,685	0,349	6,121
P	Vale do Tejo	921,19	14,33	n.a.	7,915	0,278	11,987
P	Beira Litoral	1001,24	11,65	n.a.	11,922	0,452	6,072
GB	London Power Networks	43,00	0,40	24,193	9,073	2,07	665
GB	Manweb	55,00	0,53	14,497	19,421	1,44	12,200
GB	Yorkshire Electricity Distribution	56,00	0,70	22,274	20,509	2,07	10,700
GB	NORWEB (Now United Utilities)	60,00	0,54	23,575	19,239	2,26	12,500
GB	Eastern Electricity	66,00	0,69	32,7	36,354	3,35	20,300
GB	Southern Electric Power Distribution	69,00	0,74	29,37	27,500	2,69	16,900
GB	Western Power Distribution (South West)	70,00	0,87	14,245	17,179	0,99	14,400
GB	SEEBOARD Energy	75,00	0,89	19,054	16,555	2,15	8,200
GB	Northern Electric Distribution Limited	110,00	0,98	14,089	20,098	1,50	14,400
GB	Scottish Hydro-Electric Power Distribution	111,00	1,32	n.a.	25,239	0,66	54,390
GB	East Midlands Electricity Distribution	112,00	0,91	27,093	26,736	2,42	16,000
GB	Western Power Distribution (South Wales)	123,00	1,58	9,357	23,486	1,36	14,400
GB	SP Distribution	152,00	0,92	n.a.	32,059	1,91	22,950
UK	GPU Power Networks (Now Aquila)	143,00	1,48	26,073	26,222	2,26	13,300
BG	EDC G, Oriahoviza	59	2,84	1,5	8 585	0,538962	15 017
BG	EDC Pleven	286	2,6	6,93	10 515	0,580549	19 255
BG	EDC Sofia District	n.a.	n.a.	n.a.	8 757	0,533670	19 093
BG	EDC Sofia Capital	150	4,09	2,529	3 875	0,585992	1 311
BG	EDC Varna	86	9,0	4,8	7 678	0,590600	14360
BG	EDC Plovdiv	n.a.	n.a.	n.a.	12 568	0,858432	20 000
BG	EDC St, Zagora	n.a.	n.a.	n.a.	11 048	0,682131	21 000
BG	EDC ZI, Piasaci	n.a.	n.a.	n.a.	25	0,000460	2,17
HU	DÉDÁSZ(Déldunántúli Áramszolgáltató Rt.)	267,6/ 181,2	2, 44/ 2,07	3, 018	11 640	709	18 414
HU	DÉMÁSZ (Délmagyarországi Áramszolgáltató Rt.)	332,4/ 2,95,8	2,66/ 2,72	3,244	9 401	740	18 235
HU	ELMŰ (Budapesti Elektromos Művek Rt.)	237,6/ 139,8	1,58/ 1,53	5, 813	11 451	917	18 223
HU	ÉDÁSZ (Északdunántúli Áramszolgáltató Rt.)	176,4/ 1,83	1,74/ 1,83	8,148	10 344	1 359	4 050
HU	ÉMÁSZ(Északmagyarországi Áramszolgáltató Rt.)	264,6/ 2,28,6	2,63/ 2,59	3,264	8 802	712	15 501
HU	TITÁSZ(Tiszántúli Áramszolgáltató Rt.)	252,6/ 2,15	2,46/ 2,36	3,531	11 876	748	18 608
LT	Vilniaus ET	60,6	0,48	1,8467	6459		
LT	Kauno ET	29,4	0,40	1,4024	7627		
LT	Klaipėdos ET	63	0,49	1,2112	9033		
LT	ŠiauliųET	88,2	0,52	0,7516	8668		
LT	Panevėžio ET	99	0,67	0,6851	7112		
LT	Alytaus ET	17,4	0,38	0,6498	5810		
LT	Utenos ET	98,4	0,88	0,3703	7165		

Source: "Second Benchmarking report on quality of electricity supply", Council of European Energy Regulators, September 2003 and "Quality of electricity supply" ERRA energy regulators regional association, April 2004  
Note: for HU data refers to 2002

**Map 41 High Voltage Transmission Networks under construction**

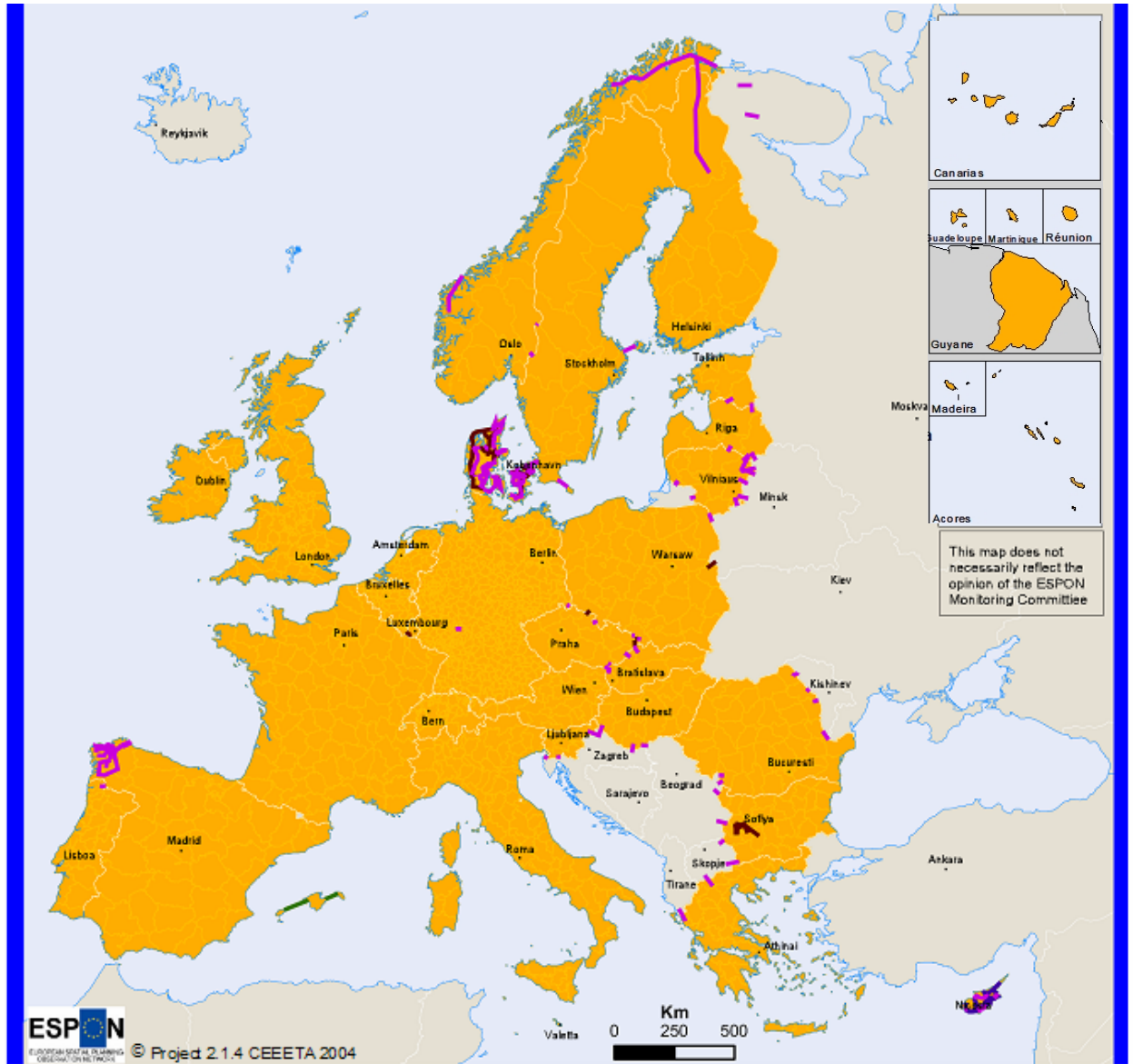


..... High Transmission Line – Under Construction

© EuroGeographics Association for the administrative boundaries  
 Origin of the data: EU24 - UCTE Map, 2003  
 Finland, Sweden, Norway – Nordregio 2000  
 Source: UCTE, Nordregio

No data for the outmost territories.

Map 42 Low Voltage Transmission Lines under construction

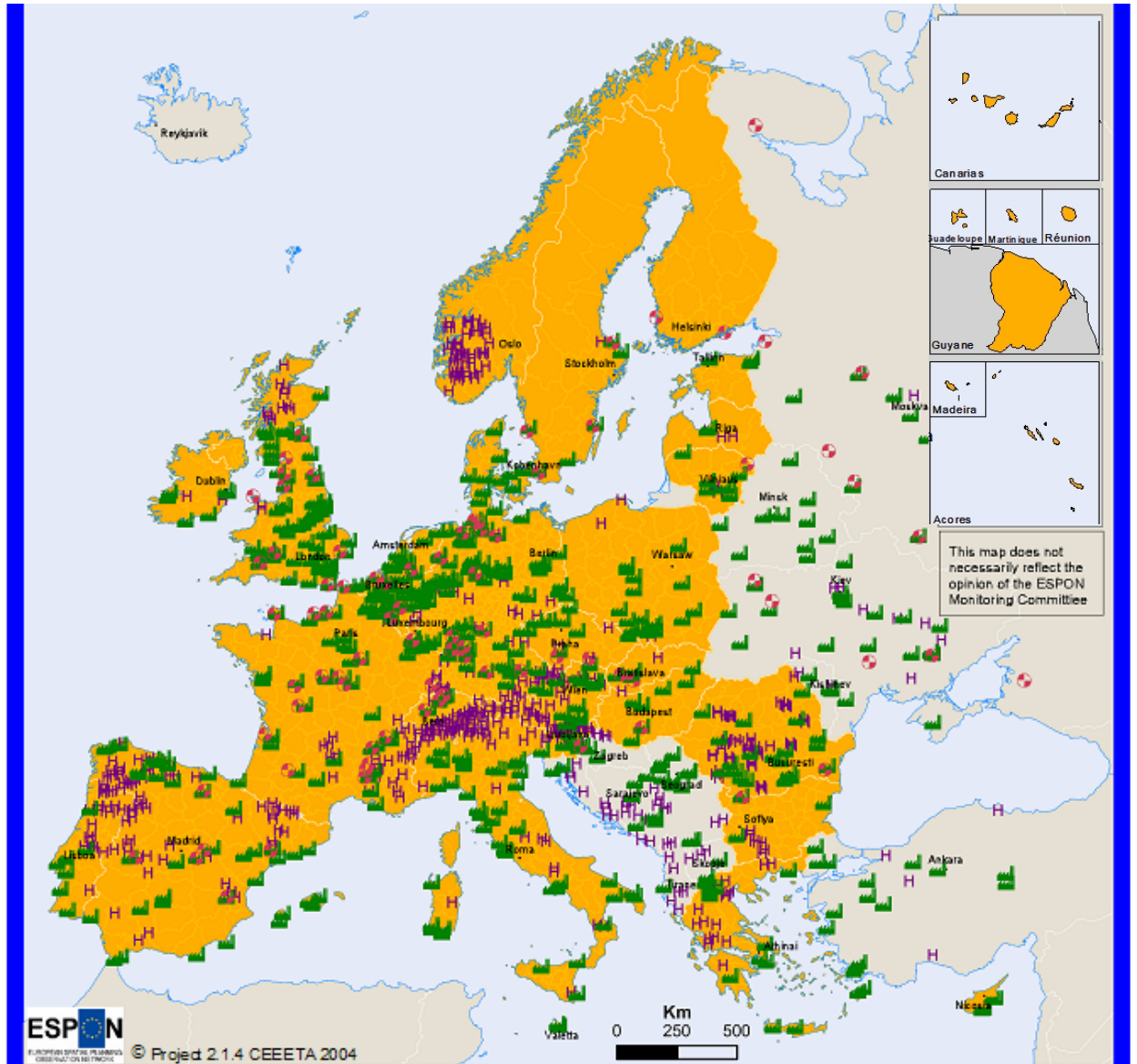





- Double Interconnection low 220 Kv
- Transmission Line low 220 Kv
- Transmission Line 66 Kv
- Transmission Line 132-150 Kv Under Construction

© EuroGeographics Association for the administrative boundaries  
 Origin of the data: UCTE Map, 2003  
 EU29 except Finland, Sweden, Norway, Malta and Cyprus  
 Nordregio, 2000  
 Enemalta Corporation, 2004  
 Electricity Authority of Cyprus, 2004  
 Source: UCTE, Nordregio, Enemalta, Electricity Authority of Cyprus

No data for the outmost territories.

Map 43 Power Stations Location by NUTS 2



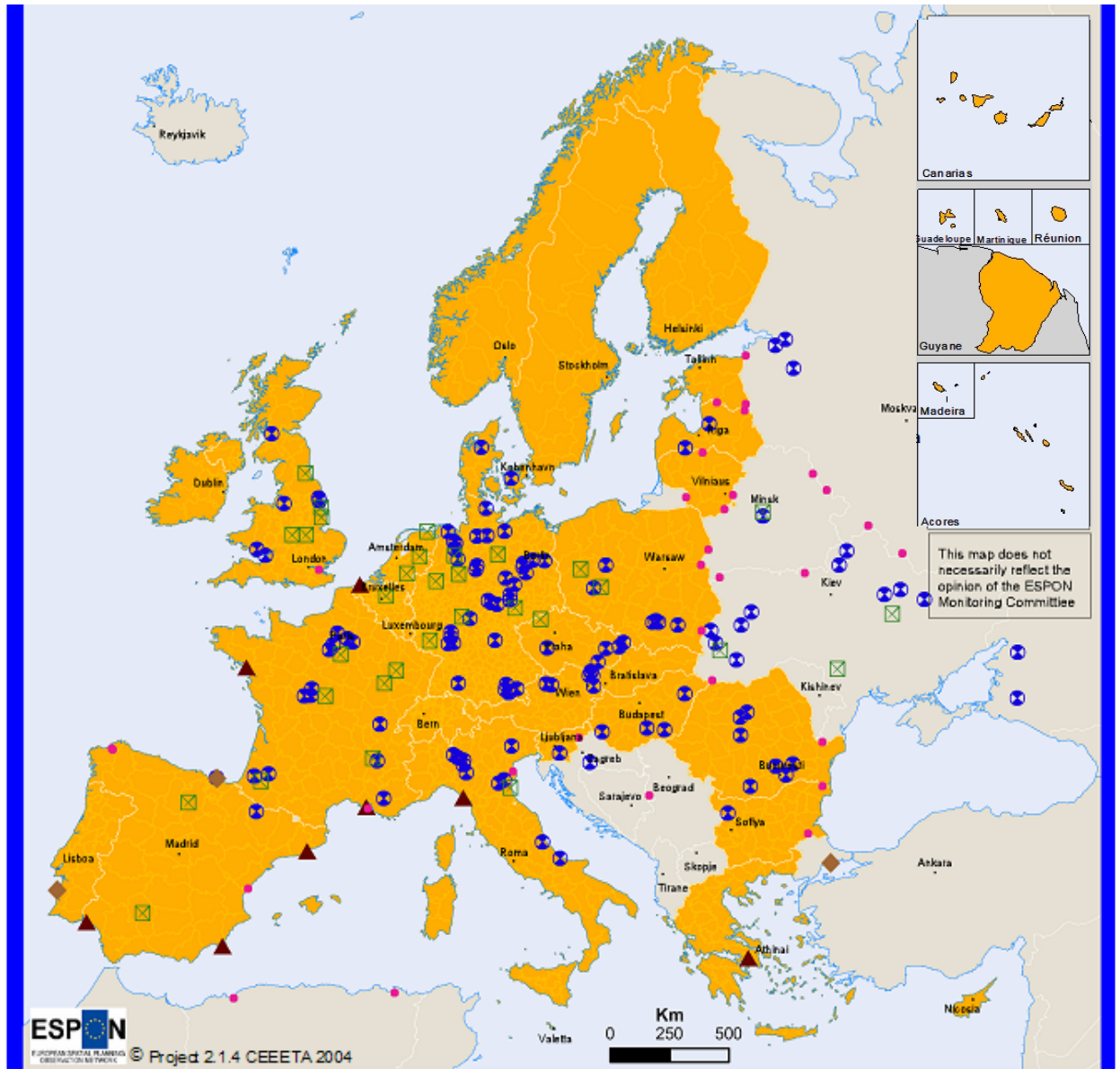
-  Thermal Power Station
-  Hydro-electric Power Station
-  Nuclear Power Station

© EuroGeographics Association for the administrative boundaries  
 Origin of the data: EU29 except Finland, Sweden, Norway, Malta and Cyprus - UCTE map, 2003; Finland, Sweden, Norway – Nordregio 2000; Malta – Enemalta Corporation 2004; Cyprus – Electricity Authority of Cyprus 2004, EU29 - Nuke database system, 2003  
 Source: UCTE, Nordregio, Enemalta, Electricity Authority of Cyprus, Nuke database system

No data for the outmost territories.



Map 44 Gas Infrastructures



- ▲ LNG Terminal
- LNG Terminal – projected
- ◆ LNG Terminal – under construction
- ⊗ Gas Storage
- ⊗ Major interconnection point

© EuroGeographics Association for the administrative boundaries  
 Origin of the data: The European Natural Gas Network Map, 2004  
 Source: Gas Transmission Europe

No data for the outmost territories.

## **Annex 9: EU energy policy**

*Source: Energy – [http://europa.eu.int/pol/ener/index\\_en.htm](http://europa.eu.int/pol/ener/index_en.htm)*

Presenting its strategic objectives for 2000-2005 [COM (2000) 154 final, "Shaping a new Europe"], the Commission indicated energy to be a key factor for Europe's competitiveness and economic development. The prime aim of the European Community's energy policy, as set out in the November 2000 Green Paper on the security of energy supply, is to ensure a supply of energy to all consumers at affordable prices while respecting the environment and promoting healthy competition on the European energy market. The European Union is facing new energy challenges for which it must have an appropriate energy strategy.

Security of the Union's energy supply and protection of the environment have been highly important in recent years. In particular, the signature of the 1997 Kyoto Protocol on Climate Change boosted the importance of the environment dimension and sustainable development in Community energy policy. The Union's external energy dependence is continuing to grow (it currently meets 50% of its energy requirements through imports). As the Green Paper states, if nothing is done, this rate of dependence will grow to 70% by 2030, which would further weaken the Union's position on the international energy market. Vigilance with regard to diversification of energy sources and supplier areas is one of the ways of ensuring security of supply. The debate on the Green Paper should be concluded at the Barcelona Summit in March 2002, following which the Commission will propose a set of specific measures to improve the EU security of energy supply (Additional information on the Green Paper "Towards a European strategy for the security of energy supply").

Creation of a single market is a part of the energy policy and has long been a priority of the Community. The Commission's aim is to provide the Union with the most effective, safest and competitive energy market. The creation of the single market, which is now well under way, has proceeded in stages. Initially, measures were taken to ensure the transparency of prices to final consumers and to facilitate the transit of gas and electricity between the Community's major grids. The next step was to remove certain restrictions so that companies would enjoy equal access to explore and prospect for hydrocarbons. In 1996 and 1998, in an important move forward in the construction of the single energy market, Directives were adopted on

common rules for electricity and gas. These Directives ensured the free movement of electricity and gas within the Community. Liberalisation of the electricity and gas markets, which were opened up to major consumers in 1999 and 2000 respectively, has enjoyed some success, though the degree of liberalisation still varies greatly from one Member State to another.

The call made at the Lisbon European Council of 23 and 24 March 2000 for the energy markets to be opened up more quickly provided a new major impetus in this area. In March 2001 the Commission adopted a set of measures to open up the gas and electricity markets fully by 2005. They include a communication on the completion of the internal market, a draft Directive amending the Directives introducing common rules for the internal market in electricity and gas and a draft regulation on conditions for access to the network for cross-border trade in electricity. These measures provide inter alia for an accelerated timetable, conditions even more conducive to genuine and fair competition, and the creation of a single market which offers guarantees to the public, protects the environment and ensures a safe and affordable supply of energy.

The completion of the internal market for energy is accompanied by measures to strengthen economic and social cohesion, such as the creation of trans-European energy networks. Legislation on Community guidelines in this area and on measures to create a favourable context for the trans-European networks was adopted during 1996. The decisions on the guidelines contain a list of projects of common interest in the trans-European electricity and natural gas networks. Under these guidelines, some 74 projects of common interest have been identified, representing a total investment of EUR 18 000 million. The funding of these projects is largely the responsibility of the operators in this sector. In a number of cases, the Union's financial instruments, consisting essentially of EIB loans and ERDF aid, have been mobilised. In its 1997 annual report on the trans-European networks, the Commission reported major progress in the gas sector. However, the priority projects in the electricity sector are facing administrative, financial and environmental problems which are slowing them down. The guidelines are to be revised to focus on remaining bottlenecks and improve the interoperability of networks.

The introduction of trans-European energy networks also has an impact on relations with third countries. Interconnections have been made with certain Mediterranean countries, the countries of Central and Eastern Europe and Norway. The CENTREL electricity grid, which covers Poland, the Czech Republic, Slovakia and Hungary, was connected to the UCPTE grid (the main



European electricity grid) in 1995. The extension of the UCPTE grid to the Balkan States and its interconnection with the countries of the CIS is the subject of studies being funded by the Community, as are gas links between Eastern and Western Europe. Projects on connection with the countries of the Mediterranean basin are also being studied and a Euro-Mediterranean partnership in the energy sector has been set up. At international level, the European Union is likewise endeavouring to establish cooperation in the energy field with almost all the main countries and regions of the world. The Synergy programme is geared to the Community's general energy relations with third countries. Cooperation with Russia in the energy field was given a boost at the EU-Russia Summit in October 2000 thanks to the concept of energy partnership. In addition, the European Community is a signatory to the European Energy Charter, which promotes East-West cooperation on energy. The European Union plays an active role in initiatives in the Baltic Sea region, including the "Northern dimension" action plan. The European Union is also developing major links with other countries such as the Balkan States and China. It is also taking care to maintain its relationships with its industrialised partners in the OECD and with its EEA partners. Finally, its links with the Gulf States are important both in themselves and as part of the dialogue between energy producers and consumers which has recently been revived. The European Union is also represented in a wide range of international forums and organisations such as the International Energy Agency (IEA).

Energy from renewable energy sources (RES) is playing a key role in the diversification and sustainability of energy sources and the campaign to combat climate change. The Altener programme, set up in 1993 and renewed in 1998, promotes RES in the European Union. The 1997 White Paper provided a strategy and a Community action plan for RES. The prime objective set by the White Paper is to double the proportion of renewable energy sources in the EU gross domestic energy consumption from 6% in 1997 to 12% in 2010. Despite some progress in this area, the report published in January 2001 emphasised that much work had yet to be done. Nonetheless, the Commission believes the goal set in the White Paper to be a realistic one. A Council and Parliament Directive on the promotion of production of electricity from renewable energy sources was adopted in September 2001; it aims to increase the percentage of "green" electricity in the Union from 14% in 1997 to 22% in 2010.

A "take-off" campaign to get RES off the ground is an integral part of the action plan and strategy for 2010 and must act as a catalyst for the

development of key renewable energy sectors for which quantitative targets have been set for 2003. The take-off campaign also includes the renewable energy partnerships, which is a system of voluntary agreements by public or private partners with the Commission to achieve the objectives of the campaign.

For the first time, the Green Paper on security of energy supply stresses the fundamental importance of influencing demand rather than concentrating solely on energy supply. In order to limit our energy dependence, the growth in our demand has to be limited by legislative means, among others. A series of measures are so presented in the Green Paper.

In the context of the Kyoto Protocol, improved energy efficiency has become even more than before an important element of Community strategy. In April 2000, the Commission adopted an action plan to improve energy efficiency in the European Community. The SAVE programme encourages energy efficiency measures, and will be the main instrument for coordination of the plan. Under the plan, for example, the Commission adopted in May 2001 a proposal for a Directive on energy efficiency in buildings covering: a common methodology for minimum energy performance standards, the application of those standards for new buildings and for major renovations of existing buildings, production of an energy performance certificate in the event of the construction, sale or renting of a building and the checking of heating and air-conditioning systems.

As 40% of energy is consumed in the transport sector which in turn is responsible for 28% of CO<sub>2</sub> emissions, the Green Paper stresses the importance of taking transport policy measures to reduce energy consumption. In this connection, the White Paper "European Transport Policy for 2010: time to decide" adopted in September 2001 by the Commission is, with its 60 proposals, a key instrument to change the present modal split. Oil accounts for 98% of energy consumption in the transport sector. An attempt at diversification is therefore essential in this sector. In November 2001, the Commission adopted an action plan and two proposals for directives to encourage the use of alternative fuels in the transport sector, beginning with regulatory and fiscal measures aimed at promoting biofuels. The first directive provides for a minimum percentage of biofuels from 2005 while the second allows the possibility of applying a reduced excise duty for biofuels.

SAVE, ALTENER, SYNERGY, SURE (nuclear safety and transport of radioactive materials) and ETAP (studies, analyses and forecasts) are

incorporated in a non-technological energy framework programme which runs until the end of 2002 and is currently being revised.

Alongside legislative measures or measures designed to encourage changes, technological progress is an important mean of achieving the objectives of the Community energy strategy. The Commission supports research, development and demonstration projects in the field of non-nuclear energy under the ENERGY sub-programme of the Fifth Framework Programme for research and technological development. This framework programme runs until the end of 2002 and the Sixth Framework Programme which will lay emphasis on the European Research Area is currently being drawn up.

On what regards nuclear energy, Union policy is responsibility of the European Atomic Energy Community (EURATOM) set up in 1957 on the basis of a separate treaty to that of the European Community. EURATOM has a number of tasks including research into and development of the peaceful use of nuclear energy, the drawing up of uniform safety standards, and the creation of a common market for nuclear energy equipment and an adequate supply of nuclear energy. It is also responsible for ensuring that nuclear materials are not used for unlawful purposes such as the production of nuclear weapons. The institutions common to the European Community (particularly the Council, Commission and European Parliament) and the Supply Agency created by the EURATOM Treaty are responsible for implementing the Treaty. EURATOM plays an active role in international initiatives, having concluded many international agreements with third countries or international organisations, such as the International Atomic Energy Agency (IAEA) with the Convention on Nuclear Safety. The EURATOM Safeguards Office, for its part, is responsible for ensuring that within the European Union nuclear materials are not diverted from their prescribed use and that the safeguards to be applied by the Community under an agreement with a third country or international organisation are observed.

Nuclear safety is of particular concern to certain countries, particularly in Eastern Europe. It has a prominent place in the negotiations underway with candidate countries. The TACIS, PHARE and to some extent SURE programmes are involved in measures to improve safety in third countries.

Lastly, in the tax field, the Commission has presented two proposals on the taxation of energy products. One proposal, presented in 1997, sets out a global tax system for such products; this proposal is however pending in the absence of political agreement between the Member States. As stated above, the Commission also adopted in November 2001 a proposal for a directive allowing the application of reduced rates of excise duty on biofuels.

The Green Paper on security of energy supply also stresses that tax measures will be needed to curb the present growth in demand.

## Annex 10: Countries energy policy

The following analysis was based, among other sources, on the IEA annual country reviews produced recently.

### AUSTRIA

#### MAIN HIGHLIGHTS

- Most important latest developments: liberalization of the electricity and natural gas markets and the commitment to meet the emissions reduction targets under the Kyoto Protocol (to reduce emissions by 13% below 1990 levels by 2008-2012) – Climate Change Mitigation Programme.
- The emissions of greenhouse gases per inhabitant in Austria amounting to 9,86 tones are about average within the EU, but considerably below the level of extra-European industrialized countries.
- Austria is a net importer of energy - of approximately 65% of its total primary energy supply in 2000.
- Austria faces no security of supply problem as Austria is in between strong electricity producing countries. Has also taken steps to ensure supply security through gas storage capabilities, comprehensive measures for oil and sizeable reserve margin for capacity for electricity.
- In April 2002 was defined a strategy to reduce energy intensity (0.107 toe/\$1000 GDP in 2003) at a rate of 1% per year.

#### MAIN CONCERNS

##### NATURAL GAS

- Major European hub in Baumgarten with main pipelines for Western and Southern Europe. Only 20% of the gas going through Austria is for national consumption.
- Austria has domestic natural gas resources providing 23% of the countries' demand.
- Together with the oil fields, natural gas production fields has declined over the last 20 years and is expected to continue to decline as the sources are exhausted.

- Austria imports almost 80% of its natural gas needs, from Russia (80%), Norway and Germany.
- On 1st October 2002, all natural gas customers were given the right to choose their own supplier.
- The Austrian Gas Act opened 50% of the natural gas market (by volume) in August 2000.

## OIL

- Austria has domestic oil resources, providing 9% of countries' demand.
- The country imports over 90% of its crude oil needs and nearly 60% of its diesel needs.

## RENEWABLES

- Austria has substantial hydropower resources which provide approximately 70% of its electricity needs.
- Small hydropower facilities (<10 MW) provided 1,3% of the countries' total primary energy supply and biomass around 10,9% in 2000.
- Other renewable energy technologies: solar, wind, geothermal, biomass electricity generation and landfill gas generation accounted in total for less than 0,5%.
- Small renewable energy technologies (i.e. excluding large hydropower and biomass) benefit from two separate support schemes. The first one is a feed-in tariff. The second one is system of green certificate trading. Electricity suppliers based in Austria must include 8% of small-scale hydro (<10 MW) and 1% (increasing to 4% by 2007) from other renewable energy technologies in the electricity sold to final consumer.
- The Green Electricity Law has a binding provision of the rise of new renewable energies to reach 4% of electricity supply by 2008; small hydro shall account for at least 9%.
- The target is to raise the total share of renewable sources in the overall generation of electric power from currently 70% to 78% (including large hydro).

## CHP

- CHP provides 27% of the Austrian electricity supply. These plants are supported by regulations requiring local utilities to pay above-market rates for electricity coming from those plants.

## ELECTRICITY

- Austria is a net exporter of electricity but trade balances vary seasonally as Austria's hydropower capability fluctuates through the year.
- On 1st October 2001, all electricity customers were given the right to choose their supplier.
- While larger consumers have enjoyed reduced power prices, smaller customers have seen little or no change to their overall bills. Less than 1% of domestic customers have switched suppliers while 20% of large consumers have done so.
- Access charges to the Austrian system, which account for approximately 35% of the average residential bill, are between 60% and 70% higher than the average of other European countries.
- The role of Austrian utilities in the liberalized Central European electricity market is evolving

## SPECIFIC FEATURES

- Climate change is the main priority within the framework of the Environment fund of the Federal Government. Climate Change related subsidies increased from 40 million Euros in 2001 to 57 million in 2002.
- Austria is a carrier of substantial international energy trade.
- Emissions reduction measures were placed into six different categories, with space heating and transport measures accounting for more than one half of the total projected emission cuts.
- Austrian energy intensity is low given in part to the fact to low energy intensity in the transport sector (resulting largely from a high share of diesel fuelled vehicles in the Austrian fleet), an economy dominated by services rather than large energy intensive industry and efforts to reduce public energy use such as public lighting.

- Austria makes substantial use of district heating, providing 12% of the countries heating supply.
- The energy related standards for buildings established by the Federal Provinces are permanently improved and thus the energy demand is reduced.
- Starting in 2001, the motor vehicles tax for trucks has been raised by 50% on average and this tax will be applicable until the introduction of a mileage based road pricing.

#### CLIMATE CHANGE

- National Allocation Plan (NAP) has been accepted by European Commission with technical changes required on “ex-post adjustment” (Austria intends to re-allocate allowances from plants that close down during the 2005-2007 period). If Austria implements this changes by 30 September 2004, all companies qualify automatically for trading. NAP allows 98.2 millions tones of CO<sub>2</sub> for 205 installations.
- In December 2003 Austria launched a CDM/JI programme, which aims to make a contribution to achieving the Austrian reduction commitments under the Kyoto protocol through the application of the project related to JI and CDM.
- The goals of this programme are on the one hand to purchase emission reduction credits from Kyoto projects. Two calls for projects (4 December 2003 for JI and 10 December 2003 for CDM) are opened until September 2004. On the other hand it will help financing of particular immaterial services, such as baselines studies, etc...
- Austria already signed Memorandum of Understanding (MoU) on Kyoto projects mechanisms with Bulgaria, China, Czech Republic, Hungary, Latvia, Morocco, Romania and Slovakia.

#### POLICY RECOMMENDATIONS

The Government of Austria should:

- Continue the liberalization of the electricity and natural gas markets.
- Review energy tax policies to prevent possible market distortion and send the right signals to consumers, taking into account the tax harmonization efforts at the EU level.



- Conduct regular monitoring of the implementation of the emissions reduction programme.
- Examine the transport sector to ensure its optimal contribution to overall GHG emission reduction strategy.
- Ensure an appropriate mix of domestic policies and flexible mechanisms with a view towards minimizing the economic cost of climate change mitigation policies for the whole economy.
- Review the support scheme for CHP plants, including its continuation after 2004. Maximize CHPs cost-effective contribution to meeting environmental goals through such measures as a gradual lowering of the support levels in accordance with a benchmarking system which includes minimum efficiency standards.
- Explore the most cost-effective measures to achieve the countries targets for contributions from renewable energies
- Monitor the oil market in order not to impede competition nor market distortion and discouragement of new entrants.
- Continue to lower system access charges to the electricity market and consider the option of further unbundling.
- Further clarify if the objectives of the R&D programmes are designed to meet in order to accomplish particular energy and environmental policy objectives.

Sources:

IEA; Energy Policies of IEA Countries – Austria – 2002 Review, IEA, 2002.

Federal Ministry of Agriculture, Forestry, Environment and Water Management; Climate Strategy – Austria's Responsibility in mitigating climate Change, October 2002.

IEA; Round Table Reports on Notable Energy Developments in Member Countries – Austria – June 2004

MINEFI – DREE/TRÉSOR ; Le marché du Gaz Naturel en Autriche ; juin 2004

MINEFI – DREE/TRÉSOR ; Le secteur de l'électricité en Autriche ; mars 2004

Austrian regulator, Austrian Energy Agency and Austrian CDM/JI programme

## BELGIUM

### MAIN HIGHLIGHTS

- Being a highly decentralized country, in Belgium energy policy involve many different players, the regions and federal governments, making the decisions inevitably complex. The CREG is the regulator at the federal level while the VREG, the IBGE and the CWAPE assure the compliance of energy decrees respectively in Flanders, Brussels and Wallonia.
- Because of the county's geographical location, cross-border trade of electricity and gas as well as the energy policies of the neighbouring countries affect Belgium's energy policy.
- Belgium's role as a transit country will become more important in the future in what concerns security of supply, competition in energy market as well as the battle on climate change and sustainable energy issues.
- Belgium's energy supply has been diversified, competition in both electricity and gas markets has been introduced and has accepted to meet the Kyoto commitment.
- The theoretical degree of market opening in 2004 is around 80% for electricity and 83% for gas.
- In 1999 energy consumption was 20 to 30% above the level of 1990.

### MAIN CONCERNS

#### OIL

- Belgian government sets price ceilings on oil products. These reflect the market price but also avoid sharp price increases caused by speculation.

#### NUCLEAR

- Belgium has committed to phase out nuclear power. The declared nuclear plants shut-down is planned to begin after 2014, therefore not creating difficulties for reaching national Kyoto target.

## ELECTRICITY & NATURAL GAS

- The federal government is responsible for generation, transmission and pricing, while the regional governments are in charge of distribution, energy efficiency, CHP and renewables promotion.
- Both electricity and gas markets are dominated by single companies there are no clear prospects for new entrants. International competition is the only apparent path to real competition in Belgium.

## ELECTRICITY

- The liberalization process is different regarding the regions
- In Flanders, the market is 100% opened since 1st July 2003.
- In Wallonia, clients at high voltage (13000 clients) are eligible from 1st July 2004. Before 1st February 2005, the government will decide on the eligibility for final client (1.4 millions clients) on the 1st July 2005.
- In Brussels, the market is opened since January 2003 for clients with an annual consumption above 10GWh. The market will be completely opened on the 1st January 2007.
- The theoretical opening degree of the electricity market is 80%.

## GAS

- The liberalization process is different regarding the regions
- In Flanders, the market is 100% opened since 1st July 2003.
- In Wallonia, the market is opened since January 2004 for clients with an annual consumption above 0.12Gwh per site. Before 1st December 2004, the government will decide on the eligibility for final client before the 1st July 2007.
- In Brussels, the market is opened since 1st July 2004 for professional clients. The market will be completely opened on date neither anterior to the 1st January 2007 nor posterior to the 1st July 2007.
- The theoretical opening degree of the gas market is 83%.

## RENEWABLES & CHP

- Belgium aims to reach 6% of electricity consumption from renewable energies by 2010.
- The regions developed a system of Green Certificates (GC) for renewable energy, in which electricity suppliers are committed to render a certain amount of GC every year to the regional regulator. In Flanders, the system works since 1st January 2002 while in Wallonia it has been implemented in 1st January 2003. To stimulate the market, the levels of GC will be increased every year. In 2005, the quotas should represent 5% of electricity supply in Wallonia and 2% in Flanders. In 2010 they should represent respectively 12% and 6%. In Brussels, the quotas will be of 2% in 2004, 2.25% in 2005 and 2.6% in 2006.
- In Flanders, a specific Green Certificate mechanism for cogeneration should be approved by 2004, leading to a double market of GC.
- The federal government started negotiations with the sector to have biofuels, at a more favourable price than traditional fuels, on the market at the beginning of 2005
- On 13 February 2004, the council of ministers decided to create the “federal investment company” which will promote energy saving in government buildings through the third party financing mechanism.

## SPECIFIC FEATURES

- Energy related green-house gas emissions continued to grow significantly during the 1990's, and the Kyoto commitment is to achieve a 7,5% reduction of emissions by 2008-2012 compared to 1990.
- It is believed that significant improvements in energy efficiency can be made in Belgium. The federal plan for sustainable development calls for reducing consumption 7% in 2010 compared to 1990. But energy intensity grew in the 1990's.

## POLICY RECOMMENDATIONS

The Government of Belgium should:

- Consider giving further support to the introduction of CHP, rational use of energy and renewables in the Belgium market and revise the actual incentives.

- Consider eliminating the remaining price ceiling mechanism to achieve full liberalization of oil prices.
- Develop policies to promoting renewables that are cost-effective, market-oriented, and consistent with the policies of neighbouring countries.
- Ensure that the environmental costs of energy are adequately reflected in final costs.
- Study the use of biomass as a supplementary fuel in CHP.

Source:

IEA; Energy Policies of IEA Countries – Belgium – 2001 Review, IEA, 2001.

IEA; Round Table: Recent National Developments – Belgium – February 2004

MINEFI – DREE/TRÉSOR ; Le marché énergétique belge ; juin 2004

MINEFI – DREE/TRÉSOR ; Le secteur du gaz en Belgique; juin 2003

Energy ministry and Environment ministry.

[www.climat.be](http://www.climat.be)

## DENMARK

### MAIN HIGHLIGHTS

- Over the last decades the Danish energy policy has been strongly influenced by environmental policy objectives.
- Denmark has many policy goals that are inspired by both energy and environmental considerations.
- Security of supply has been one of the main priorities since the oil crisis in 1973.
- Government will continue its efforts for energy savings and lower energy consumption.
- It was registered a raise of 8% of energy consumption between 1990 and 1999.
- A number of concrete initiatives are being done in order to promote the energy efficient products and buildings.
- Energy consumption in transports constitutes a rising share of energy consumption, 24% in 1999.

### MAIN CONCERNS

#### NATURAL GAS

- Since 2000, 30% of the market has been open to competition. This is expected to increase up to 38% in 2003 and 43% in 2008.
- The Danish Government is using the derogation of the Gas Directive to limit the access to some potential competitors to the national gas pipeline company – DONG, which now controls 95% of the Danish gas market.
- From 2003 onwards, network operation and gas trading activities will have to be separated.
- The Government has decided that the gas market should be fully competitive by 2004 and that DONG should be privatized at a time to be determined in the future.
- Nearly 25% of the electricity produced is from Natural Gas.

## OIL

- The rising trend on oil and gas production is continuing, contributing to an improvement of the balance of payments.
- It is expected that the North Sea oil and gas fields are still to be exploited for many years to come, although it is expected that the maximum production will be reached in 2011 after which it is most likely to decrease.

## COAL

- Electricity production stills rely largely on coal with 46% but is in constant decrease over the last years.

## ELECTRICITY

- On 29th March 2004, the parliament decided new orientations for long-term electricity policies based on 3 agreements.
- The option of renewable or green energies was confirmed.
- All electricity should be produced at market conditions, supports systems will be revised and the financial structure of producers will be opened.
- The transmission network will be nationalized in order to assure grid access conditions independent from commercial interests.
- Electricity market reform in Denmark goes beyond the requirements of the EU directive.
- The transmission network is divided in two separated and totally independent systems. The western part is connected to Norway and to the continental UCTE grid via Germany. The eastern part is linked to the northern grid Nordel. The two grids should soon be interconnected.
- The eastern part participates in the Nord Pool power exchange since 2000.
- Since 1 January 2003, all final costumers are eligible to choose their electricity supplier in the market.
- District heating is one of the pillars of Danish energy policy. Hence cogeneration is mandatory for every new power plant construction.

## RENEWABLES

- Denmark is already producing 21% of its electricity from renewables (15% from wind energy, 3% from waste and 3% from biomass).
- By 2010, wind energy could reach 25% of the national electricity production.
- The biomass agreement promotes the supplementary firing of straw in some power plants. Moreover a final decision is to be made on a capacity to burn further 150 000 tons of straw, to be established before the end of 2004.
- On 9th June 2004 a new support mechanism for renewables was voted.
- It will be possible to implement the offshore wind farm development without more costs involved for consumers than a similar land-base development.

## CHP

- Denmark has the world's highest share of electricity generated in combined heat and power, as well as one of the largest district heating systems which covers around 50% of the total heating demand.
- CHP and wind are given priority in dispatching, but control strategies are being developed to match problems with electricity overflow production during windy periods in the winter.

## CLIMATE CHANGE

- The Danish National Allocation Plan has been accepted on conditions by the European Commission. 362 companies will qualify for trading on 1st January 2005 with a total allowance of 100,5 millions tonnes of CO<sub>2</sub>.
- On 29 September 2003, seven countries of the Baltic Sea Region - Denmark, Finland, Germany, Iceland, Lithuania, Norway and Sweden signed the Regional Testing Ground Agreement for Flexible Mechanisms of the Kyoto Protocol. The Testing Ground Agreement is open to other parties which have adhered to the Kyoto Protocol. The countries will ensure issuance and transfer of greenhouse gas credits related to or accruing from Joint Implementation projects, facilitate generation, minimise transaction costs, especially regarding small and medium scale JI projects.



## R&D

- Subsidies to energy R&D initiatives are to create the best possible development basis for energy policy, including development of new energy saving technologies.
- A subsidy to study the geothermal energy potential of the Copenhagen area for heating purposes has been given now leading to a pilot plant being constructed.
- Funds are also being placed on wave energy, solar cells and hydrogen fuel cells.

## SPECIFIC FEATURES

- Denmark has the Kyoto target of reducing the greenhouse emissions (six gases) by 21% in the first budget period 2008-2012. The Kyoto protocol was ratified in 2001.
- There is also a national commitment to reduce CO<sub>2</sub> emissions by 20% by 2005, compared to 1998.
- CHP and wind are given priority in dispatching; therefore only about 60 to 65% of the power market is governed by competitive price signals – in Jutland only 35-40%.
- This priority dispatch requirement causes excess generation during certain periods.

## POLICY ISSUES

Among others, Danish energy policy issues to be addressed are:

- Review the existing policy measures with a view to developing more cost-effective policies.
- Take steps to move to market based policies as soon as possible, including the introduction of green certificates programme, or some other instrument to off-set the costs of current subsidies for renewable energies.

Sources:

IEA; Energy Policies of IEA Countries – Denmark – 2002 Review, IEA, 2002.

Statement of the Minister for the Environment and Energy pursuant to the Act on Energy Policy Measures. Energy Policy Review 2001. April 2001.

MINEFI – DREE/TRÉSOR ; "Le marché danois de l'électricité en 2003", juillet 2004

MINEFI – DREE/TRÉSOR ; "L'énergie éolienne au Danemark", juin 2003

## FINLAND

### MAIN HIGHLIGHTS

- Finnish Energy markets have undergone a period of restructuring which started in 1995. (oil, wood, district heating has been under competition a long time ago before 1995). It was then opened to the market of competition as well as the integration with the Nordic electricity market.
- It also brought competition to the natural gas market in full compliance with the EU Directive.
- The most important domestic/ energy sources are wood, peat and hydropower.
- The main source of electrical energy is nuclear power.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- One fourth of the electricity is produced by nuclear power (in 2003 it was 26 % and after the 5'th NP unit it will be about 30 %).
- The Government's favourable decision-in-principle on the new nuclear power plant ratified in May 2002 is based on the view that the nuclear power is the most cost-effective base-load power alternative within the Kyoto Protocol.

#### NATURAL GAS

- Until 1999 Finland was not interconnected to the European Union's natural gas network.
- It is expected that the greater use of natural gas, especially in electricity and heat production could be a means for CO<sub>2</sub> reduction.
- Natural gas accounts for about 11% of the Finnish primary energy supply (4 Mtoe in 2003).

## COAL

- Coal accounts for about 15% of the Finnish electricity production.
- 17 % of Finnish primary energy supply (5,8 Mtoe in 2003, when the total use was 35,3 Mtoe).

## RENEWABLES

- Renewables account for about 20% of primary energy supply.

## CHP

- Finland has one of the highest shares of combined heat and power production in the world.
- One third of the electricity production (34 % in 2003) comes from CHP and 50% (37 % of total volume of the building stock is connected to the district heating network).

## ELECTRICITY

- Finland as well as the other Nordic countries is still relatively concentrated.
- More than one third of the electricity is produced by domestic sources and out of that almost half is produced by hydropower.
- Finland is one of the countries more advanced in electricity liberalization.
- Electricity imports from the other Nordic countries as well as the eastern countries have been done for long time already.

After liberalization and releasing the electricity market, the price of electricity was decreasing, depending on the pools and how good the customers could negotiate with companies. By the same time there was a new deal in the market - small local companies were sold to big companies. The price of electricity was decreasing to 2000, after that the prices seem to increase because the big companies needs higher interests of their investments. The industry and SME, creating pools, can maybe negotiate the electrical power with better conditions in the future.

## SPECIFIC FEATURES

- The country has already exploited much of its energy efficiency potential, partly because of its cold climate and the scarcity of indigenous resources and the strong industrial development.
- Finland also has energy intensive export industries.
- About half of the target emission reduction, 14 million CO<sub>2</sub> tons, can be met by implementation of the energy conservation programme (3-4 million CO<sub>2</sub> tons) and action plan for renewable energy sources (4-5 million CO<sub>2</sub> tons).
- The most important decision was the realization of new nuclear power unit.
- The state also supports the use of domestic fuel (peat, wood chips).

## POLICY ISSUES

Among others, Finnish energy policy issues to be addressed are:

- Work towards extending and strengthening the cross-border links in grid-bound industries as soon as economically feasible.
- Ensure that during the privatization of energy companies, ownership is spread among a large number of players and that cross-ownership is reduced.
- Continue efforts to create alternative routes to diversify the supply of natural gas.

### Source:

IEA; Energy Policies of IEA Countries – Finland – 1999 Review, IEA, 1999.

[www.motiva.fi](http://www.motiva.fi) & [www.energia.fi](http://www.energia.fi)

## FRANCE

### MAIN HIGHLIGHTS

- France is poor in energy resources on its national territory and depends to a large degree on energy imports.
- The French energy sector includes 13 refineries, 58 nuclear power groups over 20 sites. The exploitation of coal ended on the 23rd April 2004 with the closure of the site of La Houvre.
- France has three main objectives: security of supply, French economy competitiveness and environment care; and two main worries: employment and public service.
- France has the lowest per-GDP carbon emissions and electricity is one of the cheapest within the OCDE, as the country's vast nuclear programme has contributed to this.

### MAIN CONCERNS

#### OIL

- Over the last 15 years France has gradually liberalized its energy markets, beginning with deregulation and privatization the oil industry. France has two major oil companies: Total Final and Elf merged in 2000, creating one of the largest oil companies of the world.
- In 2000, France imported 90,4% (85,6Mt) of its oil consumption, mainly from the North Sea (37%), Saudi Arabia and Gulf area (37%) and Africa (16%). National production (1,4Mt) is concentrated in the Parisian and Aquitanian basins.
- The French economy is very vulnerable to the oil, namely in the transport sector.

#### COAL

- In 2003, France imported 11,4 Mtep of coal, mainly from Australia (25%), South Africa (22%), Columbia (13%) and USA (11%).

## NATURAL GAS

- In 2003, France imported 496,7TWh of natural gas, mainly from Norway (30%), Russia (24%), Algeria (22%) and Netherlands (16%).
- The natural gas use has been growing rapidly over the last three decades. Its usages are mostly on electricity generation.
- All professional clients are allowed to choose their gas supplier since the 1st July 2004. The market will be completely opened on the 1st July 2007.
- A number of potential competitors of the State-owned natural gas supply company Gaz de France (GDF) exist, but GDF has a vastly dominant position in the downstream gas industry and enjoys a significant incumbent advantage.

## NUCLEAR

- France has the highest share of nuclear power in the world (77,6% of its electricity needs; 420TWh in 2003) and the second biggest production capacity (after the USA).
- The management of the nuclear fuel cycle is one of the main concerns of the French energy policy.
- France wants to maintain its high competences and invested 445 millions euros per year between 1992 and 2001 for R&D in nuclear fission technologies.
- Framatome, Cogéma and CEA-Industries merged in September 2001 to form the new company Areva, which become one of the largest operators in the nuclear industry worldwide. Areva recently sold a 1,6GW power generator with technology EPR (European Pressurized water Reactor) that should be operational in 2009.

## ELECTRICITY

- In 2003, 77% of the electricity production in France was from nuclear, 12% from hydro and 10% from coal.
- France exports about 2% of its electricity production.

- EDF produces about 90% (500,3 TWh) of French electricity production, and is responsible for distributing 92,9% (401 TWh) of the consumption. Its status changed from EPIC (Public) to Anonymous Society in June 2004.
- All professional clients are allowed to choose their electricity supplier since the 1st July 2004. The market will be completely opened on the 1st July 2007.
- Under its obligation to guarantee energy safety, the government decides a long-term investment programme for electricity production. It fixes ranges of capacity for different technologies that it would like to develop within a certain date. To reach its goals, the government is then allowed to refuse building permits or at the contrary make calls for tenders.

#### CLIMATE CHANGE

- France is committed under the Kyoto protocol to maintain CO<sub>2</sub> emissions at their level of the year 1990. Though in 2001, the total emissions of greenhouse gases approximated their 1990 level, the CO<sub>2</sub> emissions from the energy sector raised by 9,1% between 1990 and 2001 and should continue to rise, due to a continuous increase in the transport and residential sectors.
- The first strategy published in 2000 won't be sufficient to reach the Kyoto target. Another climate plan should be published by the year 2004.
- The government already announced its will to maintain the energy final consumption at its 2003 level in 2015 (especially by introducing a system of white certificates), have up to 10 000MW from wind energy installed by 2010 and reduce CO<sub>2</sub> emissions by 75% in 2050.

#### RENEWABLES

- About 6% of the total French primary energy production comes from renewables.
- Apart from hydro energy, biomass has strong importance in the French energy balance.
- France needs to reach a target of 21% of renewable electricity by 2010.
- In 2004, France had 280 MW of wind installed capacity.



- France has a heading in its energy policy of providing more support to renewables and find a way to better integrate them in the regional energy generation.

## POLICY RECOMMENDATIONS

The Government of France should:

- Continue to reform its legislation, procedures and institutions to adapt French energy policy to the challenges of the future, namely competition, energy security and climate change.
- Avoid further concentration of the French energy market.
- Determine the conditions under which the State and the local collectivities could promote the rational use of energy actions as well as renewable energies after studying the respective energy needs.
- Be prepared to go beyond the minimum provisions of the EU Gas Directive in terms of eligibility and market opening.
- Care about having more renewable energy developments and management of the renewable energies fuel cycles.
- Proceed with diversification of energy sources as well as technologies, opening the energy markets and energy taxation reform.
- Implement the spirit of the Electricity Directive as quickly as possible by putting in place practical arrangements to ensure that suppliers can compete with EDF on fair terms.
- Control emissions at local level (including nuclear residues).
- Push forward the liberalization of the electricity and gas markets.

### Sources:

Direction Générale de L'Énergie et des Matières Premières – Observatoire de l'Énergie; La Politique Énergétique Française; Ministère de L'Économie des Finances et de L'Industrie, 2002.

ADEME; Pour une Politique Ambitieuse de Maitrise des Consommations d'Énergie – Les perspectives énergétiques nationaux à 2010.

IEA; Energy Policies of IEA Countries – France – 2000 Review, IEA, 2000.

IEA; France – Standard Review 2002, IEA, 2002

IEA; Country Statement on Recent energy Policy Development (Standing Group on Long-Term Cooperation June 2004) – France, IEA, 2004

Direction Générale de L'Énergie et des Matières Premières – Observatoire de l'Énergie; Le charbon en France: les principaux résultats 2003; Ministère de L'Économie des Finances et de L'Industrie, 2004.

Direction Générale de L'Énergie et des Matières Premières – Observatoire de l'Énergie; Le pétrole en France: les principaux résultats 2003; Ministère de L'Économie des Finances et de L'Industrie, 2004.

Direction Générale de L'Énergie et des Matières Premières – Observatoire de l'Énergie; Le gaz naturel en France: les principaux résultats 2003; Ministère de L'Économie des Finances et de L'Industrie, 2004.

Direction Générale de L'Énergie et des Matières Premières – Observatoire de l'Énergie; L'électricité en France: les principaux résultats 2003; Ministère de L'Économie des Finances et de L'Industrie, 2004.

Direction Générale de L'Énergie et des Matières Premières – Observatoire de l'Énergie; Les énergies renouvelables en France: les principaux résultats 2003; Ministère de L'Économie des Finances et de L'Industrie, 2004.

[www.industrie.gouv.fr/cgi-bin/industrie/frame0.pl?url=/energie/sommaire.htm](http://www.industrie.gouv.fr/cgi-bin/industrie/frame0.pl?url=/energie/sommaire.htm)

[www.suivi-eolien.com](http://www.suivi-eolien.com)

## GERMANY

### MAIN HIGHLIGHTS

- Germany has ambitious targets to reduce green house gas emissions.
- Phase out nuclear power plants by 2025;
- Energy efficiency, conservation, cogeneration and renewables, as well as fossil fuels will play a role in replacing the nuclear plants being decommissioned.
- Germany is the largest electricity market in Europe.
- Energy security is an important issue for Germany as the country has limited indigenous energy resources.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- Germany will gradually phase out nuclear power plants until 2025, without direct costs to the Government.
- Nuclear power now covers 30% of electricity generation and 13% of total primary energy supply.
- Nuclear phase-out policy will not relieve Government and industry in the near future of the responsibilities they now carry for the ongoing nuclear programme. Competence will be needed to maintain for decades safe management of radioactive waste disposal.

#### NATURAL GAS

- Germany is the second largest European natural gas market after the UK, and one of the countries that have fully liberalized their gas markets.
- The gas supply base is diverse, with domestic production accounting for 22%. Currently there are about 750 companies operating in the German gas sector; however there is a trend for consolidation of electricity and gas markets.

## OIL

- Gasoline consumption has decreased somewhat in the transport sector in the past years.
- Oil accounts for almost 39% of the primary energy supply in Germany.
- Almost all oil is imported, from diversified sources (25% from Russia).

## COAL

- The German Government wishes to maintain a significant coal-based electricity generation capacity to avoid over-dependence, and associated supply and price risks, on imported energies.
- The policy for hard coal is also closely related to social, regional and employment policies. Because of its poor competitiveness, domestic hard coal receives a significant, but declining, amount of subsidies.
- Lignite production does not receive subsidies. Lignite power plants, however, are currently protected by legislation prohibiting new entries in the New Laender.

## RENEWABLES

- In 2000, the share of renewable energies in primary energy supply was 3,4% and in electricity generation 7,3%.
- The Renewable Energies Act of April 2000 aims at doubling the share of renewables in total energy supply by 2010 compared to 2000 level. Germany should generate 12,5% of its electricity from renewable energy by 2010.
- During the 90's, wind power was greatly developed and Germany has become the world leader in this area, with 14 609 MW of installed capacity by the end of 2003.
- Germany has also ambitious targets for off-shore wind power.
- Renewables are both supported by subsidies and feed-in tariffs.

## CHP

- Electricity produced in combined heat and power plants (CHP) accounts for 12% of total electricity supply.

- The last cogeneration act of April 2001 allows CHP operators, who are feeding in electricity into the transmission network to receive bonus payments in addition to the revenue at market prices, provided that requirements for the power-to-heat ratios are fulfilled.
- No direct subsidies are given to CHP.
- Possibilities for connecting more consumers to existing district heating networks should be explored to improve their competitiveness.

## ELECTRICITY

- Germany is the largest electricity market in Europe
- The electricity market has been fully liberalized since 1998
- There is no sectoral regulator for electricity.
- One concern is the lack of unbundling of the retailing and distribution functions of companies operating at the lower voltage networks as this can permit abusive behaviour.

## R&D

- The primary objective of R&D is to support energy policy, and the secondary one is to support industrial development and economic growth.
- Many different aspects of energy policy will demand technological innovation: phase-out nuclear plants, large scale use of renewable energies, climate change goals...

## SPECIFIC FEATURES

- In the industrial sector the emphasis is on voluntary measures, such as voluntary agreements and third party financing. However, all new buildings > 12 °C, industry buildings, too, have to comply with the EnEV.
- The housing sector relies mainly on regulatory measures. The one key challenge in this sector is to reduce energy consumption in existing buildings as there is only one regulatory measure at the moment concerning the efficiency of the boiler. However, a considerable number of new home-owners are interested to go further than what the regulatory measures requires. Low-energy houses, passive houses or 3-litre houses

are sold because of this interest (supported by funding by the government).

## POLICY ISSUES

Among others, German energy policy issues to be addressed are:

- Evaluate the cost-effectiveness of the measures used to achieve all the energy and environment policy objectives.
- Put in place a long-term stable energy policy framework giving a higher priority to energy security through the market mechanism.
- Develop strategies for managing the evolution of GHG emissions beyond Kyoto target years
- Analyze the possibilities of supplementing domestic measures with Kyoto Flexible Mechanisms
- Review and reform energy taxes and eco-tax system to better reflect the externalities of each source of energy.
- Ensure energy intensity continues to decrease and energy efficiency continues to improve
- Enhance measures to address energy efficiency in buildings
- Develop national energy efficiency strategy for the transport sector
- Continue to reduce coal subsidies
- Ensure non-discriminatory, transparent and simple arrangements for access to gas transmission and distribution networks
- Reinforce the resources and power of the Federal Cartel Office and the task force for network access to ensure anti-competitive practices.
- Facilitate access to supply by promoting the liquidity of the gas market
- Continue to monitor concentration in the gas market to avoid further dominance of major players
- Monitor the cost impact of policies that indirectly subsidize renewables
- Reinforce efforts to make the rules for network access fair
- Consider options for separating network operation from other activities
- Avoid dominance of market players in the electricity sector

- Ensure no cross-subsidization and discrimination between distribution and retailing business of electricity
- Facilitate cross-border trade and interconnection
- Promote CHP
- Clarify the role of R&D in light of nuclear phase-out
- Develop R&D for clean coal technologies.

Source:

IEA; Energy Policies of IEA Countries – Germany – 2002 Review, IEA, 2002.

## GREECE

### MAIN HIGHLIGHTS

- Greece depends heavily on imported energy, especially oil.
- Lignite is the only major domestic fuel, is extensively used for power generation and is a major responsible for CO<sub>2</sub> emissions and air pollutants.
- Electricity is expected to be just tight to respond to demand over the next years.
- The Greek Government is intending to diversify the supply sources through the increase of gas, oil and electricity connections with neighbouring countries.
- Gas to power generation and to other activities is being promoted.
- Well-designed markets need to be created in the electricity and gas markets.
- There is a strong potential for energy efficiency and energy saving measures in all sectors.

### MAIN CONCERNS

#### NATURAL GAS

- Greece successfully introduced natural gas in its energy mix in 1996.
- In 2000, natural gas accounted for 6,1% of primary energy supply and with an increasing trend.
- Natural gas has already some use in power generation and replaced some oil-use in industry.
- The most of the growth demand for natural gas is expected to come from power generation and residential and services sector.
- The current gas infrastructure is sufficient to meet next years demand, however, it would be wise to increase the LNG regasification capacity, storage capacity and to improve the supply links through Italy and Turkey.



- The natural gas market is still in a very early stage of liberalization, under the derogation clause of an emerging market until 2006 of the EU gas Directive.
- The gas-fired power plants that are planned will not be commissioned by 2005-2006.

## COAL

- Low quality lignite accounts for 82% of Greece's indigenous energy production and 64% of its electricity supply.
- While lignite use contributes positively to energy security of supply, it is also an environmental threat.
- Retrofit plans are in place to restore the lignite mines.
- Investments are being made to use state-of-the-art lignite technologies in new power generation plants.
- The Greek State owns all the lignite deposits and the Public Power Corporation had the exclusive rights to mine lignite.

## OIL

- Greek oil demand is forecast to grow about 40% between 2000 and 2010.
- Although proceeding slowly, the project of an oil pipeline between Greece and Bulgaria is advancing.
- Although the oil market has been largely liberalized, products may only be imported by refineries, oil marketing companies and few large oil users, for stockholding obligations.
- In a way to respond to the increasing oil demand, Greece will be obliged in future to stock larger oil quantities.
- To avoid market distortion and to stimulate competition, direct imports of crude oil and oil products should be allowed and non-discriminatory access to oil storage facilities should be ensured.

## RENEWABLES

- The 1995 Climate Action Plan established a target for increasing the share of renewable energy in primary energy supply to 10% by 2000.

- The target was not achieved, and the actual renewables share was 5,2% in 2000.
- The new indicative target is to generate 20,1% of electricity by renewables in 2010.
- The licenses procedures for renewables are still too complex.
- The most significant renewable potential in Greece is solar and wind energy.
- Currently renewables are promoted through financial incentives: tax breaks, direct subsidies and a feed-in tariff system.
- The exploitation of geothermal energy is an exclusive right of the state though it can assign this role to private investors

#### ELECTRICITY

- The consumption per inhabitant is around 76% of the UE average, hence the increase in electricity demand should continue. Even if the production capacity had increased of 30% since 1985, the supply is tight considering the expected evolution of demand, especially in dry years. The regulator (RAE) predicts an annual rhythm of peak demand of 5% between 1995 and 2005.
- The electricity is produced from coal (64%), hydro (7%), imported oil (15%) and natural gas (13%). The former monopoly, DEH, stills owing 98% of the installed power capacity in Greece and controls 49% of the electricity transporter (DESMHE SA; the state controls the other 51%).
- Since transmission lines are also capacity limited, trade with neighbouring countries can have only a very limited impact.
- It is urgently needed to reform the electricity market and new investments made by new entrants.
- An electricity tariff adjustment could be a possibility in abating these problems.
- About 34% of the Greek electricity market was opened to competition in February 2001 – the minimum requirements of the EU electricity Directive.
- Not many new entrants are expected in the near future.

- Greece expects to establish a south-east European Electricity pool that could increase competition in the long-term.

#### SPECIFIC FEATURES

- The institutional framework for market liberalization is already in progress and there is a Regulatory Authority for Energy established since 2000, as an independent agency with a mixed advisory and decision-making role.
- The Regulatory Authority for Energy gives an opinion in the definition of codes, regulations, end-user tariffs and licensing for generation.
- The energy markets in Greece are dominated by highly integrated state-owned enterprises.
- In 1995 Greece introduced the “Hellenic action plan for the abatement of CO<sub>2</sub> and other green house gas emissions”. It was set a target for the year 2000 of between 12% and 18% emissions (CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>) above the 1990 level.
- Under the agreement to meet the Kyoto Protocol target for 2000-2012, Greece’s greenhouse gas emissions are expected to be at most 25% above the 1990 level.
- Energy intensity in Greece is a serious matter as it exceeds the European average and with an increasing trend.
- Significant potential for energy saving is available and some measures are self-financing and might not need to rely on subsidies.
- Third party financing and voluntary agreements in industry form a great potential for energy efficiency interventions and demand side measures.
- In the residential sector there is a large potential for energy saving, namely through the introduction of tighter energy building codes, building energy certificates and information campaigns.
- There is a potential in changing electricity tariffs either to influence the promotion of renewable energies or strengthen the competition.

#### R&D

- Greece actively participates in the EU research programmes but there is still room for further developments.

## POLICY RECOMMENDATIONS

The following actions are recommended for the Greek Government:

- Continue to diversify energy supply and energy sources through reinforcement of connections and renewable energies.
- Enhance efforts to promote real competition in energy markets.
- Pursue social objectives through energy taxation and pricing.
- Complete the implementation of the National programme for Green house gas emissions.
- Place more focus on demand side measures
- Ensure that environmental costs are reflected in energy prices.
- Continue the efforts to reduce the environmental impact of lignite use and mining.
- Create an energy efficiency policy framework.
- Continue to diversify the oil sources of import
- Encourage the development of natural gas infrastructures
- Advance its commitment to liberalize the gas markets and encourage private investment.
- Exploit the cost-effective potential of renewables, namely in islands.
- Simplify the licensing process of renewables.
- Continue efforts to develop the south-east electricity market.
- Continue to encourage the participation of industry in R&D.

### Source:

IEA; Energy Policies of IEA Countries – Greece – 2002 Review, IEA, 2002.

IEA; Report on Notable Energy Development in Greece, IEA, February 2004

MINEFI – DREE/TRÉSOR; “Electricité (production, transport et distribution)”, February 2004

MINEFI – DREE/TRÉSOR; “Marché de l’environnement”, February 2004

[www.minenv.gr](http://www.minenv.gr)

## IRELAND

### MAIN HIGHLIGHTS

- Apart from Luxembourg the Irish energy market is the smallest in the EU.
- Ireland spends 7 billion Euro per year in energy, most of which is imported.
- Ireland has a lack of substantial domestic energy resources and a high level of imports.
- Ireland has initiated the reform of both electricity and gas markets and a regulatory body has been put in place.
- A rapid increase in energy demand has been shown as a consequence of an impressive level of economic growth over the last years.
- This high demand has occasionally strained the country's energy infrastructure and has increased Ireland's energy security of supply concerns.
- In 2000 only 15% of the country's energy came from indigenous resources.
- The lack of extensive international energy connections also exacerbates Ireland's vulnerability to supply disruptions and/or price spikes.
- Irish National Allocation Plan for CO<sub>2</sub> had been accepted unconditionally by the European Commission. It allows 67 millions tones of CO<sub>2</sub> for 143 companies qualified for trading on the 1st January 2005.

### MAIN CONCERNS

#### COAL

- Coal and peat play an important role in the country's energy mix. Together they account for 18% of total primary energy supply and over 36% of electricity generation.
- Both peat and coal are of high carbon content with the corresponding CO<sub>2</sub> emissions when used but they provide some security of supply as peat is domestically borne and Government subsidised.

- The largest single measure is to shut down or fuel switch the coal-fired power station. This measure would account for 22% of the total GHG emission reduction expected.

## NATURAL GAS

- The reform of the natural gas is also moving in the right direction. From 1st January 2003, 85% of the market (in volume) can now choose their own gas supplier.
- The production from a new domestic gas field has been sold to a new entrant who will use this gas to compete in the Irish market. Another gas field is scheduled to come in line in 2005, creating further possibilities for competition.
- Ireland could use natural gas to generate up to 80% of all its electricity by 2010.
- The construction and commissioning of a new sub-sea natural gas pipeline from UK shows not only the ways in which energy security can be enhanced but the costs involved in such measures.
- Gas demand has not however been growing as expected and new gas pipeline (the second from UK) might only be needed by 2005.

## RENEWABLES

- While renewables do not currently make a substantial contribution to the country's energy mix, there is a large potential, particularly in the form of wind power.
- Ireland has taken steps to encourage renewables use, primarily through an auction process which offers long term power purchase agreements to buy electricity from renewable sources.
- The Irish national Development Plan has an objective of achieving further 500 MW of additional renewable energies capacity until 2010.

## CHP

- Historically Ireland always had low levels of CHP use, but Government is now trying to increase its use.
- The absence of any heat distribution infrastructure as well as the limitations to the existing natural gas grid, low population density and difficulties in financing have contributed to this lack of CHP use.
- The NDP has a budget of 5 million Euro in a programme aiming to build greater awareness of the impacts and benefits of CHP.

## ELECTRICITY

- The market reform of the electricity sector began with the Electricity Regulation Act. Ireland envisages 100% of market opening by 2005.
- A number of obstacles remain before Ireland can fully benefit from the reform of the electricity sector. One has been the lack of interest from viable committed new entrants, and another the small size of the market.
- ESB is still the most powerful influence towards the transmission system planning and currently owns 85 to 90% of the total Irish generating capacity.
- The current arrangement for separation of grid operation and ownership should be carefully monitored.
- New electricity generation is needed in the short term – possibly in 2004 or 2005. Given the long lead times for developing and building large power stations, it is unlikely that a fully independent power plant will be on line in time to address this coming need.
- A budget of 67 million Euro is being allocated to a grid upgrade development plan with a target of 260 MW of additional clustered connection capacity.

## SPECIFIC FEATURES

- Demand side management is being looked at as it would reduce the need for new capacity.
- Passage of the country's National Climate Change Strategy in November 2000 was an important step towards addressing the country's climate change challenges.

- Ireland must limit the net increase of its greenhouse gases emissions to 13% above 1990 level by 2008-2012.
- It is believed that Kyoto Flexible Mechanisms will be needed to reach the country's target.
- Ireland has improved significantly its energy efficiency over the last years with energy intensity falling one-third from 1989 to 2000.
- Transport may provide the best opportunity to improve energy intensity, since an increase in energy use in this sector coincides with the need for a new transportation infrastructure.
- The residential sector accounts for almost 30% of Ireland's related CO<sub>2</sub> emissions. There is a specific plan stimulating the uptake of sustainable energy practices in buildings, accompanied by a "fuel poverty" campaign.

## POLICY RECOMMENDATIONS

The Government of Ireland should:

- Develop a long-term strategy for optimal energy supply mix striking an appropriate balance between energy security and climate change mitigation, noting a rapid share of the natural gas in the electricity sector.
- Review ESB's role in the liberalized electricity sector to address the impression that the company could unfairly influence the market to the disadvantage of new entrant competitors.
- Facilitate the penetration of wind energy into the electricity system by making examining the issues of system frequency stabilization and back-up power that arise with substantial wind power use.
- All support schemes to renewables are market-based and include proper incentives to reduce costs.
- Ensure that greenhouse gas mitigation measures cover all energy and non-energy sectors and reflect the externalities for each source.
- Continue to explore cost-effective mechanisms to promote CHP.
- Continue the process of strengthening the transmission grid.
- Invest in new generating capacity or through an independent power producer.



- Evaluate the role of coal in the energy mix, striking a balance between energy security and greenhouse gas mitigation.

Source:

IEA; Energy Policies of IEA Countries – Ireland – 2002 Review, IEA, 2002.

Sustainable Energy Ireland; Five Year Strategy; National Development Plan, 2002.

## ITALY

### MAIN HIGHLIGHTS

- The public sector has a large role in the Italian energy industry. ENI and ENEL still have a dominant position in the energy industry.
- The Government is implementing numerous measures to liberalize and to increase the efficiency of the energy sector.
- High energy prices, a mild climate and Italy's small number of energy intensive industries contribute to the low level of energy consumption and CO<sub>2</sub> emissions in comparison with GDP.
- The Government has issued a plan to reducing CO<sub>2</sub> emissions in order to comply with the Kyoto commitments.
- Over the past decade energy's dependence of Italy has ranged between 80 and 85%.
- Electricity consumption per GDP is much lower in the south than in the north.
- Italy is the member of the EU, which received the largest amount of loans from the European Bank for investments in the energy sector between 1995 and 2000. The total amount reaches 3.3 billions euros, a quarter of the loans conceded. They were used mostly for modernization of the petroleum installations, especially for environmental matters.
- Since the petroleum crisis, Italy promotes a policy of rational use of energy. In 2004, the authorities target to reduce the energy consumption by 2,9Mtep before 2006 (1,6Mtep in the electrical sector) using a system of White Certificates.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- In 1987, by referendum, nuclear energy was phased out in Italy.

#### NATURAL GAS

- Italy produces oil and natural gas, though both only cover 9% of its energy needs (in 2001). The removal of unnecessary barriers to oil and

gas exploration and production would increase domestic production and enhance security of supply.

- Natural gas consumption has increased rapidly and import sources are being rationalized.
- Natural gas has been replacing oil and coal in the final consumption.

## OIL

- Oil still remains the most important fuel in Italy's energy supply, corresponding to 48% of its energy total consumption. This proportion should decrease to reach 45% in 2005, 41% in 2010 and 39% in 2015, oil being replaced by alternative energies especially natural gas.
- In the domestic oil sector, competition should enhance security of supply.
- The Government has taken steps to rationalize the downstream oil sector and should continue to ensure the development of effective competition.

## COAL

- Coal production is actually negligible

## ELECTRICITY

- The prices are particularly high and Italian consumers pay their electricity 30% above the European average.
- Since the 1st July 2004, all non-residential users are free to choose their supplier. The opening rate of the market is consequently around 78%.
- The liberalization process put an antitrust limit (50% of the national offer), hence obliging the historical operator Enel to cede parts of its production capacity. Though, in 2002, the market is still dominated by Enel (46,5% of the production). Edison and its partners represent 17,6% of the production, EndesaItalia 7%, Acea and Interpower 2,9%.
- The sector suffers from important difficulties in organizing the market. Due to dissensions on decision repartition between central and regional authorities, the rules are unstable and sometimes contradictory.
- This uncertainty for investment, combined with strong local oppositions, leads to a situation of low capacity for production and transport. The

general blackout on the 28th September 2003 pointed out the weakness of the electrical system.

- Italy is the world biggest electricity importer. Indeed, due to the mostly old and costly production structure, imported electricity is cheaper, especially for industrial consumers in the North. Importations come mostly from France (70%) and represent nearly 16% of the total electricity consumption.
- The Italian power exchange, Ipex, had been launched in April 2004. But due to the insufficient supply compare to demand, Enel keeps its place of price maker and prices are much higher than the European average. They reached 67,84€/Mwh in June 2004, while by comparison the average price on the French Powernext for the year 2003 was 29.35€/MWh.

## RENEWABLES

- Energies from renewable sources have increased significantly since 1990, mostly because of high buy-back tariffs for electricity.
- The government has set ambitious targets for energy production from renewables as one of its measures to reduce CO2 emissions. On the 31st January 2004, a decree implementing the European directive 2001/77/CE sets a national reference framework for the promotion of renewable energy sources particularly for their use in micro-generation plants.
- Italy implemented a system of Green Certificates. Producers have to include 2% of renewables in the electricity emitted to the grid. This rate increases by 0.35% per year for the period 2004-2007.

## SPECIFIC FEATURES

- Energy efficiency can be improved in many sectors and measures should concentrate on being cost-effective.
- Specific measures are needed to improve the use of public transportation.
- Most of the energy-related CO2 emissions come from oil combustion. Emissions from natural gas use have been increasing while from coal have been decreasing.

## POLICY RECOMMENDATIONS

The Government of Italy should:

- Continue to monitor the evolution of the gas market to ensure security of supply.
- Continue to increase the competition in the oil, natural gas and electricity sectors.
- Promote the increase the share of public transportation.
- Continue to implement EU directives on electricity, gas, buildings, electrical appliances, etc.
- Reduce the losses in the electricity and gas transmission and distribution grids.
- Continue to seek the most cost-effective ways of promoting renewable energies and avoid distortions in competition.
- Integrate the policies of energy – environment – employment, etc.
- Strengthen the role of communes, provinces and regions in energy policy.
- Promote training and information on energy efficiency and renewable energies.
- Improve the energy research field.

### Source:

IEA; Energy Policies of IEA Countries – Italy – 1999 Review, IEA, 1999.

IEA; New Energy Developments in Italy, IEA, 2004

MINEFI – DREE/TRESOR; Le secteur électrique en Italie, MINEFI, July 2004

MINEFI – DREE/TRESOR; Le pétrole en Italie, MINEFI, July 2003

## LUXEMBOURG

### MAIN HIGHLIGHTS

- Luxembourg is one of the smallest EU-25 countries.
- Energy consumption per inhabitant is high because of country's iron and steel industry, the large sales of transport fuel and the overall wealth of the country.
- Domestic energy resources are limited to renewable energies and the country has a dependence of over 99% on imported energy.
- Luxembourg's energy markets are greatly influenced by the energy policies and energy markets of surrounding countries.
- The Kyoto target is of 28% reduction in greenhouse gases emissions to Luxembourg, to 1990 levels by 2008-2012.

### MAIN CONCERNS

#### OIL

- Luxembourg is totally dependent on oil products imports. The oil market consists only on retailing.
- Oil arrives mainly via Belgium (82%) and Netherlands (7%).
- Final energy consumption in the transport sector grew by 87% between 1990-2000. One of the key factors in this growth was the gap in excise taxes on oil products between Luxembourg and its neighbouring countries, leading to increased purchases of car fuel by foreigners. The ECOFIN agreement on the 21st march 2003, harmonizing taxation on energy within the EU before 1st January 2012, should put an end to this tendency.
- The government sets price ceilings to avoid inflation.

## NATURAL GAS

- Luxembourg is totally dependent on natural gas imports.
- Natural Gas supply increased by 56% in 1990-2000. It increased by 36% between 2001 and 2002, substantially because of the starting of a new CCGT plant in Esch-sur-Alzette in may 2002.
- Since 1st October 2003 the market is opened for customers over 5 millions m<sup>3</sup> per year, (74% of the market in volume).
- Imports are being diversified in order to increase Luxembourg's security of supply.

## ELECTRICITY

- 90% of the electricity consumed in Luxembourg is imported until 2002 when a combined cycle power plant came into operation.
- Since 1st July 2004 all clients with an annual consumption over 1GWh (approximately 30000 clients) are allowed to choose their supplier. This means a market opening of about 85%. The market should be completely liberalized on the 1st July 2007.

## RENEWABLES & CHP

- Electricity generation from renewables and cogeneration expanded rapidly because of generous buy-back tariffs and direct subsidies.
- The directive 2001/77/CE says that Luxembourg should cover 5,7% of its electricity needs from renewables by 2010. It currently reaches 2,6%.
- With installations on the two main rivers in the country, the Moselle and the Sûre, the potential for hydraulic energy reached its maximum.
- Solar thermal energy is being used on swimming pools and sports centres.
- A few applications of solar photovoltaic exist namely for vehicles re-charging.
- A wind energy map is already completed. The ministry of environment gives subsidy for wind energy since 1st January 2001.
- Domestic users can decide of the share of Green Current (produced: 10% from gas cogeneration, 1% from photovoltaic, 1% from wind energy, 2% from biomass and 86% from hydro) that he wants to consume, for which he will have to pay 2,5 €/kWh.

## SPECIFIC FEATURES

- Some municipalities are directly engaged in electricity and natural gas distribution activities.
- Energy efficiency has been seriously taken since 1993 supported by a series of decrees and energy taxes.
- The restructuring of iron and steel industry led to a sharp reduction in CO2 emissions and other pollutant emissions in Luxembourg.

## POLICY RECOMMENDATIONS

The Government of Luxembourg should:

- Continue to cooperate with neighbouring countries on energy issues namely in electricity and gas liberalization.
- Follow closely the programmes on promotion of energy efficiency in buildings.
- Develop and implement a concrete climate change mitigation plan towards Kyoto Commitments.
- Continue to seek solutions in regional level (with neighbouring countries) to reduce energy consumption in the transport sector.

### Source:

IEA; Energy Policies of IEA Countries – Luxembourg – 2000 Review, IEA, 2000.

IEA; Luxembourg – Standard Review, IEA, 2002.

MINEFI – DREE/TRÉSOR; “L’électricité au Luxembourg”, MINEFI, August 2003

MINEFI – DREE/TRÉSOR; “Le pétrole au Luxembourg”, MINEFI, August 2003

MINEFI – DREE/TRÉSOR; “Le gaz naturel au Luxembourg”, MINEFI, August 2003



## THE NETHERLANDS

### MAIN HIGHLIGHTS

- The potential tension between the search for low energy prices through competition and environmental imperatives is quite visible.
- The Dutch are generally very environmentally minded and the government is setting very ambitious targets for carbon dioxide emissions, energy efficiency improvements and the share of renewables in the energy mix.
- Competition is being introduced both in power and gas industries and it is expected full introduction by July 2004.
- The power generation in the Netherlands is almost dominated by the use of fossil fuels.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- There is a small amount of nuclear (only 450 MW) and there is a strong public resistance to the use of nuclear.
- There is a government intention to shut down this reactor by 2004. But there are some "forces" trying to keep this plant, in the province of Zeeland (Borsele), open.

#### NATURAL GAS

- The Netherlands has one of the major gas fields in EU – 15 (field Slochteren).
- The Dutch government has the challenge to preserve the small field's policy in the potentially highly competitive new gas market. The preservation of nature (Waddenzee) is hereby a difficult political issue.
- The Netherlands also imports gas from Russia.
- Natural gas has one of the highest penetrations in the market among the world countries.

## OIL

- There are very small oil fields in the Netherlands.
- Rotterdam and Amsterdam are two large harbours that receive the oil and coal products for the whole Europe.

## COAL

- Dutch prices for the imported coal are among the lowest in Europe.

## RENEWABLES

- The country aims to increase the share of renewables from 1 per cent in 1995 to 5% in 2010 and 10% in 2020.
- There is a target of 12 PJ of solar thermal energy supply by 2020 and 10 PJ of solar photovoltaic by the same year.
- Since the opening of the Dutch retail market for renewable electricity in July 2001, the number of its customers has increased from about 250,000 to approximately 1,4 million in January 2003, mainly due the favourable fiscal incentives for renewable electricity production and consumption and further stimulated by the growth of the European green certificate market.
- Under the EU Renewable Electricity Directive, the Netherlands was allocated an indicative renewable electricity target of 9% in 2010.
- Because of the country's geography, the use of hydropower for electricity generation is almost impossible.

## CHP

- Flower and plant growers account for a significant amount of CHP production using natural gas.
- There are some ten large municipal district-heating plants (Rotterdam, Utrecht, Amsterdam, Almere and others).
- It is foreseen a total capacity of 15 000 MW by 2010. At 1997 already 7 800 MW was in place.

## ELECTRICITY

- Competition was introduced in 1998 for big consumers (market full open by July 2004).
- There is strong trade as well as foreign direct investment.
- Although the existence of overcapacity of power generating in the Dutch market, the demand for imports is such that interconnected capacity is oversubscribed.

## SPECIFIC FEATURES

- To meet its climate change commitments, the country must reduce its greenhouse gas emissions from 1990 levels by 6% until 2008-2012.

## POLICY ISSUES

Among others, Netherlands's energy policy issues to be addressed are:

- Maintain the current balance between economic efficiency goals and environmental considerations.
- Continue to closely monitor the energy market and emissions trends and continue to respond to them in a flexible way.
- Maintain its policy in liberalizing the gas market and encourage the gas companies to continue their adaptation to competition.
- Work towards a solution to long-term security of supply and awareness of protection of the small consumers.
- Ensure that no further concentration occurs in the electricity generation market.
- Closely monitor competition in the generation market.
- Closely monitor the expansion of CHP.
- Ensure that grid development allows a fully open market, in particular with respect to cross-border trade.
- Maintain its research and development policy according to its overall energy policy objectives.

Source:

IEA; Energy Policies of IEA Countries – The Netherlands – 2000 Review, IEA, 2000.

Water, A. F. J. van de; Bosselaar, L.; Lysen, E. H.; The Netherlands Policy on Solar Energy, Recent Progress and the Role of Utilities. NOVEM.

Sambeek, E. J. W. van; Thuijil, E. van; The Dutch Renewable Electricity Market in 2003. Energy Research Centre of the Netherlands, 2003.

## PORTUGAL

### MAIN HIGHLIGHTS

- Portugal has an imported energy dependence of over 85%.
- Portugal has been implementing a policy of liberalization of the energy markets, ensuring security of energy supply and further introduction of renewable energies.
- Portuguese energy companies are being restructured and privatized.
- An Iberian electricity market is under preparation.

### MAIN CONCERNS

#### NATURAL GAS

- Portugal is doing efforts to diversify the energy sources namely by the introduction of natural gas.
- From 2003, Portugal will receive gas both by pipeline and by a LNG terminal.
- Gas was first used for electricity generation (in a combined cycle power plant), being since then expanded to industry and the tertiary sectors.
- Because Portugal is an emergent gas market, European legislation permits the introduction of competition to be delayed for ten years after the beginning of gas supplies. Therefore, Portugal has until 2008 to introduce competition in the gas market.

#### OIL

- In the early 1990's the Portuguese oil sector experienced major changes: competition was introduced in a short time frame, in parallel with the privatization of Petrogal.
- Price ceilings protect consumers from abuses.

#### RENEWABLES

- All of Portugal's energy production is from renewable energy.

- Currently there is a target of implementing up to 7 000 MW of renewable energy projects until 2010. Most of this capacity will be sought by the use of wind energy.
- Hydro is the most important among the renewable energies, however varying year by year for climatic reasons.

## ELECTRICITY

- Portugal has taken a cautious approach towards the liberalization of the electricity sector.
- Because of Portugal's mild climate energy, little energy is used in space heating, however, electricity demand has been growing with the increased use of domestic appliances.
- On 20th January 2004 was signed the agreement for creation of the electricity Iberian Market (MIBEL) between Spain and Portugal. This will involve the creation of the Iberian Market Operator (OMI) that will merge the two current operators (OMEL in Spain will deal with the daily market, OMIP in Portugal will deal with futures and options) and an Iberian regulator. This market should be implemented by the year 2004. In this new market Endesa, Iberdrola, Union Fenosa and EDP will own 75% of production capacity and 93% of distribution.

## SPECIFIC FEATURES

- Improving energy efficiency is an important measure giving the sharp increase in energy demand, as well as to lower the increase in greenhouse gas emissions and to help the Portuguese companies to be competitive.
- To achieve the Kyoto target of limiting the increase in greenhouse gas emissions to 27% over 1990 levels between 2008-2012, further efforts on energy efficiency, renewable energies and cogeneration should be implemented.

## POLICY RECOMMENDATIONS

The Government of Portugal should:

- Take further measures to stimulate competition in the energy sector.
- Continue to work for the development of effective, competitive Iberian natural gas and electricity markets.
- Reform the tax system to better internalize external costs of using energy.
- Start implementing the new programmes for the energy efficiency in the different sectors.
- Increase the information to energy consumers on energy efficiency measures.
- Continue to enhance and develop modern public transport in major towns.
- Ensure maximum compliance with EU Directives on labelling, buildings, etc.
- Continue to take steps in the competition in the oil sector.
- Take measures to clarify the rules for handling of bottlenecks and reinforcement of the grid when new generation/ consumption or trading requires it.
- Develop a national energy R&D strategy that is coherent with Portuguese energy policy and that encourages private companies to undertake R&D.

### Source:

IEA; Energy Policies of IEA Countries – Portugal – 2000 Review, IEA, 2000.

DGE, Energia Portugal 2001; Ministério da Economia, Direcção Geral de Energia, 2001.

IEA; Roundtable Report on Notable Energy Developments, IEA, February 2004

## SPAIN

### MAIN HIGHLIGHTS

- The Spanish energy sector changed fundamentally during the 90's. Energy demand grew rapidly with the economy.
- Internal energy resources cover about 25% of total primary energy supply and security of supply is an important issue of the Spanish energy policy.
- The electricity oil and gas markets have been liberalized.
- The main challenges are to satisfy the growing energy demand as well as to curb CO2 emissions to meet the country's Kyoto target as well as to introduce the full liberalization of the electricity, oil and gas markets.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- Nuclear power is an important energy source. It covers about 30% of total electricity generation and 13% of country's total primary energy supply.
- The last nuclear power plant was constructed in 1988. Nuclear energy is subject to a moratorium: there shouldn't be any construction of new power plants before 2010. Though, Spain has not ruled out nuclear power as an option to future capacity needs.
- The energy plan for 2002-2011 indicates that nuclear should represent 19,4% of electricity produced in Spain by 2011.

#### NATURAL GAS

- The development of Natural Gas in Spain is recent and has a strong dynamism. In 2011, it should represent 22,5% of the total energy consumption (12,2% in 2000). The energy plan for 2002-2011 indicates that Natural Gas should represent 33,1% of electricity produced in Spain by 2011.
- Numerous combined cycle plants are under construction and should provide 12000MWe before 2010.



- A transmission system operator has been established and the arrangements to separating the vertically integrated incumbent are in process.
- Spain depends nearly entirely on importations (97%) and the Spanish government is making continuous effort to diversify the sources of natural gas supply, including the expansion of connections to EU grids and construction of regasification plants.
- Natural gas is subject to lower taxes than other oil products.

#### OIL

- There is a tax distortion between gasoline and diesel giving favour to diesel over gasoline, although the environmental externalities do not favour this option.

#### COAL

- There has been a steady process in restructuring domestic coal mines.
- Subsidies are still paid to domestic coal producers

#### RENEWABLES & CHP

- The government has strongly promoted combined heat and power and renewable energy sources. It has created a special status for electricity production from CHP, renewables, and waste under 50MW of installed power.
- The energy plan for 2002-2011 indicates that renewables should represent 28,4% of electricity produced in Spain by 2011.
- Wind energy has had a tremendous development over the last years supported on the strong technological content and the progressive reduction of unit costs. Spain has the world third largest wind capacity with 6411MW installed in 2003. Spain is considered the world most attractive country for on-shore wind energy by Ernst & Young.
- Solar photovoltaic has had a strong growth (25% per year since 1999, with an installed power of 22,2MW in 2002) and a wide application area.

## ELECTRICITY

- The private company REE (Red Eléctrica de España) rules the transport, while OMEL (Compañía Operadora del Mercado Español de Electricidad) is the unique pool manager. Independent from other participants, OMEL is in charge of adjusting supply with demand. The CNE (Comisión Nacional de Energía) is the regulator.
- The electrical sector still concentrated around 6 national actors, the 4 historical actors (Endesa, Iberdrola, Union Fenosa and Hidrocantabrico) and 2 newcomers (Viesgo and Gas Natural).
- Two different markets are given to the choice of the client: one regulated with a tariff fixed by law, the other one liberalized. The clients that have chosen liberalized market can come back to regulated tariff after one year.
- In 2003, the unregulated market represents 30,6% of electricity sells in Spain. From the clients entered in this liberalized market, 21% changed supplier, which represents 6,4% of the total market.
- On 20th January 2004 was signed the agreement for creation of the electricity Iberian Market (MIBEL) between Spain and Portugal. This will involve the creation of the Iberian Market Operator (OMI) that will merge the two current operators (OMEL in Spain will deal with the daily market, OMIP in Portugal will deal with futures and options) and an Iberian regulator. This market should be implemented by the year 2004. In this new market Endesa, Iberdrola, Union Fenosa and EDP will owe 75% of production capacity and 93% of distribution.

## SPECIFIC FEATURES

- Spain's greenhouse gas emissions objective is set at 15% above 1990, but Spain's CO<sub>2</sub> emissions in 1998 were already 21% above than in 1990.
- The government sees a real potential in energy efficiency measures, however the country's energy intensity slightly increased in the last years.

## POLICY RECOMMENDATIONS

Spanish Government should

- Study the feasibility of emissions trading scheme.
- Continue to review supply-demand projections, especially in light of the sharp growth of demand and progress in liberalization.

- Consider how to increase the number of energy market players to stimulate competition further.
- Speed up the implementation of the national Kyoto implementation plan.
- Establish a new, coherent and comprehensive energy efficiency programme to help slow the growth in energy demand in all sectors.
- Regularly verify compliance with building codes in both new and retrofitted buildings.
- Encourage efforts to build new interconnections with neighbouring countries and increase the capacity of existing ones.
- Assist in defining technical details for opening the market for small consumers and help them prepare for full market liberalization.
- Set a clear time frame for implementing legislation for increasing competition.
- Continue restructuring the coal industry, cutting subsidies and eliminate other distortions.
- Study the benefits of implementing a nation-wide green-certificate system.
- Continue support for development and demonstration of clean coal technologies.

Source:

IEA; Energy Policies of IEA Countries – Spain – 2001 Review, IEA, 2001.

IDAE – Ministerio de Economía; Plan de Fomento de las Energías Renovables, IDAE, 1999.

IEA; Spain Round Table, IEA, February 2004

MINEFI – DREE/TRÉSOR; Le marché de l'électricité en Espagne, MINEFI, April 2004

MINEFI – DREE/TRÉSOR; Production et Transport d'électricité en Espagne, MINEFI, June 2003

MINEFI – DREE/TRÉSOR; L'énergie éolienne en Espagne, MINEFI, April 2004

MINEFI – DREE/TRÉSOR; Les infrastructures d'approvisionnement gazier en Espagne, MINEFI, January 2003

## SWEDEN

### MAIN HIGHLIGHTS

- Sweden is focusing on the development of an international market in electricity, in cooperation with the Baltic countries.
- Sweden is intending to phase out all nuclear power.
- About two thirds of Sweden energy supply comes from oil and nuclear power.
- Coal gas and peat give minor contribution to the power system.
- Under the Kyoto protocol Sweden has made a commitment to reduce greenhouse gases to 8% below their 1990 level by 2008-2012.
- The energy policy bill of March 2002 underline the following objectives:
  - Create the conditions for efficient energy use and cost efficient Swedish energy supply with low adverse impact on the health, environment and climate.
  - Facilitate the transformation into an ecologically sustainable society, promoting sound economic and social development in Sweden
  - Contribute to the creation of stable conditions for a competitive business sector, and to renewal and development of Swedish industry
  - Contribute to broadening the co-operation within the Baltic region with regard to energy, the environment and the climate.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- The electricity supply industry expects major reductions in nuclear capacity over the next 20 years because of competitive pressures.
- A nuclear phase out framework has been proposed by the government following a German model.

## NATURAL GAS

- Natural gas is being considered a competitive alternative to nuclear power. However the natural gas grid is not largely developed in Sweden.

## OIL

- Sweden imports about 35% of its energy supply, mostly oil.
- Oil accounts for about 40% of final energy consumption.

## RENEWABLES

- Combustible renewables and wastes (biomass=principally woods and forest wastes) account for 17.5% and hydro 14.3% in year 2000.
- Renewables and CHP are the means to replace nuclear power capacity.
- Measures to increase the participation of renewables are being focused primarily on the use of biofuels.
- Sweden has currently a support scheme of environmental bonus tax exemptions for electricity coming from wind power, small scale hydro (<1.5 MW) or bio-fuel-fired CHP plants.

## ELECTRICITY

- Low electricity prices have reduced the interest in investment in new generating capacity.
- Electricity intensity in Sweden is among the highest in the world.
- Taxes on electricity are already quite high and have been raised sharply during the last couple of years.
- Currently, electricity production accounts for 5% of the total CO<sub>2</sub> emissions.
- The electricity market in Sweden has been liberated since 1996 for all costumers. Since then wholesale electricity prices have fallen. However, retail level prices have gone up for residential use and down for industrial use.

## SPECIFIC FEATURES

- Sweden has developed important studies on using Kyoto Flexible Mechanisms, namely in the Baltic Sea region.
- Development of alternative transport fuels to replace oil is a priority, and closer attention should be given to ethanol.
- It is planned that future reactor closures will be compensated, in part, by decreased electricity consumption – namely through replacement of electrical building heating.
- The largest proportion of the CO<sub>2</sub> emissions comes from the transport sector.

## POLICY ISSUES

Among others, Swedish energy policy issues to be addressed are:

- Simplify the tax regime in Sweden, the balance between revenue, environmental and energy policy goals need to be clarified, and the tax regime stabilized over time.
- Implement the EU gas Directive with a view to opening the market as soon as possible.
- Address the influence of major suppliers in the gas and electricity markets on the development of the gas market.
- Facilitate the access to the system network and the development of gas infrastructure by interested parties.
- Existing nuclear capacity should be used productively pending any definitive policy on its future. A sufficient level of support should be maintained to ensure the continuing safe operation of reactors, the disposal of waste, and the attractiveness of the industry for competent new personnel.
- Harmonize cross-border transmission tariffs;
- Address domestic transmission tariff issues, including congestion;
- Address generation capacity constraints;
- Address ownership issues in the gas and electricity markets;
- Address independence of regulation.

Source:

IEA; Energy Policies of IEA Countries – Sweden – 2000 Review, IEA, 2000.

## UNITED KINGDOM

### MAIN HIGHLIGHTS

- The UK has been liberalizing the energy sector over the last years.
- Since 1998 and 1999 all natural gas and electricity consumers are free to choose their supplier, respectively.
- The restructuring has resulted in closer integration of the gas and electricity markets, as well as other utility services: water, telecommunications and financial services.
- Under the Kyoto Protocol, UK has a target of a 12,5% reduction in greenhouse gas emissions by 2008-2012, but has also an autonomous national target of cutting its CO<sub>2</sub> emissions by 20% by 2010.
- The two main elements of UK policy regarding climate changes are the Climate Change Levy (not applicable to residential sector) and the Domestic Emission Trading scheme.
- The UK's Energy White paper states that distributed energy sources (micro-CHP and fuel cells) will make UK less vulnerable to security threats.
- Since 1970, overall energy consumption in the UK has increased by around 15% while the size of the economy has doubled. In future this trend should be maintained.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- Nuclear power is currently an important source of carbon-free electricity but, its current economics make it an unattractive option for new generating capacity.
- There are currently no proposals for building new nuclear power plants, but they might be necessary to meet the carbon targets.
- The report of the House of Lords recommends that the UK maintain its present ability to produce less than 20% of domestic electricity demand from nuclear.



## NATURAL GAS

- There are eight major gas suppliers in the UK.
- Bottlenecks are felt as it was fetched very high bid prices in recent years.
- New pipeline constructions are needed.
- North Sea part of the UK continental shelf is now a mature province, characterized by a large number of small discoveries and undeveloped finds close to existing pipeline infrastructure.
- UK might be a net gas importer by 2005 and Norway might be the major source of gas.
- Additional gas connections are needed both pipelines and LNG terminals.

## OIL

- It is expected that by 2010 UK will be a net importer of oil.

## COAL

- Domestic coal production is likely to continue to decline as existing pits reach the end of their geological and economic lives.
- UK almost imports half of the coal it uses and most of the economically viable deep mined coal is likely to be exhausted in ten years.
- The government will proceed with supporting relevant research on clean coal technologies.

## CLIMATE CHANGE

- UK emissions reduction target under the Kyoto Protocol is to reduce emissions by 12,5% below 1990 levels by 2008-2012. But UK government also set a national reduction goal for CO<sub>2</sub> of 20% before 2010.
- The Climate Change Levy entered in force on the 1st April 2001 and taxes energy consumption of industrial consumers, commercial and public sector.
- A domestic GHG emission trading scheme was launched in April 2002.

## RENEWABLES

- The Government has implemented the Renewables Obligation that will raise the contribution of renewable energy sources to England and Wales electricity supply to 10% by 2010. It corresponds approximately to the installation of 10 000 MW of renewable energies capacity by 2010.
- It was introduced in 2002 the Renewables Obligation which requires suppliers in England and Wales to obtain an increasing proportion of electricity from renewables year on year. The share of renewables should be of 10% in 2010, with an intermediate step of 5% by 2003.
- Renewable energy generation is exempted from Climate Change Levy.
- Funding for renewables capital grants 60 million GBP, additional to the 38 million GBP of extra-funding announced in 2002 Spending Review.
- It is expected a voluntary green certificates market to emerge on the basis of this obligation.
- Developers have entered into agreements for leases wind farm sites around UK coast with a total capacity of at least 1400 MW.
- Off-shore wind industry considers a further 3000-4000 MW can be built by 2010. The current installed capacity is of about 250MW.

## CHP

- The UK has 5 GW of CHP installed capacity, mainly on an industrial scale.
- The UK has a target of 10 GWe of good quality CHP by 2010. This target could save about 1,25MtC per year.
- It is expected to see a lot of micro CHP for heating and electricity generation in homes as well as businesses. Field trials will be supported to evaluate the benefits of micro CHP.

## ELECTRICITY

- England and Wales have 38 major power producers and 7 large power supplier companies.
- New Electricity Trading Arrangements (NETA) replaced the Electricity Pool, which represented the decisive breakthrough towards the fully liberalized market. It has led to a decline in electricity wholesale prices of 20-25%.
- Massive construction of gas fired plants are replacing coal plants.

## SPECIFIC FEATURES

- There is an intention to raise energy efficiency of buildings and businesses (by 2005 Buildings Regulation to be issued).
- There is an energy efficiency programme of fuel poverty that applies to low-income households in old poorly insulated buildings.
- A 3,2 millions GBP grant from the DTI will be used to develop fuel cell technology in a bid to make it a more efficient and economically viable energy source.

## POLICY RECOMMENDATIONS

The Government of the UK should:

- Ensure secure, diverse and sustainable energy supplies at competitive prices.
- Consider carbon taxation for households.
- Modify the Climate Change levy to accommodate the carbon content of fuels.
- Consider extending voluntary agreements to cover all larger industries and consider including small and medium-sized industries.
- Review the practical potential of energy efficiency policies to curb energy consumption and CO<sub>2</sub> emissions with special emphasis on transport sector.
- Implement the reforms relating to renewables.
- Revise the upstream taxation system to ensure an optimal exploitation of the North Sea resources and standardize off-shore regulation.
- Give incentives to eliminating bottlenecks of gas transportation.
- Encourage full participation of demand side in the balancing market.
- Seek consistency in the regulation of gas and electricity networks
- Take pro-active attitude in the design and implementation of national policy for the decommissioning of nuclear power plants and fuel cycle facilities and disposal of radioactive waste.

Source:

IEA; Energy Policies of IEA Countries – United Kingdom – 2002 Review, IEA, 2002.

DTI - UK; Energy White Paper: Our Energy Future – creating a low carbon economy; 2003.

IEA; Country Statement on recent Energy Policy Development (Standing Group on Long-Term Co-operation June 2004) – United Kingdom, IEA, 2004

MINEFI – DREE/TRÉSOR; Politique environnementale du Royaume-Uni, MINEFI, 2002

MINEFI – DREE/TRÉSOR; Le Marché de l'électricité au Royaume-Uni, MINEFI, 2004

## BULGARIA

### Energy summary

- Dependency on imports for 70% of the energy supply.
- The domestic resources of fossil fuels account for small proven reserves of gas and large deposits of low-quality brown coal.
- The electricity supply relies mainly on nuclear power and coal. The country remains a net importer of coal because metallurgical industries need high quality hard coal.
- Heavy dependence on nuclear power (6 x 400 MWe at the Kozloduy nuclear power plant), of which two groups have been shut down on 2002 under some EU pressure and two others are expected to be closed by 2006.
- The hydroelectric resources are modest (1800 MWe installed, against 3760 Nuclear and 6330 conventional thermal).
- There are plans for a new nuclear power plant (600 MWe Belene facility) to be built till 2010, for 1500 MWe of coal-fired generating capacity and 430 MWe of hydroelectric power.
- The independent producers have 1606 MWe of thermal capacity for cogeneration and they generate 14% of the electricity. There are also small heating power plants in 21 cities and towns, providing 22% of the total public and residential district heating.
- The electric grid is interconnected with the neighbouring countries, which enables international transit. Bulgaria is an exporter of electricity, supplying power to Turkey, Greece, Yugoslavia, Macedonia and Albania.
- There are no crude oil pipelines in Bulgaria but a 178 mile underground pipeline is projected to enable Russia to export oil through the Bulgarian Sea port of Burgas.
- The natural gas pipelines from Russia enable the gas transit to Turkey, Greece and Macedonia and supply to the national big consuming industries and some big towns. There are projects to expand the network to medium-sized towns.
- Hydro is the most important renewable energy resource available in the country. The availability of nuclear power and the excess capacity will not encourage renewable resources development in the near future.

- Huge investments are necessary to improve the functioning of the energy system. For the electric power sector and until 2005 the investment is expected to attain 4 438 million US dollars.
- Bulgaria is following the recommendations set by the EU directives in what the reform of the energy sector is concerned.

### **Energy Policy – main highlights**

- There are plans to sell the majority of the state-owned energy companies.
- The electricity sector is being reformed according to the unbundling principles. There is now a single buyer and a single supplier to the electricity distribution companies.
- The natural gas market has been partially deregulated in 2001. The big consumers are allowed to negotiate directly with suppliers of imported gas.
- Inefficient coal mines have been closed recently and other privatised. Bulk coal and coal briquettes are still subsidized but there is a strategy to eliminate subsidies and approach market prices as a means to encourage investment in coal mining.

### **Main concerns**

- The security in the nuclear power plant.
- The inefficiency of the supply energy system.
- The restructuring of the Bulgarian state-owned electricity company.
- The dimension of the state-owned energy sector.
- The level of price support through subsidies.
- The inefficiency of the coal mining sector.

### Source:

<http://www.fe.doe.gov/international/bulgover.html>.

## HUNGARY

### Energy summary

- Dependency on imports for 50% of the energy supply.
- Hungary has important domestic energy resources which meet approximately 50% of the energy requirements. Those resources are: oil, gas, nuclear power, low caloric coal and lignite.
- In the primary energy balance natural gas and oil account for about 70% and renewables about 4%.
- The country oil reserves are expected to decrease 6-9% annually and at the same time oil products demand (mainly light petroleum products) is expected to increase, which obliges the oil company to look for new supply sources.
- The natural gas reserves could last still 20 years at the current production rate. About 75% of the total consumption of natural gas is imported from Russia. There has been important price increases in the last years in order to eliminate subsidies.
- The coal reserves, mainly lignite, are also important but the quality is not so good (high sulphur and ash content). The power plants using the coal are adjacent to the mines. Small mines supply coal for home heating.
- Hungary has one nuclear power plant (Paks power plant) which is working in safe conditions, according to the EU judgement.
- Hungary has only limited hydroelectric potential because it is not a mountainous region. Only three small sites are in operation amounting to a capacity of 43,8 MWe.
- The Hungarian system is integrated with the West-European UCPTE system.
- There are currently about 65 000 km of pipelines in Hungary, in line with the importance of this fuel in the energy system.
- The oil imports come from the Russian Federation and the infrastructure is being used to export oil to other countries.
- The electricity generation capacity in 2001 was 8 310 MWe (6 410 conventional thermal and 1850 nuclear). Hungary is a net importer of electricity (about 9% of electricity demand in 2000), mainly from Slovakia and Ukraine.

- The generating companies have been privatised in the early 1990s, some of them with the adjacent mines.
- For the expansion of the electric generation capacity Hungary is relying on combined cycle gas turbines.
- The electricity prices have increased significantly over the last years, with removal of subsidies.

### **Energy Policy – main highlights**

The major concerns of the country's energy policy come as follows:

- Develop diverse energy supplies and eliminate dependency on imports from the Former Soviet Union;
- Improve environmental protection;
- Increase energy efficiency through modernization of supply structures and better management of electricity consumption;
- Attract foreign capital for investment in capital-intensive energy projects;
- The EU directives in terms of market building, removal of subsidies and third party access to the grids are being considered by the Hungarian energy policy. Large electricity consumers can choose their supplier and the same will happen with large natural gas consumers in a near future.

### **Main concerns**

- The importance of coal, mainly lignite, in electricity generation and the social impact of phasing out coal production.
- The air pollution caused by the burning of coal both in thermal power plants and in the residential sector for heat production.

#### Source:

<http://www.fe.doe.gov/international/hungover.html>



## ROMANIA

### Energy summary

- Dependency on imports for 50% of the energy supply.
- Romania has abundant fossil fuels and hydroelectric resources. Primary energy production represented in 2001 74% of the energy consumption.
- Crude oil production represents more than 50% of total consumption and explains why the refining system is the largest in Central and Eastern Europe. The refining system has to be reduced and large sums have to be invested to upgrade the system. There is actually an excess capacity.
- Proven reserves of natural gas are enough for 25% at the current consumption level. Production covers about 80% of consumption.
- Both the oil and the natural gas sectors are expected to develop in the coming years owing to World Bank and western countries companies interest.
- Coal reserves are also very important and production almost covers demand. However some mines are uneconomic and have to be closed or modernised.
- The hydroelectric potential amounts to 14 800 MWe and only a fraction is still developed (representing about 35% of the potential in terms of production). Small hydro power plants have an interesting potential (about 5 000 locations).
- In what other renewable energy sources are concerned only small amounts of electricity is being produced using biomass and waste residues.
- Gas pipelines transport gas from Greece and Bulgaria. Some of the distribution pipelines need to be replaced because of security reasons. The most of the imported natural gas comes from Russia, via a pipeline from Ukraine.
- The electricity power network is interconnected and strong links exist with Ukraine, Bulgaria and the former Yugoslavia. Negotiations to become more fully integrated into UCPTE system are being carried out.
- Romania is a net exporter of electricity and its export capacity is being increased.

## **Energy Policy – main highlights**

- The reorganization of the energy sector passed in 1990 maintained state holding companies for sectors considered as strategic. This includes electric power, oil, natural gas, lignite and coal. In the future it is expected an evolution towards a competitive electricity market.
- Romania is opening up its electricity market to follow the EU directives. With 15% of the electricity market liberalized, meaning that some large consumers can choose their suppliers, the regulatory authority plans to go deep in the reform.
- For electricity production Romania accounts with one nuclear power station (750 MWe), responsible for 10% of the Romania electricity production and a second group (700 MWe) is 40% complete.
- The government intends to launch a new program for increasing the use of renewable energy.

## **Main concerns**

- The low level of energy prices when compared to other European countries.
- The excess refining capacity (522 000 b/d from the 10 refineries), which has already been reduced in the past (9 million tons have been closed).
- The mining activity is important and part of the capacity has to be dismantled which poses severe social problems in the mining regions.
- Romania has some industrial zones with severe environmental problems. Land, water and air pollution are among the most severe problems that have to be dealt with by the government.

### Source:

<http://www.fe.doe.gov/international/romnover.html>

## SLOVENIA

### Energy summary

- Electricity generation counts with a nuclear power plant (638 MWe) exploited jointly with Croatia is responsible for 25% of the electricity produced. The remaining comes from hydroelectricity (31%) and conventional thermal sources – coal and oil - (43%). Total capacity installed amounts to 2 660 MWe.
- New capacity relying on gas is being installed (286 MEe).
- The country is a net exporter of electricity.
- Hydroelectricity has an interesting potential even for small scale units. There are about 40 small units that are very old and need to be refurbished. The large-scale units can also be improved with additional capacity.
- The most of commercial heat produced comes from municipal and self-production CHP units.
- Slovenia produces only 45% of the primary energy consumed.
- The country has minor oil and natural gas resources and relies heavily on imports. There was in the past only a small refinery that has been closed down for economic reasons.
- Domestic coal accounted in 2001 for almost 90% of consumption.
- Other renewables have a negligible role in the energy supply system. Biomass from wood waste from the wood processing industry has an interesting potential and there are some district heating installations using it. Firewood for rural households is also extensively used.
- Large gas consumers and distributors are allowed to access the gas grid.
- The electricity network is part of UCPTE grid.

### Energy Policy – main highlights

- The main lines of the energy strategy adopted by the government come as follow: sustainable electricity production to meet the demand, with increase in cogeneration, decommissioning nuclear power production, increasing natural gas use by commercial and residential users, maintaining the rate of domestic coal use, and increasing the share of

renewable energy sources (hydropower, biomass, geothermal, solar and waste residues). Tax incentives are offered as a means to promote renewable energy.

- The energy markets have also been liberalized and prices had to increase.
- Hydropower is one of the main concerns in terms of energy policy because of the interesting potential available.

### **Main concerns**

- The investments needed to refurbish small-scale hydropower units and to increase capacity in the larger ones.
- Lack of storage capacity for oil which increases the possibility of supply shortages.

### Source:

<http://www.fe.doe.gov/international/slvnover.html>

## CZECH REPUBLIC

### Energy summary

- 70% of the TPEC is domestically produced.
- A high priority to build nuclear energy units is part of the energy policy.
- Coal represented about 50% in the TPES registered in 2002, oil and gas about 19,6ans 19,6% and nuclear about 8,7%.
- The Czech Republic has minor oil and gas reserves and the imports of oil come from Russian and Germany.
- Two important refineries already privatised exist in the country. A small one with a processing capacity of 20 000 b/d is operated by a public company.
- Important investments are necessary to improve the refineries as well as oil production.
- Natural gas is used for electricity and heat production which puts a high pressure on the pipelines capacity during the winter months.
- The coal and lignite reserves are moderate but the conditions for an economic exploitation of mining are not met. There are some marginal exports for Slovakia, Germany and Austria. Some of the mines have been closed because of stricter regulations put in place and following UE recommendations. About 64 000 jobs have been destroyed in northern Moravia.
- Two nuclear power plants are in operation: Dukovany with 1760 MWe providing 19% of the electricity produced and Tamelin with 981 MWe which began operation in May 2003 and is expected to produce 20% of the electricity demand.
- The total electricity capacity installed was 15180 MWe in 2001 of which 11 470 conventional thermal, 2 760 nuclear and 950 hydroelectric.
- Hydro is also relevant, mainly because of the pumping capacity.
- The country has a sophisticated electricity system and supplies electricity to other countries.
- Other renewables are negligible.
- There is a high degree of interconnection with other grids. The gas network provides natural gas from Russia to Western Europe.

### **Energy Policy – main highlights**

- The energy policy is based on the following ideas: energy prices determined by the market, privatisation of the energy companies, energy efficiency, environmental concerns, connection to international networks, and efficiency of the domestic supply energy sector.
- The recommendations of the EU are being considered by the authorities.
- Open gradually the third party access to the grids.
- Mandatory energy audits for the government facilities with energy use greater than 1 500 GJ per year and for the non-government energy users consuming more than 35 000 GJ per year.

### **Main concerns**

- The investments needed to improve energy efficiency and improve the environmental conditions as well as productivities and upgrading in quality in the existing refineries.

### Source:

<http://www.fe.doe.gov/international/czekover.html>.

## LATVIA

### Energy summary

- Latvia has no fossil fuel reserves with the exception of peat, which is extracted by a large number of privatized companies. Some of the peat is exported. Wood is also used as an energy resource. Domestic production accounted only 14% of TPEC.
- There are possibilities of offshore oil reserves.
- There is a dependency of 100% on oil products imports to meet the demand. The country has no refining capacity.
- The natural gas is imported from Russia and stored in summer for consumption in winter. The storage facilities are important for the modulation of exports by the Russian company Gazprom. District heat and electricity production are the major clients for natural gas.
- Coal and coke are imported from Poland and other neighbouring countries.
- About 75% of the electricity generating capacity is hydroelectric. Latvia is a net importer of electricity from Lithuania and Estonia (about 25% of the electricity consumed).
- Latvia is an important transshipment location for oil products.

### Energy Policy – main highlights

- As an adhesion country Latvia has passed a number of reforms of the energy sector in order to follow the main practices of EU.
- Competition, transparent pricing, development of renewables are among some of the main principles of the reform.
- Cogeneration is also encouraged.

### Main concerns

- Energy for households is still subsidized.
- The efficiency of the district heating systems has to be improved and loans have been negotiated with the World Bank.

### Source:

<http://www.fe.doe.gov/international/latvoer.html>

## ESTONIA

### Energy summary

- Natural gas and petroleum products are imported. Peat and wood waste are being used in small heating plants. The peat reserves are important and small hydro power plants deliver electricity to some villages in isolated grids.
- Shale oil is a major energy resource in Estonia (in 1997 it represented 76% of TPES). It is the main source of fuel for the thermal power plants and has been used also by the cement manufacturing company and to produce oil distillates. About 9 mines are in operation. EU has been pressing the government to reduce the use of shale oil because of the environment impact but in the final negotiations EU accepted to treat shale oil as coal.
- There are neither imports nor refining of crude oil.
- Natural gas is imported from Russia and is the primary fuel for a cogeneration plant supplying electricity and heat to Tallin.
- The consumption of imported coal is declining and has been substituted by natural gas.
- The hydro resources are not important. Very small hydroelectric power plants exist but the overall capacity is approximately 1 MWe. There are still a potential to exploit but only for very small projects.
- Estonia has two ports for transshipment of oil exports
- Thermal production of electricity uses oil shale as the main fuel. The capacity of the electric power plants is 3 210 MWe. Some electricity is being exported.

### Energy Policy – main highlights

- Security of supply at lower prices is the driving force of the energy policy for the country in the reform procedure.
- The electricity and gas sector are being liberalized according to EU directives.

### Main concerns

- High dependence on shale oil and its environmental impact.

### Source:

<http://www.fe.doe.gov/international/estnover.html>



## LITHUANIA

### Energy summary

- TPEP represents about 30% of the TPEC.
- Nuclear power is the main source of the electricity generated.
- The country imports crude oil and natural gas and exports gasoline and electricity.
- There are some proven oil reserves that are being exploited but production is almost negligible regarding consumption (7%).
- The refinery although using less capacity than available is supplying refined products to the Baltic republics.
- There is no natural gas production. All the imports are done from Russia. If agreement is reached with Gazprom for the building of a transit pipeline to carry gas to Russian Kaliningrad and Poland Lithuania would become an important transit centre for natural gas.
- All the coal is imported as there are no significant coal reserves.
- In terms of electricity the nuclear power plant of Ignalina with 3 000 MWe is the main source of electricity (about 78% in 2001). UE is pressing the government to close the unit but its importance in the energy panorama of the country will raise difficult negotiations.
- The hydroelectric resources are not important. Three hydroelectric facilities have been counted with 909 MWe. Conventional thermal has a capacity of 2 600 MWe.
- The country is exporting important quantities of electricity (about 43% of net generation in 2001).
- Besides the CHP plants there are also some companies that only provide district heating.
- Pipelines and electric transmission lines are being expanded.
- As a renewable source, geothermal energy will be used to produce electricity.

### **Energy Policy – main highlights**

- Privatization of the electric grid and of the gas and oil business has been conducted.
- The gas distribution network, additional storage facilities and diversification of sources of supply for natural gas are among the main guidelines for the energy policy.

### **Main concerns**

- The safety of Ignalina nuclear power plant.
- Restructuring of the electricity industry according to the separation of functions (unbundling).
- Modernization of the cogeneration units.

### Source:

<http://www.fe.doe.gov/international/lithover.html>

## SLOVAK REPUBLIC

### Energy summary

- TPEP covers 36% of total primary energy consumption.
- Solid and liquid fuels are being substituted by natural gas. In the demand side household and services consumptions are growing and industry and agriculture consumptions are decreasing.
- 97% of the oil needs are met by imports from Russia. Domestic extraction of crude oil covers about 1,5% of domestic consumption.
- Natural gas resources are also almost negligible. Slovakia is a transit centre for natural gas coming from Russia to Western countries.
- The coal resources are not important and the existing reserves are of a low quality. Domestic production accounted about 35% of total consumption of coal in 2001.
- Two nuclear power stations with six reactors are now in operation.
- Slovakia has approximately 2 500 MWe of installed hydroelectric capacity and there are still additional potential to exploit. 2 600 MWe of nuclear capacity and 2 400 of thermal capacity complete the generation system. The country is a net exporter of electricity but import-export movements exist with the neighbour countries.
- The electricity grid is interconnected with the UCPTE system. The north-south transmission grids are requiring improvement.

### Energy Policy – main highlights

- The Law on Energy of 1998 stated the need to stimulate competitiveness, protect consumers and ensure reliable energy supply.
- The electricity and natural gas markets are opened for large consumers to choose their suppliers.

### Main concerns

- Diversification of the crude oil suppliers.
- The safety of the nuclear power reactors.

### Source:

<http://www.fe.doe.gov/international/slvkover.html>

## POLAND

### Energy summary

- Poland is heavy dependent on coal (66.3% of primary energy supply in 1998, followed by oil and natural gas with 20,9 and 11,4%).
- TPEP accounts for 87% of TPEC.
- Poland has proven oil reserves and some oil is being exploited. But 98% of the consumption is covered by imports.
- Poland has several refineries but is not an exporter of refined products.
- Natural gas reserves are an important asset for Poland. But domestic production meets only 39% of the consumption.
- Poland has important coal resources and is an important exporter.
- Hydroelectricity is not very important (2 180 MWe are installed). Coal accounts for 97% of the electricity produced and hydro for 3%. Poland is a net exporter of electricity.

### Energy Policy – main highlights

- Regulation of the energy sector and third party access to the electricity and gas transmission grids.
- Increase the penetration of oil and natural gas.
- Privatization of the energy companies.

### Main concerns

- Modernization of the crude oil refining system.
- The age of the electricity generation capacity.

### Source:

<http://www.fe.doe.gov/international/plndover.html>

## CYPRUS

### Energy summary

- Cyprus has no conventional energy resources.
- Renewable energy, mainly solar, wind power and biomass is the only indigenous resource, accounting to 4,5% of the total energy requirements. By far solar is the most important renewable energy used. About 90% of the individual homes, 80 % of the apartments and 50% of hotels are equipped with solar heating systems.
- Presently, Cyprus imports annually about 1 million toe of oil products and 1.3 million toe of crude oil, which is processed in the national refinery. Power generation is oil-based and uses about a third of oil imports.
- Coal is imported for cement production.

### Energy Policy – main highlights

- Security of supply, meeting demand, energy conservation.
- Development of energy renewable sources, mitigation of energy consumption on the environment.
- Harmonization of the energy sector with the Acquis Communautaire.

### Main concerns

- The financial burden on the economy of energy imports, which represented in 1999 about 70% of the exports value.
- Development of renewable energy.

### Source:

Ioannis, Chrysis, "Policy Initiatives Regarding RES in the Republic of Cyprus"

<b>MALTA</b>
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### **Energy summary**

- The main energy requirement of the Maltese Islands is electricity generation.
- Electricity is generated by two power stations, relying solely on the importation of residual fuel oil and gas oil (formerly also coal).
- Solar energy represents less than 0,5% of the energy supply.

### **Energy Policy – main highlights**

- Fuel switch from coal to oil.

#### Source:

<http://www.fe.doe.gov/international/bulgover.html>

## NORWAY

### MAIN HIGHLIGHTS

- Norway is a major producer and exporter of energy.
- Government involvement in the energy sector continues to be prominent in Norway.
- The Norwegian commitment under the Kyoto Protocol is to limit the increase in greenhouse gas emissions to 1% above 1990 levels in the first commitment period, 2008-2012.
- Greenhouse gas emissions fell between 1999 and 2000 (by 1%), mainly because of unusually mild weather resulting in lower consumption of heating oil and heating kerosene and the shut-down of several air services, reducing sales of aviation fuel.
- Some agreements have been made with OPEC in order to defend the oil prices.
- New expansion of electricity generation capacity is being made with natural gas power plants.
- The Government has announced the intention to stop the development of new big hydro power plants.
- Air pollution and acid rains are of big concern.

### MAIN CONCERNS

#### ELECTRICITY

- Norway has the highest electricity consumption per capita in the world, reflecting its large hydro power resource endowment, substantial energy-intensive industries, and its cold climate.
- 99% of its electricity generation comes from hydroelectricity. In wet years it is a net exporter of electricity and an importer in drier years.
- Competition has developed in the electricity market, although public involvement is still strong.

- Expansion of Nord Pool should provide more flexibility in responding to growing electricity demand.
- Investment in transmission has been declining over the past decade as efficiency gains have improved the capability of the system to meet growing demand.

## OIL AND GAS

- Norway is a major non-OPEC oil producer and exporter. Natural gas reserves are also very important accounting for 60% of its offshore hydrocarbon reserves. It is the second largest exporter of natural gas in Europe.
- Partial privatisation of Statoil and the restructuring of the State Direct Financial Interest (SDFI).

## COAL

- Norway is producing coal at Svalbard Islands where the only coal-fired power plant is located. However it is a coal net importer country.

## POLICY ISSUES

- Review the impact of environmental policies on the development of energy projects.
- Evaluate the efficiency and effectiveness of existing policies and measures, in particular the carbon dioxide tax.
- In developing new policies and measures, give particular attention to the petroleum and transport sectors, which are both key emitters in Norway.
- Proactively encourage the private marketing of gas as a means of assisting the closer integration of the Norwegian gas industry with the European market.
- Continue to work towards harmonisation of taxation and other factors influencing the operation of the Nordic electricity market.
- Review the influence of the hydro concession on the level of private and foreign investment in hydro-based generation.
- Review the impact of small-scale and municipal ownership on efficiency and investment in the electricity sector.



- The exhaustion of hydrocarbon reserves. To account for the decrease in future export revenues and to control inflation part of the export revenues of the country are directed to an Investment Fund.

Source:

IEA; Energy policies of IEA Countries – Norway – 2001 Review, IEA, 2001. EIA – Country Analysis Brief (<http://www.eia.doe.gov/emeu/cabs/norway.html>).

## SWITZERLAND

### MAIN HIGHLIGHTS

- Switzerland carries out energy policy in a federal system with very decentralised decision-making.
- The current energy policy of Switzerland is defined in the Swiss Energy Action Plan (“SwissEnergy”), which was launched by the federal government in 2001 and replaced the Energy 2000 Action Plan.
- Targets: reduce consumption of fossil fuels by 10% and limit the increase of electricity consumption at 5% between 2000 and 2010. The share of non-hydro renewables in electricity generation is planned to increase from 2.2% in 1999 to 3.2% in 2010.
- Between 1990 and 1997, the slowing-down of fossil fuel use and electricity demand and the stabilisation of CO<sub>2</sub> emissions were achieved as a result of economic stagnation and the Energy 2000 Action Plan.
- The Swiss Government and the cantons have put strong emphasis on promoting non-hydro renewables.
- Switzerland has a robust, comprehensive and well-managed research and development programme in the energy field.
- Ambitious goal accepted in Kyoto: an 8% cut in greenhouse gas emissions from those of 1990 by the period 2008-2012.

### MAIN CONCERNS

#### NUCLEAR ENERGY

- In 1999 five nuclear units were in operation representing nearly 20% of the total generation capacity in the country.
- The Swiss nuclear power plants are efficiently run and contribute significantly to Swiss electricity supply. It provides 40% of electricity supply.
- Together with hydroelectricity nuclear contributes to 98% carbon-free electricity production.

## RENEWABLES

- In 1999, the contribution of all renewables, including hydropower, to primary energy supply was 18.9%.
- SwissEnergy is continuing to implement the measures to promote renewables of the Energy 2000 Action Plan.

## NATURAL GAS

- Switzerland no longer has domestic gas production and has been totally dependent on imports since 1994.
- About 100 companies are currently active in the transmission and distribution of gas. Most of them belong to the public sector (communes and cantons).
- The gas industry expects to expand in the area of co-generation, possibly by replacing nuclear energy.

## ELECTRICITY AND NATURAL GAS

- Only 2% of Swiss electricity production comes from fossil fuels, 40% is based on nuclear energy and 58% on hydro energy.
- A large number of companies are present in the electricity and natural gas sectors. Suppliers have monopoly rights in their areas and set prices for final consumers.
- Strong involvement of local authorities in both ownership and regulation, e.g. price controls.
- High average electricity and gas prices, in particular for industrial customers.
- Initiative to introduce competition in the electricity and natural gas sectors.

## OIL

- Switzerland has no domestic production of fossil fuels and thus is totally dependent on imports.
- Oil consumption has stabilised since the beginning of the 1990s.

- Competition in the retail market is increasing although oil supply is still mainly concentrated in the hands of four large suppliers.

## COAL

- Coal is not used for electricity generation and is mostly consumed in the cement industry. This industry has committed itself to replace coal by waste-derived fuels for 75% of its energy consumption.

## POLICY ISSUES

- Strengthen public information on energy policy measures. Make sure that trade-offs between various policy options are well understood.
- Improve the review of the cantons' energy policies. Promote co-operation among cantons.
- Further enhance co-operation with the cantons on energy policy, especially on the Energy 2000 Action Plan and on the introduction of competition in the energy markets to ensure successful implementation of energy policy measures.
- Focus on the most cost-effective measures to promote non-hydro renewables and ensure that these measures are designed to increase their competitiveness.
- Ensure that the public receives accurate information about renewable energy available on the market.
- Seriously consider the future of electricity supply, taking into account probable future developments (i.e. introduction of competition, CO<sub>2</sub> emissions reduction) and the merits of the different production options from the point of view of economy and environment.
- Implement an energy tax reform based on ecological considerations.

### Source:

IEA; Energy policies of IEA Countries – Switzerland – 1999 Review, IEA, 1999; Energy Policies of IEA Countries 2001 Review.

## **Annex 11: Case studies of the project in brief**

### **DENMARK**

#### **The Danish policy and programme for introducing active solar heating in Denmark.**

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## **1. Case study objective and scope**

The scope of this case study is the implementation and results of the Danish official policy programmes to introduce active solar heating systems in Denmark. The objective being to understand the effect of these policy programmes influenced on the actual development of the market in Denmark and on the development of supporting organisational structures.

## **2. Methodology used and information sources**

The case study is organised as a historical account of the implementation of different policy programmes during the years 1979-2001. The sources of information are: Laws, statistics, reports, conference papers, web-sites.

## **3. Description of the case study**

### **3.1 How it all began**

The Danish solar thermal development started without governmental programme at the time of the first energy crisis 1973/74. A little group of small manufacturers started 3 different productions of solar thermal systems, 2 of them Batec and Arcon are still active in the field as the largest manufacturers in Denmark.

At the same time the Danish Technical University (DTU) took the initiative to start research in active solar thermal energy (ASTE).

### **3.2 The first governmental initiatives**

The first official governmental initiative started in 1978/79 with 2 elements:

#### **3.2.1 The renewable energy research programme**

The Ministry of Trade allocated means for research and development of renewable energy technologies. In the field of solar energy DTU carried out basic research including demonstration projects and monitoring programmes, which formed the basis for the development in the 80th carried out in a co-operation between DTU, Danish Technological Institute (DTI) and the manufacturers. The financing of the programme were in 1981 delegated to Danish Energy Agency (DEA) – today the Danish Energy Authority.

### **3.3 Further R&D&D - the solar development programme**

As a consequence of the growing dissemination of solar thermal systems, increased research and development was necessary. Under the supporting programme Development of Renewable Energy (UVE) DEA allocated in the 90th between € 1,6 and 2,6 million yearly to solar research, development, information, solar computer programmes, campaigns and demonstrations projects including monitoring.

Moreover the UVE-programme administrated the grants to standard solar systems and medium sized and large plants (yearly € 2,6 million rising to € 5,3 million in 1996) and the basic support to the test laboratory. The total yearly solar budget rose from € 3,7 million in 1991 to € 8,9 million in 1996.

To assist DEA in the organization in the future development and in prioritising the means, the Solar Energy Council was established in 1991. It consisted of 15-20 leading members of the Danish solar stakeholder group, encompassing manufacturers, installers, the test laboratory, Technical University (DTU), consulting engineers and architects, Renewable Energy Information Centre and the Danish Organization for Renewable Energy (OVE).

The Solar Energy Council worked out 3 plans of action for the periods of 1991-95, 1995-97 and 1998-2000. The council played a very important role in the organization, and assisted DEA with detailing the plans of actions, fixing the order of priority to incoming projects, follow-up upon on-going activities and evaluation of finished projects until 2002, where the new government cancelled the UVE-programme.

#### **3.3.1 Economical subsidies**

The Danish government decided as soon as in 1979 to give direct grants at 30 % of the costs of the installation of standard solar thermal systems. The administrative set-up was very simple in the beginning, but more restricted in the 80th under the administration of DEA. After some years it was clear, that some of the solar installation bills contained certain plumber tasks not related to the solar installation. Moreover, a fixed 30% grant to every solar plant regardless of its quality was not appropriate in the long run. DEA decided therefore in the late 80th that subsidies could only be given to approved products, and later on in the beginning of the 90th, that subsidy should be dependent on the energy harvest of the system under standard conditions, but max.30% of the costs. This meant on the negative side increased administration, but on the positive side increased stimulation among the manufacturers to produce the best collectors, since they would call forth the highest grants. The revised subsidy rules shifted to € 0.67 per kWh of the yearly solar energy production - for a standard 5 m<sup>2</sup> plant producing 1800 kWh a year: € 1200.

As the dissemination increased in the 90th DEA decided to reduce the grants stepwise with the goal of ordinary commercial conditions without subsidies after 5 years. The first step was reducing €0,67 to € 0,53 per kWh in 1996, and the year after subsidies in district heating areas were cancelled, and in 2002 the new government decided to remove subsidies to all solar thermal plants.

### **3.4 Quality testing and assurance**

#### **3.4.1 Establishment of a test laboratory**

In the years of 1979-80 a lot of immature solar systems were installed, not only in Denmark, but also in a lot of European countries. The collectors were often made of iron and corroded very quickly. To cure these 'children-diseases' DEA reacted and established 1981 a test laboratory in DTI to guard the quality of the products. An approval scheme encompassing the whole system of collector, tank and electronic control was made, and the national grants could only be given to approved systems.

Later the approval scheme was changed to separate type-approval of each main component, stimulating product development of these separately, and the plumbers could therefore combine components from different manufacturers, according to guidelines produced by the test laboratory. This also resulted in price reductions of a complete solar thermal system.

The test laboratory participated together with DTU and about 12 manufacturers actively in the product development of the components and systems. Most of the researchers, developers and administrators from DTI, DTU and DEA are still active in the field to day, showing the importance of having skilled and long-term devoted people to stimulate a development in a minority area. The approval and development activities in the test laboratory were financed by DEA with a yearly budget of € 0.5 million in 1981 rising to € 1 million a year in the end of the 90th. As a result the average solar thermal yield increased from about 300 to 500 kWh per m<sup>2</sup> a year in the period.

In 1998 the DTI solar test laboratory and the solar activities in DTU made a fusion in The Danish Solar Energy Centre.

### **3.5 Quality assurance scheme**

As part of the national campaigns two independent market analyses were carried out including telephone interviews with potential customers. The first investigation concluded, that information about solar thermal was already wide spread, and that the primary target group still was schoolteachers, police officers, academics, idealists and people with great environmental



awareness. Another large group of 'ordinary' Danes were interested – especially women – but wouldn't be 'rabbits' for experiments with new technology or uncertain installations.

As a consequence of this result a quality assurance scheme for solar installations (KSO) was therefore established in co-operation with the plumber organizations, parallel to the already existing quality assurance scheme for solar thermal products and components. A transition scheme for the already educated solar plumbers was made, but new solar plumbers had to participate in a 3 days course with a following approval of an actual solar installation to obtain certification.

The scheme resulted in more than 1000 certificated solar installers, that is one third of the total amount of Danish plumbers.

The comprehensive control in the field of a number of casual selected installations was very important and were carried out smoothly, probably because the controlling leader of the KSO-secretary besides being an engineer also was educated as a plumber (He is still leader of the secretary and also participating in the Irish SolaCert project). Due to the scheme only 25 out of 4000 installations were reported as problematic in 1996.

The plumber organizations – being at the beginning sceptical to the scheme – adopted gradually the arrangement fully, also as a marketing factor guaranteeing the quality and thereby increasing the business of the plumbers. For this reason the plumbers were opposed to a possible parallel DIY (Do-It-Yourself) scheme, but it succeeded to make a DIT-scheme: 'do-it-together' with a certificated solar plumber as supervisor. The DIT concept, which was approved by the Solar Energy Centre, consists of components that are prepared for easy installation following a detailed installation manual which also have to be approved. During the installation the customer can call the installer for help or clarification and after completing of the installation the installer have to approve the plant. Such installations could obtain grants as normal installations.

### **3.6 Information campaigns**

#### **3.6.1 Regional campaigns**

The quality assurance activities resulted in reliable national standards, but it lasted 6 year before the negative image of solar thermal due to the former functioning problems was obliterated in the eyes of the population. The yearly amount of solar installations was only 250, compared to 1000 in the 'boom years' in 1979/80. Not till 1987 it was possible to start campaigns for

ASTE of these reasons. In 1988 the first regional campaign was carried out in the county of northern Jutland, financed by DEA with € 1,5 million.

The campaign intentions were twofold:

1. To create public awareness of the possibilities of solar thermal systems through advertising, a solar energy newspaper, exhibitions on market days, cattle shows etc.
2. To educate a local cops of solar plumbers. The plumbers got a simple one-day course in installing solar thermal systems, and could thereafter man the exhibitions and try to sell systems.

Around 100 systems were installed as a result of the campaign, but more important 30 solar installers were initiated in the county.

In the following years 3 new regional campaigns were carried out with 3-4 new Danish counties in each of them, financed by DEA. The yearly budget was about 1,7 million € and crucial for the organizing was the appointment of a campaign coordinator and the involvement of local energy offices and the central Renewable Energy Information Centre (comparable to REIO) as well as the following up of DEA. The success was very clear: the public awareness and the confidence in the products were significant increased, and the yearly amount of solar installation rose from 250 to about 1000. At the same time more than 300 solar installers were recruited.

The regional campaign set-up was honoured with the European solar energy price in 1994.

### **3.6.2 National solar thermal campaigns**

With the regional campaigns the foundation was created for further dissemination, but more campaigns were needed to maintain the gradient in the development. DEA decided therefore in co-operation with the Solar Energy Counsel to implement a series of national campaigns with the assistance of professional marketing bureaus. The campaign elements were advertising in regionally distributed newspapers, posters, television and radio spots, homepage, and various solar information brochures, pamphlets and fact sheets. The local follow up by the solar plumbers was organized with assistance of the independent nationwide regional energy offices.

The yearly budget of these campaigns (1992-98) was € 0.3-0,4 million.

### **3.6.3 Involvement of architects**

A barrier in the development has been relative little involvement of architects in the field of solar energy, and the opinion among many people,

that solar thermal plants in application forms did not adorn the buildings. Several manufacturers therefore developed roof-integrated solutions. DEA arranged a solar architecture competition, and consulting architects worked out booklets with guidelines for placing solar systems.

#### **3.6.4 Involvement of utilities**

A strong element in the national campaigns 1995-98 was the involvement of utilities, especially the natural gas-companies. The electricity companies and the oil companies participated in the campaigns with limited success, but the natural gas-companies doubled in two years the yearly amount of solar thermal installations from 2000 to 4000, thanks to their very effective marketing.

This solar marketing filled in a big hole, since the weak point in the Danish development was absence of commercial sales companies (except the manufacturers), and since only a few of the installers were in possession of the necessary capacity and ability for marketing. The gas-companies co-financed the solar campaigns with nearly half of the budgets.

However, the engagement of the natural gas-companies in the field of solar thermal was not lasting for long, and relying on the special circumstance, that the companies could use a combined gas-solar offer as a idealistic 'lever' in a marketing process of stimulating potential customers to convert from oil or electricity to gas. Having used these residual possibilities to its limit, the involvement of the gas-companies in solar thermal marketing decreased.

A similar slight opportunism among some of the solar plumbers was seen in the years after, where 'boom' in kitchen- and bathroom installations persuaded a lot of the installers to do without solar installations. These two 'desertions' caused a very serious setback of the development, which moreover in 2002 had to suffer from the governmental cancelling of the grants to solar installations.

#### **3.6.5 Special campaigns**

Besides the regional and national campaigns special campaigning activities were carried out:

- 1.** Campaigns for medium sized and large plants. To these a sketch project scheme was established, making it possible for institutions and housing companies to get a sketch project for a solar plant without expenses. The projects were sketched out and economically calculated by a group of solar engineers, supported by DEA.

2. Nomination of Danish cities as 'Solar City of the Year'. Based on neutral recommendations the Renewable Energy Information Centre appointed in a period every year a city as Solar City, due to its solar initiatives.
3. Campaign for solar prepared tanks. This was addressed to the situations where old hot water tanks should be replaced quickly without the time to consider an installation of a solar thermal system. In such situations a part of the standard solar subsidy could be obtained, if a solar tank was chosen.
4. A special information campaign for renewable energy including solar energy in the schools was carried out in the 'Energy Forum of the Schools'.

### **3.7 Legal initiatives - solar thermal obligation in new buildings**

In 2000 the Danish Parliament passed a law about obligation to install solar thermal plants in most of the new buildings, if economically attractive – that is, if the value of the energy savings was comparable or lesser than the solar system costs.

However, the obligation was never carried out in practise as the new government cancelled the law by a new anti-law in 2002.

### **3.8 Results of the programme**

The total active solar thermal programme in the period of 1979-2003 resulted in nearly 40.000 solar thermal systems, corresponding to 350.000 m<sup>2</sup> collector area.

The development lasted more than 25 years, but only the last 12 years had the character of an actual organized programme.

The total amount of public means to solar thermal energy in the period of 1979-2001 was in round figures € 75 million, comparable to one third of the commercial costs of the installed solar thermal plants.

Around two thirds of the public funding were spent on grants, the rest were spent on R, D & D, quality assurance, information and campaigns

#### **3.8.1 Summary statistics:**

Year 2001:

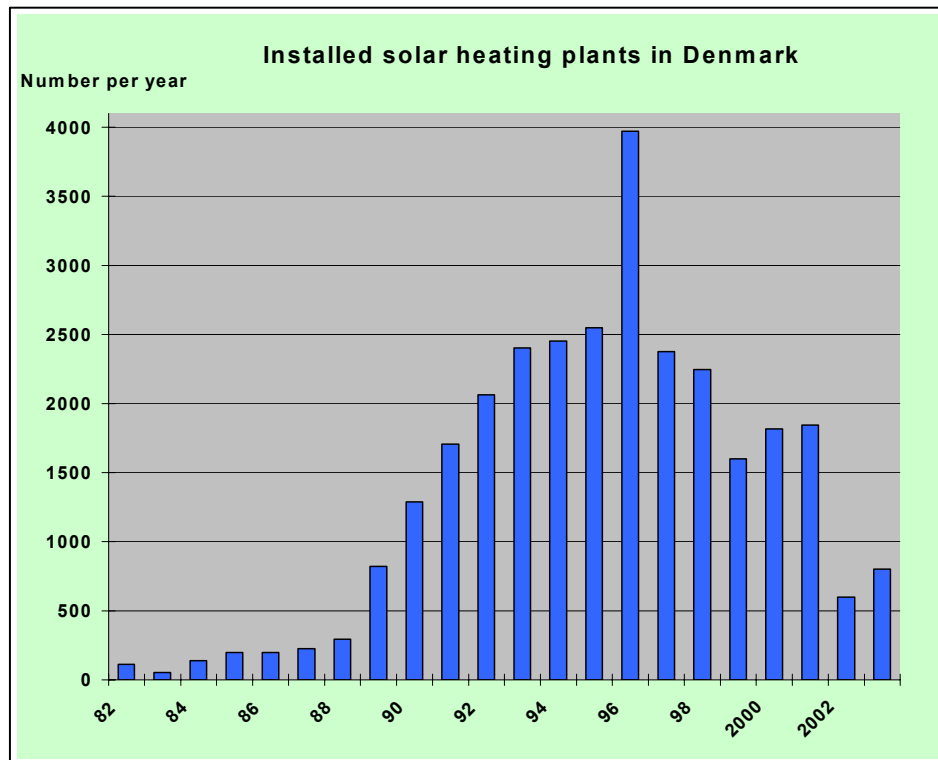
Inhabitants: 5,3 million

Solar collector area, cumulative: 259.000 m<sup>2</sup>

Solar collector area, cumulative per inhabitant: 0,049 m<sup>2</sup>

Solar collector area, installed 2001: 13.000 m<sup>2</sup>

Market trend: Declining



#### 4. The observed phenomena – descriptions and conclusions

The programmes of the Danish Government to introduce active solar heating systems into the market covered a number of different activities:

- R&D&D
- Economical subsidies
- A quality assurance scheme
- Information campaigns – regional and national and a
- Legal initiative

It can be concluded that the overall result of these programmes was a successful introduction of solar heating systems into the Danish market and with that a maturing of the Danish Active Solar Heating Industry that has lead to a situation where it is competitive on the international market – especially when it comes to the quality of products and systems.

The conclusions for the individual elements of the programme are stated below:

#### **4.1 R&D and Quality assurance scheme**

There was a close interconnection/synergy between these two parts of the programme and it can be clearly seen that the efficiency of the solar collectors and of the whole systems as well as the general quality of the components were greatly improved thanks to these programmes. To day, Danish collectors are top-quality products that are sold on the international market and Danish know-how is currently transferred to developing countries.

An internationally recognized collector and system testing laboratory was established at the Danish Technological Institute. But as the present government has withdrawn the support to the testing laboratory its annual turnover was too small to keeo it running and it has therefore been closed.

#### **4.2 Economical subsidies**

Active solar heating has difficulties competing on the Danish energy market due to relatively low energy prices and limited solar input. Therefore the subsidy was an essential part of the Danish programme as it boosted the Danish home market for the industry and installers. Again the present government has stopped the subsidy part of the programme and the sales of solar systems has dropped more that 50 % as a result of that.

#### **4.3 Information campaigns – regional and national**

The information campaigns has worked hand in hand with the other parts of the programme and has created a considerable awareness about the possibilities of active solar systems in Denmark and has thus created part of the demand for the systems. As most of the Danes are quite concerned with the economical payback of these systems – such awareness should and has in the past work in combination with a subsidy programme.

#### **4.4 Legal initiative**

The legal initiative that is described under 3.7 was never in force and it is not possible to draw any conclusions as to what effect it might have had. However, the very existence of the initiative made some builders consider the possibility of installing solar heating systems for new constructions and have these economically evaluated. Therefore it is quite likely that such a law would have had a positive effect on the sales of active solar heating systems in Denmark.

#### **4.5 The transferability of the observed results**

The barriers to large scale introduction of solar heating systems in Denmark are not much different to the barriers that can be observed in many other countries. It is basically questions about awareness, quality and economy of the systems that govern the situation. Also based on observations of parallel programmes that have been active in other countries, for example: Sweden, Austria and the Netherlands similar observations can be made and conclusions drawn.

#### **5. Recommendations**

Based on the experiences of this case study in Denmark a number of recommendations can be drawn up. These are categorised in two areas: political and research below.

##### **5.1 Policy recommendations**

- Financial incentives and subsidies are only effective when they are stable.
- The co-ordination of a large campaign with many different activities like training, marketing and promotion requires a strong central organisation that has the end responsibility on content and financial sides, and that assumes a co-ordinating role.
- Merely realising an investment subsidy for solar water heaters without taking other promotion measures has proven insufficient. In several countries, such subsidies are or have not been well used because of a lack of demand.
- Energy performance regulations for buildings, like the European Directive under construction, can be effective, but only when they are strict enough so that solar water heaters are able to fulfil the requirements.

##### **5.2 Research recommendations**

- In the long term, research and development remains an important driving factor to fully exploit the potential.

## PORTUGAL

# PEGO Coal Power Station and its impact on local and regional development

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        Assessment of the impacts in local public finance

        Assessment of the impact on society

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References

## Case study objective and scope

The scope of this case study is the impact at local and regional levels of a relevant project like a big energy infrastructure. In Portugal, two power plants are using coal to generate electricity. The more recent one (Pego coal power station) is the one chosen for the present case study.

Pego power station was build between 1988 and 1995, reinforcing the electric national producing system in response to the increasing of consumption in 90's and the necessity of energy sources diversification. Pego project was designed to receive four units of 300 MW each. Nevertheless, until now, only two units have been constructed and are operating.

In 1993 Tejo Energia, S.A. entered into an agreement with Electricidade de Portugal S.A. ("EDP") to own, operate and maintain the Pego Power Station for a period of 28 years. An international consortium bought the power station, introducing the private sector in a significant part of the electricity national production. Since then Tejo Energia became an innovation project (a joint venture involving four companies from different countries, United Kingdom, Spain and France), a reference in the world wide electricity

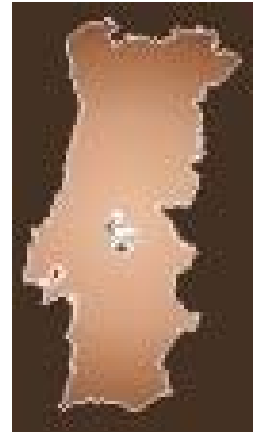


markets.

From the administration point of view, Pego power station occupies a site of 180 ha, close to the Tagus River, in the parishes of Pego and Concávada, a particularly rural area surrounded by an olive grove and a cork plantation, located in *Abrantes municipality* in the region **NUTS III - Médio Tejo** and **NUTS II - Centro**.

Pego power station became a reference place especially to local and regional schools, as well as universities (more than 7.000 people visit the power station in 2002).

In 2003 the Pego Power Station represented more than 10% of the total installed generating capacity in Portugal.



The present case study is a contribute to understand:

- how energy policy and infrastructures changes socio-economic territorial patterns;
- how investment in this type of infrastructure is translated into more favourable conditions of energy supply to industry and households;
- what are the relations between the development of this infrastructure and the growth of regional economy;
- how investors and households changes their behaviour in consequence of changes in the conditions of energy supply;
- what are the real degrees of regional disparities concerning access to energy;

To answer these questions the following research areas have been distinguished:

- environmental,
- demographic (structure and qualifications in labour market),
- economic (business activity, local finance),
- energy infrastructure, (technical, quality),
- social infrastructure (living standards).

This will give valuable information about the relation of this type of energy infrastructure to local and regional development, achieving the following objectives:

1. assessment of the impact of the infrastructure implementation,
  - a. assessment of the business activity growth and its influence on labour market

- b. the influence of the power station on the development of other activities, e.g. education
2. evaluation of the role and performance of local public authorities (municipality) in policy implementation,
3. evaluation of local energy infrastructure influence on the image and attractiveness of the municipality for potential investors.

## **Methodology and information sources**

The case study methodology is based on collection and analysis of relevant data. The main sources of information were the following:

- companies annual reports,
- regional studies,
- articles in local and national newspapers,
- official statistics.

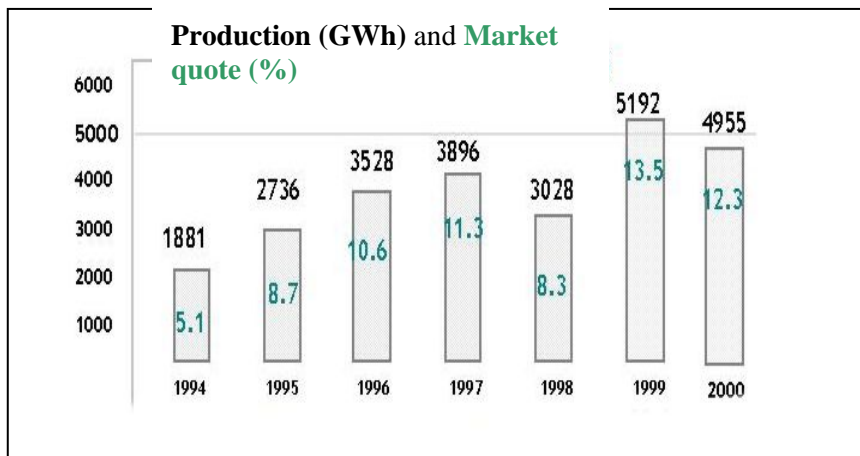
## **Actual and forecasted outcomes of the observed phenomena**

The research is based on the “historical” observations concerning the impacts of previous activities, as well as on forecasted outcomes.

### ***Actual outcomes***

PEGOP is the managing company of the Pego power station, and it constitutes the biggest enterprise group of the Santarém district, with a volume business-oriented of 258 million euros in 2003. The income tax (IRC) is about 20 million euros, which represents 26 percent of the total IRC in Santarém district and 80 percent of total IRC in Abrantes municipality.

In 2000 the Pego power station assures with two units (300 MW per unit) an annual electricity generation of 4.955 GWh, which represented approximately 12 percent of the total Portuguese electricity consumption in that year.



Source: Pegop, Energia Eléctrica, SA

The initial investment was about 848 million euros (direct technical costs at constant prices of 1988) not including financial costs. The national participation in the project was very significant, regarding to the engineering of conception and management of the project (EDP Portuguese electricity national company) as well as the metal national industry.

### **Assessment of the impacts in environment**

The power station generates electricity from pulverised coal through direct combustion. The coal used is mainly imported and transported by railway from the harbour of Sines (NUTS II - *Alentejo Litoral*) to the power plant, covering a distance of 320 km<sup>8</sup>.

The major burdens identified for this fuel cycle are the atmospheric emissions of pollutants from the transport and power generation stages, solid wastes from the power generation stage, and occupational and public accidents from the mining and transport stages. The most relevant impacts are those caused by atmospheric emissions from the power generation stage on human health and by global warming effects.

Nevertheless, in 1997 Pego Station gained ISO 14001 approval for its environmental

<sup>8</sup> In "Implementation in Portugal of the Externe accounting framework", CEETA, Portugal.

management system. This was an important step for PEGOP, the managing company, as the electricity industry worldwide attaches considerable importance to achieving and maintaining environmental standards due to the high profile associated with the burning of fossil fuels.

Since 2000 the company has an EMAS's registration (Eco-Management and Audit Scheme, which is a voluntary initiative designed to improve companies' environmental performance) having been the first company in Portugal to obtain this classification.

The station manager for Pegop observed: "The roll-out of the certification enabled us to demonstrate a thorough understanding of the issues and the actions we were putting in place to further increase our levels of environmental control. This has helped us to achieve a situation where the power station appears to be fully accepted as part of the surroundings. We have over 6,000 visitors annually to the site and it is very important that we can show them something of how we care for the environment in which we operate."

Environment studies had been carried through allowing a previously characterization of the place and its involving region to the beginning of the power station construction. It had been defined several measures of environment protection which were incorporated by the power station, to assure that the resultant environment impacts of its construction and exploration if kept below of the levels that the regulations application, as well as the knowledge of the characteristics of the involving region, had allowed to establish as permissible.

The control instruments had been established, which allow a permanent monitoring of the quality of the environment after the entrance in service of the first unit of the power station. The automatic measures of the pollutant emissions and of the parameters that characterize the atmospheric and the fluvial way, supply the necessary information on the evolution of the quality of the environment to the exploration of the power station and to the responsible entities.

The main objective of the previous study of environmental impact consisted in a systematic evaluation of the induced effect in the involving environment, having in account economic and technician factors of the project, as well as characterization data of environment and social environment.

Its results, proven per some years of functioning of the installations, had indicated that the global impact of the enterprise is not only compatible with the maintenance of demanding standards of environment quality, as also induces dynamic effects to the social and economic development of the region.

### **Assessment of the impact on job creation and local business activity.**

The approach adopted to estimate the effects on employment used statistical data on employment to estimate direct labour and input-output methodology to estimate indirect labour<sup>9</sup>.

In order to assess the impact on job creation, we distinguish between:

- direct employment (number of jobs that exist at each stage of the coal fuel cycle: mining, construction and dismantling of the power plant, transport of lime, gypsum, coal and ash and operation of the power plant)
- indirect employment (employment generated by the production of goods and services needed to build and operate the Pego power plant).

Although not completely quantified, the annual direct labour requirements of the Pego power plant are relatively substantial. They amount to more than 284 jobs equivalent per year. The impact in terms of indirect labour requirements is 33.486 jobs equivalent per year.

The installation of the Pego power station induced an intense search of construction materials, services (ceramic, hardened, inert, wood, transports, tourism, etc.), and workforce at local level.

During the construction the number of jobs was increasing until the 3rd year of construction, reaching a maximum that exceeded the 2.000 workers, having in consideration the staff of the contractors, sub-contractors and the ones of the national electricity company (EDP).

When exploration started more than 200 direct jobs were created in the region and some indirect jobs related to food services, cleaning, security, transports and conservation. In the last years the power station employed in average 114 people.

### **Assessment of the impacts in local public finance**

Regarding the evolution of some of local public administration finance items, after the power station began its exploration, the public investment in Abrantes municipality increased around 160% in the period 1995-1998, which reveals some dynamism in the local development, related to this infrastructure.

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<sup>9</sup> See previous footnote.

1995 -1998	Abrantes Municipality		Médio Tejo (NUTS III)	
	Variation	Average Anual Growth	Variation	Average Anual Growth
<b>Current revenue</b>	+40,9%	+13,6%	+30,8%	+10,3%
<b>Direct Taxes</b>	+72,9%	+24,3%	+54%	+18%
<b>Central Public Administration Transfers</b>	+24,8%	+8,3%	+22,6%	+7,5%
<b>Investment</b>	+159,8%	+53,3%	+114%	+38%

Source: "As finanças locais no distrito de Santarém. Estrutura e evolução entre 1995 e 1998". Governo Civil de Santarém.

### Assessment of the impact on society

Apart from production and distribution of electricity the company provides consulting and education services. Pego thermal power station has on-going community support activities in cooperation with a number of local organisations. The investments reveal a social responsibility inherent to the economic activity.

Notable projects include financial support to a care centre for the elderly and a care centre for children. Along with staff from Tejo Energia, Pego personnel have volunteered their time to facilitate the running of a summer holiday camp for a group of children suffering from Leukaemia and Aids. Activities have also included hosting a Christmas party for children from a local orphanage.

Besides being one of the biggest entities employers, the group of companies of the Pego's thermal power station has supported the improvement of the living conditions of the Abrantes inhabitants. The politics "has been to support the people most disfavoured, through the entities related to this activity". As all the production of the power station is sold, it is not necessary to invest in campaigns of marketing or advertising and this amount of money is canalized for the social support.

From the didactic point of view, the Pego's thermal power station constitutes an important centre in the region, having been increasing the number of visitors who annually visit it. Only in 1998, this number surpassed the 6500 visitors.

### **Forecasted outcomes**

The PEGOP, managing entity, was created five years after the entrance in functioning of the thermal power station that produces energy through the coal, and will go to invest

100 million euros in the acquisition of equipment sophisticated for the reduction of the gaseous emissions.

The energy production, integrally sold to the National Electricity Net (Rede Eléctrica Nacional (REN)), through natural gas appears as a new challenge. This alteration in the raw material will compel to the construction of two new groups of energy production. This project is being studied and it will have that to count on the new rules of the Iberian electricity market.

## **Transferability of the observed results**

The observed results such as:

- stimulation of business activity in the region,
- adaptation of professional skills and qualifications of inhabitants to the local labour market demand,
- growth in the number of people running private businesses (specially in service sector),
- higher living standard of rural communities,
- involvement with local community, at social level.

can be produced elsewhere in our overall project territorial scope. This phenomena is possible to be observed elsewhere.

If conveniently inserted in programs of regional development, a project of this nature can be inductive of progress and social and economic welfare, regarding the:

- Appealing to coordinating entities - Inter-ministerial Commissions of Accompaniment - that, for beyond the responsible agencies of the Central Administration for the licensing and the company that assures the power station exploration, they still involve the interested municipalities;
- Engagement in a continued politic of dialogue, clarification and information of the populations;
- Anticipated accomplishment of characterization environmental studies and evaluation of the power station predicable impacts;
- Decision to include in the project effective measures of environment protection and control.

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## **POLAND**

# **DEVELOPMENT OF BIOMASS-FOR ENERGY SECTOR IN POLAND**

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## 1. Case study objective and scope

The objective of this Case Study is to analyze the present state of development of the biomass-based energy production in Poland, to identify the existing barriers and the needs for stimulating further development of this sector, as well as to assess the impact of the programmes in this area.

The scope of the Study comprises the assessment of the impact of energy policy (local, national or European) on the development of the biomass-for-energy sector in Poland, evaluation of the role of local (self-government) authorities, assessment of the growth in biomass business activity and its implications for the labour market and for the development of other economic activities. From the end use perspective the scope of the Study covers the use of biomass for heating and power generation (and co-generation), as well as for biomass derived motor fuels. The gaseous biomass-derived fuels are not included in the Study due to their minor role at present and lack of actual field data.

Based on the information gathered, an attempt is made at finding a common denominator for the observed tendencies and phenomena. Common features, problems, success factors are identified along with the existing barriers and reasons for failures. Actual and forecasted outcomes and development trends of the observed phenomena are outlined. Potential transferability of the good practice examples is discussed and observations concerning measures that should be taken to avoid errors, which have led to failures, are given. Special attention is devoted to recommendations related to research aimed at optimization of the use of the biomass resources available in a given area.

The particular aspects are illustrated by selected representative examples, which are described in more detail in the Annexes. The examples address the issues of planning and implementation, barriers to and needs for further development and the environmental impacts of the use of biomass for energy purposes.

## 2. Methodology used and information sources

In designing this case study we had to bear in mind that the problem of the energy use of biomass cannot be treated consistently in an item-by-item manor. This basic observation follows from the fact that the final forms of biomass-derived energy compete to the same **limited resource in a given territory**, which basically is determined by: **(i)** available land area, **(ii)** soil characteristics and **(iii)** insolation and rainfall levels. Consequently, the Case Study is organized as a thematic (issue) account, rather than individual case analysis, although it includes also historical notes on planning and implementation of particular projects selected as examples for the Study. Depending on the particular example or issue the sources of information are: **(i)** own data, **(ii)** national official documents and reports (or other reports), **(iii)** laws and statistics, **(iv)** articles in local and national newspapers, **(v)** conference papers, **(vi)** professional publications, **(vii)** web sites, and information obtained directly from:

- Interviews with stakeholders (direct or telephone),
- Units of the local administration,

- District Heat Companies,
- Agriculture and Environment Protection Departments,
- Business sector (public and private, especially SMEs),
- Agencies for: Energy, Employment, Agriculture Modernization, Communal Development,
- Representatives of member communes and farmers in the area.

### **3. Description of the structure of the Case Study**

In the next Section a general geographical and historical background of the Study is given, including relevant, most important general statistical data. **Section 5** deals with the administrative division of the country, which provides important background information for the understanding of the Study. In **Section 6** the general legal framework related to Renewable Energy Sources in Poland is described to justify why biomass – one of the RES – has been selected for the Study.

A more detailed treatment of biomass as one of the Renewable Energy Sources (**RES**) is presented in **Section 7**, including political, legal, planning, financial and physical potential issues. **Section 8** is focused on the description of identified barriers as well as on the needs to promote further development of the Sector. The role of public authorities and involvement of private sector or capital investors (PPP ventures) is discussed. A separate important issue dealt with is integration of fuel conversion from fossil fuels to biomass with energy efficiency measures on the demand side, which is addressed in **Section 9**. Section 9 describes also the problems associated with co-firing biomass with coal, a tendency that has exploded recently in Poland. **Section 10** is a case study of a failed political initiative to promote liquid biofuels for motor vehicles. **Section 11** summarises the results of the Study and gives suggestions for overcoming the existing barriers to the development of the biomass-for-energy sector in Poland. It contains discussion of: **(i)** actual and forecasted outcomes and development trends of the observed phenomena, **(ii)** potential transferability of the good practice examples, **(iii)** recommendations concerning measures that should be taken to avoid errors, which have led to failures. Special attention is devoted to **(iv)** policy recommendations concerning local energy planning and **(v)** recommendations concerning research aimed at optimisation of the use of the biomass resources available in a given territorial area.

The Study is supplemented by concrete examples illustrating the particular issues raised earlier. For the sake of clarity these are presented separately in Annexes 1- 5.

## 4. General political background and historical note

### 4.1 General information about Poland

Poland is situated between the Baltic Sea in the North and Carpathian Mountains in the South. Polish climate is temperate: the yearly temperature average is about +7°C. In winter, the average is about –8°C and in summer about +15°C. These averages have varied over time: between 1951 and 1995, maximum temperatures ranged from +30.7°C to 38.0°C, while the minimum temperatures from –18.2°C to –35.4°C. Therefore, the use of energy for heating is one of the major problems.

The population of Poland is approximately 39 million, which gives the population density of ca. 125 persons per square kilometer. There are approximately 12.5 million households with 61.7% of the population living in cities. Forests cover 28.1% of the country (remarkably: the forested area has increased from 27.7% over the past 10 years, as a result of a continued, planned effort). Farmland constitutes 59% of the country area, which gives 0.38 hectares per capita - much more than that of EU15. The average farm size is only 5,76 hectare; while in large parts of the country it is still smaller (e.g. in Malopolska, a Southern province, it is merely 2,1ha).

The Polish economy has grown in 2003 at an annual rate of 4,5%. Per capita GDP is estimated at 4500 USD, which constitutes only 42,5% of the EU-15 average. Unemployment remains at a high level of around 20%, and is particularly high in rural areas; this is exactly where the potential for biomass production is the greatest and its wider use for energy production could create new jobs.

### 4.2 Historical note

In 1989 Poland initiated the political and economic reforms in the former Soviet bloc.. The political and economic transition in Poland, which led to this reform, began in 1980 with the peaceful revolt of the Polish shipyard workers in Gdansk, which ended on August 31, 1980 with creation of the independent trade Union “Solidarnosc”.

In the wake of the victorious emergence of “Solidarnosc”, first independent environmental NGO, the Polish Ecological Club (PKE), was established in September 1980, which began campaigning for a cleaner environment - a topic that had been a taboo in all communist countries before then. Based on early PKE achievements (e.g. closure of the Aluminium Plant in Krakow, contribution to cancellation of the nuclear programme) it is worth mentioning that the role of the environmental NGOs was no doubt significant in the initial phase of the transition. Unfortunately, their significance decreased with time, yielding influence to **powerful businesses and media** for which the environmental issues are often of a secondary (if any) importance. Also the public opinion, which considered the environmental pollution as one of top priority issues in early eighties, has become gradually much less interested in this issue, as unemployment, crime and other compelling problems became dominant.

The dominance of energy intensive, heavily polluting raw material industries was ingrained in the official ideology. The extensive industrial development had led to a lavish use of energy. Even stable imports of gas and oil from (then) the Soviet Union

and abundance of domestic coal were not sufficient to meet the demand; power shortages were commonplace.

The fossil-based energy was heavily subsidized, and no motivation existed for increasing energy efficiency or looking for alternatives offered by renewable energy sources. With the transition to a market economy and with withdrawal of most of the subsidies, the energy prices increased by nearly one order of magnitude. In early 90-ties most of the energy intensive industries drastically reduced their output or collapsed; other improved their energy efficiency. Consequently, the energy shortages soon turned into oversupply. This situation has remained till present as regards electricity and gas supplies, which is an important factor when considering the use of biomass for power generation in particular.

In 1989 the first non-communist government cancelled plans made before 1980 to build nuclear power plants. The program has not been resumed until present and Poland remains nuclear free, which is another important factor for the development of RES in the long-term perspective.

### 4.3 Primary Energy Structure and the Environment

As a result of the price increases the energy intensity of Poland's economy improved significantly as illustrated in Fig. 1. The main mechanism, which induced this change, was market force. The economic necessity has lead to increased energy awareness and development of businesses offering services such as thermal insulation of buildings. Other instruments (legal, financial support), however important, seem to have played a rather secondary or supplementary role.

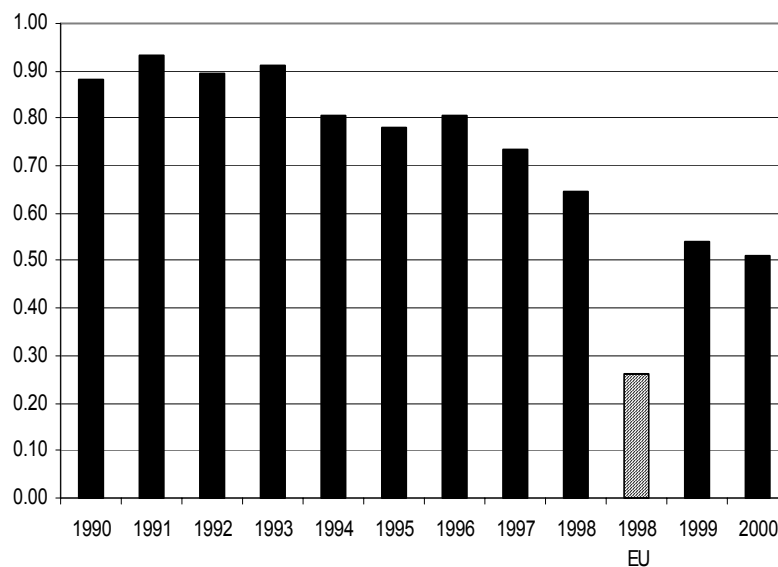


Figure 1, (primary) energy intensity of GDP in Poland [kgoe/000\$]. Source: Current situation in energy sector, Ministry of Economy, <http://www.mg.gov.pl>; European Union Energy & Transport in Figures 2001, European Commission in co-operation with Eurostat

The development of renewable energies was much slower, as the price-stick couldn't be applied here and there was very little or virtually no money for carrots.

The Polish economy still relies heavily on domestic coal, which provides 64,6% (c.a. 3 times more than in OECD countries) of primary energy, despite dramatic reduction of its output (from 76,2% in 1990). Oil and gas contribute 32,5%, and other sources,, including RES, contribute the remaining c.a. 2,9%.

In fact, Poland has only very scarce deposits of gas and oil. In addition, the potential for hydropower and wind energy is relatively small. Consequently, power generation and space heating (to a somewhat smaller degree) are almost entirely coal-based. This places Poland high on the list of per capita air polluters, with 8.74 tones per capita in 1998 which is the baseline year for Poland's Kyoto commitment.

## **5. Administrative structure of the country, responsibilities**

Before the transition in 1989 there were two-levels of the territorial division of the country: the basic unit, *gmina* (commune or municipality) and *województwo* (or province). There were above 2500 municipalities and 49 provinces. As for a country of nearly 40 million people and 312 thousand square km, the provinces (*województwo*) were too small to play any essential role in politics, in particular in the regional development planning. The communists replaced the traditional (pre-World War II) three-stage division of the country (commune, county, province) by the two-stage one with the aim of strengthening the authoritarian rule of the Communist Party. With the political transition in early 1989, a long and heated discussion began which finally led to returning to the three-stage administration system in January 1999, with 16 provinces, over 300 *powiats* and above 2500 *gminas*.

The local and regional administrations were given significant autonomy, in particular in the planning area, including energy planning. However, this devolution of power and responsibilities has not been sufficiently matched with the ability of the local governments to finance the new tasks. In case of energy, apart from the national level issues (international contracts, high voltage grids etc), energy plans to secure energy supplies to the local residents and industries were made the responsibility of the lowest administration units, the *gminas*.

By this virtue, the role of the local administrations in Poland's fulfilment of its international obligations related to the global environmental threats increased immensely. However, at such a low level, neither the expert potential nor financial resources to produce reliable forecasts or assessments are usually in place. This is a serious obstacle for a rational development of Renewable Energy Sources in particular.

## **6. Policy framework for renewable energies in Poland**

The legal framework for the promotion of Renewable Energies has been established as a component of Sustainable Energy Development by the Energy Act of April 10<sup>th</sup>, 1997. The Act entered into force in January 1998 and it still remains the main legal document in the field of energy in Poland.

The Act defines the principles of the national energy policy regarding the supply and use of energy, as well as concerning operation of energy enterprises. It also defines which agencies have jurisdiction over the issues of fuel and energy economy.

The purpose of the Act is to create conditions to provide energy security, rational use of energy, and the development of competition. It also defines the conditions of conducting economic activities in the energy sector, imposes certain obligations on economic entities, and guarantees certain rights for them. Since 1998 the Energy Act was updated several times. The most recent and major amendment was done in July 2002 and the changes entered into force in January 2003.

Both basic components of energy sustainability: Energy Efficiency and Renewable Energy Sources are addressed in the Act as important factors in energy planning and policy-making. As far as energy planning is concerned the Act stipulates that the main authority responsible for national energy planning is the Minister of Economy, while energy utilities and municipalities are obliged to prepare plans for energy supplies in their respective service areas.

As mentioned before, the improvements in Energy Efficiency have been driven primarily by the price signals, which provided sufficient economic motivation without the need to refer to additional financial support (state or foreign). However, in the case of Renewable Energies this has turned out to be not sufficient or even possible. Thus, unlike energy efficiency, the driving factors of the development of RES have been so far Poland's international obligations related to Climate Change. This emphasizes, in particular, the significant role and impact of the EU legislation and accession requirements on Poland's policy making and – as a consequence – on the progress achieved in the development of Renewable Energy Sources.

Poland signed the UNFCCC in 1992. The ratification procedure was completed in 1994 and Poland became party to the Convention. The Kyoto Protocol was signed in July 1998 and ratified in 2002. Poland's commitment was a 6% reduction of GHG emissions related to 1988, which - as trends indicate - is likely to be achieved or even exceeded.

The main legal framework for RES is the *Development Strategy of Renewable Energy Sources*, adopted by the Polish Parliament in 2001. The *Strategy* sets a goal to increase the RES share in Poland's primary energy balance from the present ca. 2.5% to 7.5% in 2010 and 14% in 2020. The goal is ambitious and achieving it will not be easy. The problem is huge costs of the investment needed to achieve these targets, which is the main barrier to a wider use RES.

## **7. Importance of biomass as RES in Poland**

Poland is not particularly rich in Renewable Energy Resources. Estimates given by different authors vary widely. It is rather understandable, as the estimates are strongly dependent on the cost threshold assumed.

Poland is a predominantly flat country; consequently it possesses rather little hydro-energy potential. The same applies to wind with the exception of the Baltic coast or offshore sites. Geothermal potential is significant, but investment costs prevent any fast progress in this area in the foreseeable future. Solar potential is moderate, typical for this geographic latitude.

**The dominant Renewable Energy Source is biomass, which will constitute up to 85% in the RES mix in Poland in short and medium term.**

Due to its local character, biomass is an important factor for social, economical and spatial development of individual regions. It may play a very important role, particularly in areas where access to the central gas grid does not exist or is limited. Biomass for energy production is of a particular importance for rural areas, where unemployment rate is usually high. The bioenergy business may create jobs and provide income to the local population.

This, in particular, concerns the dedicated energy plantations, such those of fast growing willow copies (*salix viminalis*). With insufficient domestic demand for nutrition crops and decreasing exports, about 2 million hectares of agricultural land are not used at present. Additionally, as mentioned above, the per capita area of farmland is almost four times higher than in EU. In this situation the energy plantations provide a very attractive alternative, which may **create jobs and provide the much needed income for farmers**. For example, the estimates obtained from the *salix viminalis* plantation owners (sample: total area of ca. 1200 ha) show that on average **1 person full time equivalent employed is created per 10 ha** of the plantation. The assumption is that at least in the near future the work will be done manually, which is justified by the present rate of unemployment in rural areas and cost of labour.

The relative importance of different Renewable Energy Sources in Poland and their present use are illustrated in Tables 1 and 2 and Fig. 2. It is seen that the dynamics of the growth of straw based District heating systems is remarkable, which illustrates the success of the Polish policies in support of biomass. This statement would be most likely questioned by those doing business in the bioenergy sector in Poland. Still, one should admit that the existing financial support schemes have a positive impact on the development of bioenergy in Poland, while the legislative solutions at least do not hamper the initiatives. The exception is the failed attempt of the Polish Liquid Biofuels Act, which is described separately in Section 10.

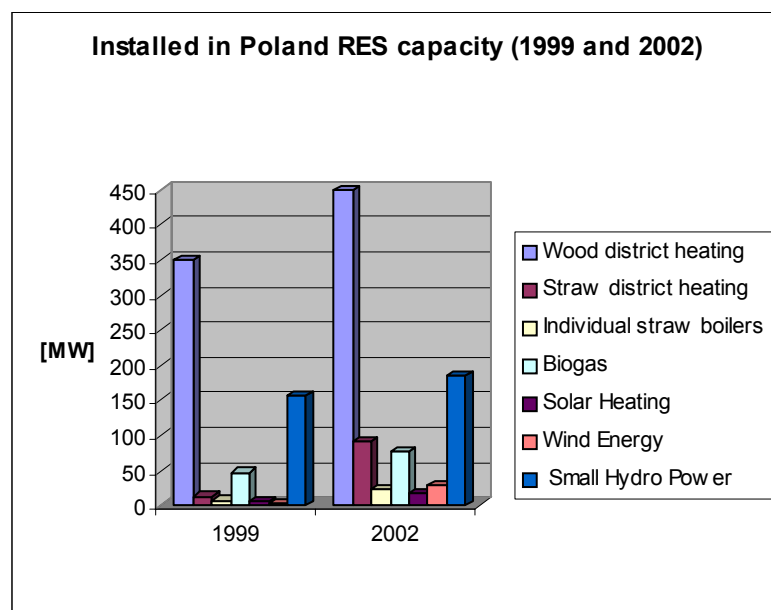


Fig. 2. RES installed capacity in Poland in 1999 and 2002



As can be seen the potential of biomass is quite significant. However, its wider use faces several important barriers, which are discussed below together with description of the support schemes for promotion of the energy use of biomass.

**Table 1. Estimated potentials of RES in Poland and their present use [derived from Wisniewski, ECBREC 2004]**

RES	<u>Total potential</u> [PJ]	Total production 2002 [PJ]	Percentage of total production [%]
<b>1. BIOMASS (total)</b>	<b>891,6</b>	<b>107</b>	<b>97,83</b>
2. Solar Energy	1 500	0,03	0,08
3. Wind Energy	50	0,05	0,41
4. Small Hydro Power	40	2	1,68
<b>Total RES</b>	<b>2 681,6</b>	<b>109,3</b>	<b>100</b>



Fig. 3. Territorial distribution of straw available for energy production in different provinces.

For illustration Fig.3 shows the distribution over different provinces of the straw potential [thousand tonnes] that could be used for energy production (1999/2000). As can be seen the distribution is rather uneven, which means that the RES policies should be adapted to the regional conditions.

**Table 2. Installed RES capacity in 1999 and 2002 [Wisniewski, ECBREC 2004]**

RES	Installed capacity 1999 [MW]	Installed capacity 2002 [MW]	Incremental rate [%]
<b>Wood</b> district heating	350	450	29
<b>Straw</b> district heating	13	92	<b>610</b>
Individual <b>straw boilers</b>	~ 7	~23	~229
Individual <b>wood boilers</b>	?	?	?
<i>Biogas</i>	48	77	61
<b>Solar</b> Heating	6,5	17	166
<b>Wind</b> Energy	4	28,5	612
Small <b>Hydro</b> Power	156	184,9	25
<b>Total RES</b>	<b>584,4</b>	<b>872,3</b>	<b>49</b>

## 8. Barriers vs. Support

There are several factors influencing the growth of the bioenergy sector in Poland. The most important of them are:

- (i) investment costs,
- (ii) technology
- (iii) local expert potential,
- (iv) structure of farming
- (v) institutional solutions
- (vi) (energy/environment related level of awareness and knowledge of the decision-makers

The particular factors are discussed below with the emphasis put on the existing barriers hampering the growth of the bioenergy sector on one hand, and the support schemes on the other.

## 8.1 Investment costs

As mentioned above the remarkable improvement of energy efficiency of Poland's economy has been driven primarily by the energy price shock of early 90-ties. The high prices have on one hand made people to save energy by reducing the level of energy service and, on the other hand, they made the industries (and individual people as well) to invest in more efficient equipment or in insulation of buildings to decrease the energy demand.

The situation was different as regards Renewable Energy Sources. Economic motivation without additional financial support (state or foreign) has turned out here to be far from sufficient. Conversion from coal to biomass was usually much more expensive than continuing exploitation of the old inefficient coal boilers. As coal was becoming more and more expensive, individual people living in areas with available logwood started increasingly using wood to minimize the purchase of coal. However, they still continued using their old inefficient coal stoves or furnaces. With decentralized coal sales (individual deliveries by lorries) it is difficult to assess, even approximately, the extent of this phenomenon (use of wood in individual farms or households in rural areas).

It should be admitted that the investment cost barrier has been relatively well addressed by the existing domestic grant and soft loan schemes. Over the past decade the main sources of financial support have been the National Fund for Environmental Protection (NFOS) and its 16 provincial branches (WFOS). Their revenues come predominantly from the environmental fees and penalties paid by industrial enterprises operating in Poland. Both subsidies and soft loans have been granted, the latter being channelled largely by the Bank of Environmental Protection (BOS). In 1989-2000, NFOS alone disbursed 710 million USD in support to air pollution reduction measures (SO<sub>2</sub>, NO<sub>x</sub>, particulates, efficiency). The other important source is ECOFUND, which distributes the debt-for-nature swap money (eco-conversion of Poland's debt to the Paris Club). The policies of these funding sources differ in details, however; support is given primarily to public institutions (municipalities in particular). For example, ECOFUND supports projects only by grants in the implementation stage, i.e. it does not provide finance for project preparation or documentation. During the 10 years of its activity (1992-2002) ECOFUND distributed nearly 230 mln USD in environmental protection projects, which generated projects' total of 1250 mln USD. In recent years increasing emphasis is put on RES projects, which were supported by a total of 32 mln USD in 2002 alone. The role of biomass has significantly increased in their funding over the past few years. **The "hardware oriented" policy of ECOFUND and NFOS/WFOS (the latter provide money also for design), is no doubt a very effective way of supporting the fuel conversion or new biomass projects.** This should be confronted with many foreign (including EU) assistance schemes. These often seem to put (too) much emphasis on "soft" projects, which involve more routine consulting services than innovative engineering work. Too much money seems to be spent on soft ("report oriented") projects, which end with documents that get outdated before they manage to be implemented. An example is given in Annex 3. This observation does not apply to projects, which are directed to concrete, demonstration-based training of decision-makers and at research aimed at technological development or adaptation of existing

technologies to given local conditions. The latter should include also the design of the projects of a genuinely innovative character, which could not be financed otherwise.

One should mention, however, that the aforementioned domestic schemes (ECOFUND or NFOS/WFOS) also misspent some money, as far as promotion of biomass is concerned. Both schemes included initially a substantial support for conversion from coal to gas or oil in space heating, with the aim of decreasing local air pollution from individual inefficient coal stoves. Such support was, no doubt, justified in urban areas. Unfortunately, it was also used to build gas grids in areas with scattered settlement structure. From the environmental perspective this support has been rather counterproductive, as in those mostly rural areas the biomass potential is usually sufficient to replace large fraction of coal used for heating. Moreover, the ability of the individual investors to finance the gas or oil installation, often did not match their ability to pay high bills for the new fuel, as the prices of these energy carriers increased significantly afterwards. Consequently, many people who had not dismantled their coal stoves (old, inefficient and polluting) started using them again as their primary heat source. In some cases, alas rarely, gas or oil boilers have later on been replaced by the biomass ones. One could expect many more such “reverse” fuel conversions, would ECOFUND or the NFOS/WFOS have included them in their subsidy portfolios. Unfortunately this is not the case as yet.

Another tool to address the cost barrier is the **effect of scale**. Considering the structure of the agricultural sector in Poland, where small and medium-size farms dominate, there exists a huge market for biomass boilers of low-to-medium capacity (25-300 kW) for straw or wood in various forms (logwood, chips, industrial or forest residues, willow from energy plantations, etc). The estimates give a potential of ca. 400 000 units, which could be installed countrywide in individual farms. The first pilot project of this kind has been developed in the commune of Trzcianne in northeastern Poland, where 41 small individual boilers and 3 larger ones have been installed in a single project. The transaction costs, project design, shipment of boilers and costs of boilers themselves have been significantly reduced. The support to the hardware component was given by NFOS and the regional WFOS in Bialystok. Small Grants Programme of the Global Environment Facility (GEF) contributed to the design of the project taking into account its innovative character. It should be noted that the biomass fuel for these boilers would be locally produced (mostly auto-produced). This will:

- lower the energy bills of the users
- create local jobs as installation and maintenance is left to local companies
- boost countrywide the SME businesses involved in boiler manufacturing, especially if the “400000 program” is launched successfully.

In fact the phenomenon of the latter development has already been observed also for industries larger than SMEs. Annex 1 gives the list of companies which developed their business in biomass boilers in the wake of the growing interest in renewable energies observed in Poland in the past decade.

## 8.2 Technology

Technology itself does not constitute any more any significant barrier. As far as the traditional – even advanced – solutions or designs are concerned, there exists sufficient engineering potential (both design and manufacturing) to meet the existing and development needs (the latter holds under assumption that the potential will grow as the market grows). As far as the emerging advanced technologies are concerned (e.g. fuel cells using biogas or syngas) there are also highly qualified scientists who would be able to lead practical development in these areas. Progress in these fields will be most likely achieved as a result of a common Pan-European effort.

An important observation seems to be that the experience (at least the Polish one) indicates that the **progress cannot be achieved by relying on market force alone. Market is an important player, provided its signals are based on scientific research and demonstration.** Business – especially SMEs – is too often driven by fashions and power of advertising, instead of well scientifically grounded data and information. A good example seems to be provided by the “rat race” to invest in *salix viminalis* plantations in Poland (see Section 9.2).

## 8.3 Structure of agricultural sector – the PPP option

As it has been mentioned in Section 4.1. The average farm size in Poland is only 5.76 ha, while in some parts of Poland it is still smaller. This structure will certainly change in favor of bigger farms; however, it will take time. This observation constitutes an important factor when one considers the domestically grown biomass as a source of energy. Small farms taken separately cannot produce biomass on an industrial scale. Organizations of producers need to be created. This – of course - applies to all kinds of agricultural production, biomass-for energy including. Attempts of such initiatives are observed, but the scale of the phenomenon is very small at present.

A special case is biomass used for energy purposes locally (self supply or local supply to meet the local needs). Straw as by-product of cereals production is particularly important. Small farms do not provide sufficient economic stimulus to convert from coal to biomass. As a result a widespread practice of burning the post-harvest straw in the fields is observed countrywide. Apart from environmental damage, such practice means tremendous waste of the precious clean energy resource.

One way to solve the problem is the approach used in Trzcianne, which was described above. It basically relies on self-supplies. However, the size of farms in a given area varies largely. Consequently, some of them may have surplus biomass, while the others may need supplementary supplies. Moreover, the situation may be different in different seasons, due to weather conditions, disease or mix of contracted crops.

In typically agricultural areas the total potential of the residue biomass exceeds the total individual demand and the surplus can be sold to the neighbouring, municipalities (cities or housing establishments). There are already numerous examples of such arrangements. One of them is described in more detail in Annex 2.

Yet one more factor needs to be taken into account: In rural areas with a compact settlement structure it may be more cost-effective to make a common District Heat (DH) investment instead of investing in hundreds of individual boilers. Such solution would

increase the comfort of the consumers and create local jobs. An example of such an attempt is described in Annex 3 (project in Podhale).

The project in Podhale is an example based on creation of a local public-private company; a Public-Private Partnership (or PPP) venture of the involved municipalities and a capital investor. The biomass there is wood waste produced by ca. 900 small timber mills and wood-processing workshops scattered over an area of ca. 10x20 kilometres. These are rural communities where small wood-processing industry supplements (and gradually replaces) the farming activity. The surplus wood waste that is not used by the producers themselves for heating or timber drying is dumped in unauthorised landfills, riverbanks or roadside ditches. As in the case of straw, precious energy resource is wasted and environment (especially rivers) is polluted. The “topological” structure of the problem is exactly the same as for straw. Consequently an organisational solution found for agricultural waste will apply in this case too (or vice versa). Moreover, the same “topological” feature and possible solution applies to organic waste (manure and slaughter house residues).

The possible structure would be that of a co-operative or Ltd. Company. The latter would preferably be a PPP venture, as it would help solve the problem of access to capital and involvement and control function of public bodies. One should note that, there is practically no positive tradition of co-operative ventures in Poland, the more that the forced introduction of them by the communist government after World War II and the economic failure of that move, have created a psychological barrier that will be not easily overcome. One may conclude that taking into account the structure (small size farms) of the Polish agriculture and the above-mentioned factors, **creation of PPP based local biomass markets seems to be a very appropriate solution.**

#### **8.4 Local expert potential**

Having said in Section 8.2 above that there is sufficient engineering (design and manufacturing) potential to develop bioenergy technologies in Poland, it should be noted that it is not matched by the potential of local experts who would be able to introduce RES options into the local energy development plans, oversee their implementation and supervise management of such projects. The importance of this problem follows from the Polish Energy Act of 1997, which delegates the preparation of local energy plans for heat, electricity and gas supplies to the basic territorial units, the *gmina*. The general planning principles are defined by the *National Energy Policy until 2020 Guidelines Act* of 2001, which highlights the importance of renewable energy sources and energy efficiency in the local energy planning. However, in the majority of rural or semi-rural areas there are no experts who would be sufficiently trained in technological, environmental or economic aspects of RES. In this situation the plans are most often done in a “traditional” way, i.e., with giving little or no consideration to biomass or energy efficiency (DSM) actions.

Another related factor, hampering the introduction of biomass options into the local energy plans is the competition of gas and oil. The ‘marketing power’ of gas and oil boiler dealers or installers greatly exceeds that of their biomass counterparts, especially at the local level. The experts - if hired by the municipality - most often line up with the oil or gas lobby and give no attention to the use of RES. **Biomass is given due attention practically only when the mayor and/or important local decision-makers**

**possess sufficient own knowledge about sustainable energy options. Most of the successful biomass projects were realized in *gminas* where at least some of the important local decision makers underwent relevant training.** This emphasizes the need to continue and enhance education and training effort targeted at local decision-makers such as the TEMPUS Project described in Annex 5. Unfortunately, the local administrations are preoccupied by other problems, such as health care or unemployment and are not anxious to spend their limited financial resources on training related to sustainable energy. The programs, such as TEMPUS, were successful primarily due to the external funding. An example illustrating the need of continuation of such projects is the fate of the plan to train forestry administration people in modern energy oriented forest management and establishing fast growing tree plantations, which are also described in Annex 5.

**The availability of local experts and awareness of local decision-makers becomes particularly important when it comes to the use of the Structural Funds where production and utilization of biomass for energy production should be included as a very important component.**

## **8.5 Biomass in local energy planning**

At this point it is important to note that the lowest level administration units (*gmina*) is usually not an optimum size for local energy planning, especially as regards inclusion of the biomass option. The majority of *gminas* in Poland are rural or semi-rural, where – as mentioned above - there are no people who would be sufficiently trained in the area of RES (or Energy Sustainability in general), as far as the technological, environmental or economic aspects are concerned. The financial resources of the municipalities are as a rule scarce or very scarce so that doing the necessary research, which most often requires hiring external experts, creates a significant burden for their budgets. Hence, municipalities face a difficult task, because neither the expert potential nor the financial capacities are usually available locally. Moreover, it should be mentioned that – although the preparation of such plans is mandatory by law – the deadlines for completion of this task have not been set. Consequently, so far, only ca. 10 % of the municipalities have prepared the mandatory plans. Unfortunately, due to the lack of sufficient knowledge about the RES or energy efficiency potentials and technologies, such plans are most often done in the “traditional” way, i.e. without giving consideration to any DSM actions or elimination of fossil fuels by RES. The latter, if taken into account at all, usually boil down to plans to eliminate coal boilers by switching to grid gas or heating oil, which is an obvious misunderstanding. This is usually seconded by intensive marketing of such equipment by dealers and installers, as well by a supportive attitude of the Gas Distribution Utilities. Also, the external experts, once hired, often line up with the oil or gas lobbies and no insufficient attention is put to use of RES.

Energy utilities are also obliged to prepare their own plans for energy supplies. They have to make them available (free of charge) to the municipal administrations in their respective service areas. Optimally the plans should be developed in cooperation of both, the utilities and the municipalities. However, the utilities are rather reluctant to purchase expensive RES-energy, basically because it is in conflict with their business policy. Power utilities and producers have to secure certain mandatory fractions of “green electricity” which has led to a dramatic increase of interest of power generators

in buying wood chips for co-firing with coal (see Section 9.2). On the other hand, District Heat Utilities are obliged to buy any offered green heat. However, the obligation applies only if such purchase doesn't lead to deterioration of their economic performance indicators. This can hardly be denied if the DHU claims so. In order to avoid the potential conflicts between a municipality, which may be interested in using local biomass for heating, as a representative of local biomass suppliers or heat consumers, a strong instrument has been given to municipalities. If the energy development plan prepared by the local energy utility does not meet the guidelines of municipal energy development, the municipality mayor (or president) is in charge of preparing their own plan, based on the guidelines set forth by the municipal council.

According to the Energy Act, the provincial governor reviews the compliance of local energy development plans with the national energy policy. Additionally, co-ordination with the plans of other municipalities in the province should be assessed by provincial administration. However, in case of RES and DSM, co-ordination hardly exists in practice. Moreover, even if such co-ordination were attempted, the province level would not be relevant to the sustainable energy part of the plans for reasons described below.

As mentioned above, energy planning at the basic territorial units level has been so far rather ineffective. Moreover, for such small territorial level the production and use of biomass cannot be effectively optimized: some of the neighbouring *gminas* may have surplus (or potential surplus) of biomass, while the other may have too little. Besides the lack of financial capacity and know-how, it is difficult to coordinate the actions among municipalities (*gminas*) if plans are made independently. On the other hand, Polish provinces (*województwo*) are territorially too large and inhomogeneous for such planning to be effectively harmonized, as the topological and agricultural conditions, potential resources, settlement structure and development priorities differ in different parts of the same province. **In the present administrative structure, the most appropriate level seems to be the level of *powiats* (counties) or groups of several neighbouring ones with similar or complementary characteristics. Such a scale of planning of the use of RES would, in particular, facilitate the cost-effective allocation of surplus biomass from the production area to the communes where the demand is higher than the existing potential. Thus the effective solution would be to bring the co-ordination down to the county or NUTS3 level (groups of counties) and bring the local planning to same level from *gminas*.**

One should note that in the future such territorial units for energy planning might comprise counties or municipalities neighbouring across the national borders. An example of such an initial attempt was the *"Strategy for the Use of Biomass in the Polish-Slovak Border Region with Emphasis on Wood Waste"* developed jointly by "Biomasa", Association of Slovak Municipalities, and the Krakow Institute for Sustainable Energy in 2003.

#### 8.6 Energy awareness of local decision-makers

The environmental awareness of local decision-makers (elected representatives and executive officers alike) related to energy production and use, is of crucial importance for re-orienting the present non-sustainable energy management patterns towards more environmentally oriented ones. In Poland the average level of energy-environmental awareness of local decision makers is still highly insufficient. However, it must be admitted that the situation has significantly improved over the past decade. It should be



largely attributed to the variety of training and education projects supported by the NFOS and other sources such as the EU TEMPUS Programme, German Marshall Fund of the US and other American or European organizations. From the point of view of the development of RES, the most important target groups were the representatives of the local administration and Small and Medium Size Enterprises. Many examples can be given of the implemented projects, inspired by such training and education efforts. One should note, however, that the 4-year term in office of the local government is often not sufficient to close the investment cycle. It happens that a good biomass project is cancelled by the new mayor or municipal council, often for political reasons rather than based on its environmental or economic merits. **Therefore the awareness-raising and education effort targeted at local decision-makers should be a continuous process.**

One of the factors, which generated the interest of the local administrators in RES, has been the planning obligation imposed on the local authorities by the Energy Law of 1997, through its emphasis on renewable energies and energy efficiency. This factor should become interested in the issue, was the financial support schemes for energy efficiency, such as the Thermal Renovation Fund on one hand, and grants or soft loans for RES provided by ECOFUND or the National Fund for Environmental Protection and its provincial branches. One should note here that the support schemes once driven only by simplified financial considerations, have sometimes led to counterproductive results from the point of view of RES, as illustrated above by conversions to gas and oil. In this situation, the awareness raising effort of an educational character is very important and needed. Such an effort can produce particularly good results if it includes visiting the working demonstration sites, as is illustrated by the impact of training courses addressing the issue of on Sustainable Energy Development organised for Polish local decision makers within the TEMPUS Programme (see Annex 5).

## 9. Particular issues

### 9.1 Integration with energy Efficiency

Although energy efficiency of Polish economy has substantially increased since 1990, Poland's energy intensity still remains higher by a factor of c.a. 2 compared with the EU-15 average. The energy saving potential is especially significant in the space-heating sector. A fundamental question that arises when policy of supporting biomass is considered is why such schemes should be used for supporting also losses of energy (heat or electricity) derived from RES. Most of the support schemes (Polish, EU or other international) address the two issues separately, while the logic would indicate that **the RES investments should be integrated with energy efficiency improvements to the greatest possible extent.**

In Poland the very successful GEF-IFC Project "Polish Efficient Lighting Project, PELP, (promotion of Compact Fluorescent Lamps) implemented in 1996-1998, preceded the green electricity promotion scheme (mandatory quota) introduced in 2001. However, as the recent experience shows there is still ample room for increasing the efficiency of the end-use of electricity that should be harmonized with the green electricity drive. **Market**

**signals will not solve this problem in the deregulated electricity system.** A regulatory solution has to be devised,

In 1999 the Krakow Centre of the Polish Foundation for Energy Efficiency (FEWE) suggested an idea of an integrated approach to space heating and shaped into a project together with the AGH-University of Science and Technology (see Annex 3). Conversion of ca. 6 MW from coal to locally produced wood waste was to be integrated with low-cost thermal retrofits of the buildings that were to be connected to the DH grid fed by biomass-derived heat. At that time the project was sufficiently innovative to obtain the GEF grant of 950 000 USD, which was finally approved by the GEF Council in March 2001. At present, possibly related in time to that initiative, more and more similar support schemes have been put in place. Notably the Thermal Modernisation Act includes as eligible also costs associated with conversion from coal to biomass. Similarly ECOFUND has launched grant lines integrating RES and energy efficiency. Another project following the same philosophy is described (Slupsk in Annex 3). One should consider this development as very positive. **The “Integrated Approach” is worth to be “institutionalised” as an inherent component of the RES projects also at the EU and/or GEF level.**

## **9.2 Co-firing of biomass with coal**

The last (amended) version of the Polish Energy Act introduces obligation for energy utilities to purchase RES electricity. The minimum quotas on the share of green electricity in their purchase portfolios are determined quantitatively by the ordinance of Minister of Economic Affairs. The first ordinance to the Energy Act concerning RE purchase obligation came into effect on December 15<sup>th</sup> 2000. The Ordinance set the green energy fraction at 2.4% in 2001, which would be gradually increased up to 7.5% in 2010. However, the Ordinance had several essential drawbacks: there were uncertainties about fulfilling recommended quotas and about penalties that were to be imposed on energy utilities failing to meet the targets. Most importantly, it made it possible to count the same green electricity several times by different utilities, as the “certificates of origin” were not yet in place. Consequently, the Ordinance was updated on May 30<sup>th</sup>, 2003 with the fractional quotas remaining unchanged, but now also extended to power generation. Presently the Energy Regulatory Authority (URE) is preparing an updated version of the Ordinance, extending it to co-generation. The Green Heat obligation remains so far unchanged and there is no work going on its modification.

The enacting of the green electricity ordinance and prospects of its consequent execution has led to an explosion of demand for biomass for co-firing with coal in power stations. Although, from the global environmental point of view, the tendency should be welcome, a critical analysis is needed. On one hand, it is argued that with the ca. 2 million hectares on unused arable land the needs of Polish thermal coal-based power plants and needs of other users can be satisfied, even leaving room for exports. Indeed, this is possible and attractive, since technical evidence already exists that replacing up to ca. 10% of coal in the existing power plants is technologically feasible and does not require any significant investments. On the other hand, however, one may expect that within the radius of 50-100 km from most of the power plants the potentially available biomass will be totally drained by power stations for electricity generation, leaving no

biomass for space heating. From the social, economic and environmental perspective this solution can be far from optima. In Poland, where coal is abundant, the rationale for introducing green electricity quota is **mitigation of Global Climate Change rather than economic considerations**. On the other hand, it is not so when it comes to the local use of biomass, where it is often a practically free resource. Therefore, a careful analysis is needed which should take into account also such factors as embedded GHG emissions and energy costs for the final consumer. The Ordinance should be appropriately modified to reconcile the global environmental benefits with the national and local ones. Finding the solution to this problem is important also for other EU countries, notably to the coal based transition ones, as e.g. the Czech Republic. Such an analysis may also provide an input to revision of EU RES policies, which seem to put too little emphasis on biomass as fuel for space heating as opposed to electricity production or co-generation.

The associated problem is the explosion of interest in plantations of fast growing willow (*salix viminalis*), which is driven by the green electricity purchase obligation. The expectation of huge profits has stimulated significant investment in willow plantations. Given the local agro-technical conditions this needs not to be an optimum solution, as there are other plants that may give more final energy yield or financial revenue per hectare. A systemic approach to the problem is lacking. At present there is practically no co-ordination of actions and initiatives, which are mostly undertaken *ad hoc*, to locate “hot money”. These may turn out to be investments leading to stranded costs, especially that *salix viminalis* is an investment calculated for a lifetime of 25-30 years. In this situation **a research effort to optimize the production and use of biomass in a given territorial area should be undertaken as soon as possible, the more that scientifically meaningful results of such a research would not be available “overnight”**. An attempt to fill this gap is described in Annex 4.

## 10. Motor Biofuels

The fate of the Polish Liquid Biofuel Act is an example of a failure to achieve political solution that would provide Poland’s contribution to mitigating the global environmental threat posed by Climate Change. In the past two years Poland witnessed a hot political debate about liquid biofuels for motor vehicles. Several proposals were prepared, submitted for the Parliament’s approval, accepted, vetoed afterward by the President, returned to the Parliament, modified, again approved, again submitted...Finally a tediously elaborated agreement was reached, the bill was signed by the President of the country in November 2003 only to be killed by the Constitutional Tribunal in the end of April 2004, on grounds of violating (according to CT interpretation) the principles of the Polish Constitution. Consequently, over two years of tedious negotiations and huge amount of work done by experts and politicians in rounds of exchanges between the government, Parliament and President have been wasted.

Below the history of the Biofuel Act is described in some detail as it provides a case study of a political failure of great significance for Poland and possibly for other countries.

The **first proposal** of the Biofuel Act of **early 2002** was rather radical. It would place Poland as the European leader in imposing mandatory contents of bio-components in

motor fuels. The proposal was successfully lobbied by the (then) coalition party PSL, representing mainly the Polish farmers. The main goal of the Act was to promote biofuels i.e., mixtures of petrol with ethanol or diesel with the methyl or ethyl esters. The proposed mandatory admixture of bio-components was 4.5%, to be enacted starting from January 1<sup>st</sup>, 2003. The proposal faced fierce opposition from the oil and car lobbies, and from the opposition parties, mostly from the right wing liberal Citizens' Platform (Platforma Obywatelska, PO) and the populist Samoobrona. On July 23<sup>rd</sup> three different proposals were submitted to the Chamber: the aforementioned government proposal, and two other proposals prepared by PO and Samoobrona. After prolonged wrangling in the parliamentary commissions, the version proposed by the government was finally adopted on **November 13<sup>th</sup>, 2002** with the SLD-PSL coalition votes. According to constitutional procedures the Act was passed to the Senate for approval. The Senate, however, "softened" the proposal to the extent hardly acceptable by the leading proposer, the PSL. In particular, the Senate's amendment #49 required leaving consumers the choice of buying "pure" fossil-derived fuels and placing information on the filling stations which fuel is which at each pump. This would, of course, require huge investments, as additional tanks and pumps would have to be installed in all petrol stations. The modified Act was returned to the Lower Chamber, which rejected the Senate's amendments on **December 12<sup>th</sup>, 2002**. Since then, only the signature of the President of the country remained for the proposal to become law. However, the president Mr. Kwasniewski yielded to the pressure of the anti-biofuel lobby and **vetoed the Act, on January 18<sup>th</sup>, 2003**. This meant returning the whole Act to the Sejm (the lower chamber) to introduce changes required by the Senate and President or to reject the President's veto. The veto, however, was not rejected, due to the split in the SLD MPs' ranks. This was a serious blow to the prestige of the coalition party PSL. Consequently, PSL took a deadly revenge, by voting against another act that envisaged introducing payments for the use of Poland's roads, based on the examples of (e.g.) Austria or Slovakia. That act was an initiative of SLD; no doubt very much needed to raise funds for construction of new roads and motorways to match the EU support. This exchange of blows soon led to the split of the coalition in March 2003.

This notwithstanding the (since then) minority SLD government prepared a **second proposal**, which was approved by the Lower Chamber on **July 10<sup>th</sup>, 2003**. The date for introducing the obligation to add bio-components was shifted to **October 1<sup>st</sup>, 2003** and the minimum fraction of admixture was lowered to 3.5% from 4.5%, for the period October 1<sup>st</sup> – December 31<sup>st</sup>, 2003, and to 4% since then on. At the same time, the upper limit on the bio-component fraction was set at 5%. The new Biofuel Act took into account the newest World Fuel Chart of December 5<sup>th</sup>, 2002 and the EU directive 2003/30/EC.

This time the Senate introduced "only" 15 changes, among them shifting again the commencement date **to January 1<sup>st</sup>, 2004** and adding obligation to place information for consumers about what is the actual fraction of bio-component at each pump. The Act was returned to the Sejm on August 7<sup>th</sup>, 2003. However, at this point a puzzling thing was discovered. The text, now again in the Lower Chamber, differed from the one the MPs believed they had voted for. The difference was merely two words: "**and other**". This difference was, however, absolutely crucial in the whole debate for winning the support of the farmers' parties, PSL included (now in opposition). Indeed, the „believed" version stipulated that the bio-components must be produced only from plants harvested domestically for the period of five years since the Act would have

entered into force. To make it sure the “eligible” plants were explicitly enumerated. Somehow, rather mysteriously, at the end of the list two words: “and other” (plants) appeared, invalidating the whole idea.

This evoked an abrupt reaction of the Marshal (President) of the Lower Chamber, Mr. Borowski, who scrapped the whole Act and ceased the legislative procedure on **August 28<sup>th</sup>, 2003**. No wonder, Poland was then living with a huge corruption scandal, where an attempt was apparently made to “buy” changes in the parliamentary act regulating the media market. The trick was very similar; in that case two words, “**or periodicals**”, were deleted which meant in practice millions of EURO annually for the potential beneficiaries. The case was subject to public prosecutor’s inquiry, and an investigation by a special parliamentary commission (labeled “Rywingate” = Polish Watergate). The Biofuel Act case was also brought to the prosecutor, who concluded, however, that this time it was merely a technical mistake.

The work on the formally new act was resumed quickly. This time, both the ruling party SLD and all opposition parties, except for PO (the rightmost party as far as economical policies are concerned) worked jointly. Sejm accepted **the third consecutive proposal on October 2<sup>nd</sup>, 2003**. The “domestic origin” clause was limited in time only until accession on May 1<sup>st</sup>, 2004, although the pressure to protect Polish farmers was quite significant. This time the Act also set an upper limit on bio-components in the fuel at 5%. The lower bound has been delegated to government executive regulation, which would be revised annually. The fuels with contents below 5% were classified as “normal” fuels and no additional information for consumers at the filling columns needed to be displayed. Only columns with fuels with a higher content (now referred to as “biofuels”) would have to be labeled appropriately (if a particular filling station would decide to include them in its offer). This time the Senate introduced no changes and president Kwasniewski signed the Act on **November 17<sup>th</sup>, 2003**. Consequently, the Act should have entered into force on **January 1<sup>st</sup>, 2004**. Unfortunately, this was not the case, as the supplementary legislation delegated to the ministerial level was not yet ready. Those were soon prepared. However, meantime the Polish ombudsman filed the case to the Constitutional Tribunal, which - as mentioned above - killed the bill on **April 21<sup>st</sup> 2004** arguing that it violates several principles of the Polish Constitution. The arguments were that it would

- (1) limit the freedom of the (free market) economic activity,
- (2) infringe consumers’ right of free choice and
- (3) cut consumers’ access to information about product specification.

Over two years were wasted in exchange of blows, more than pondering arguments related to the subject of the matter. The delay was due mostly to regrettable political wrangling and infighting, having little to do with the real issue itself. Unfortunately, as mentioned in Section 4.2, the environmental NGOs proved to be too weak to influence the process of decision-making. Public opinion was greatly influenced by media. The majority of media implicitly or explicitly sided with the powerful anti-biofuel lobby, and created a degree of panic among the car users and fuelled arguments for anti-biofuel politicians.

At the same time, the arguments that the introduction of the mandatory admixtures of bio-components to fossil fuels for motor vehicles - apart from the global impact - would greatly help the troubled Polish agricultural sector and, by this virtue, Poland’s economy

at large, were played down. Other arguments were overshadowed as well (energy security of the country, improved trade balance, increased volume of Poland's GHG emission credits). Even the hot unemployment issue did not surface, despite the fact that job creation in unemployment-ridden areas would be a significant effect; according to government estimates **ca. 100 thousand people would find employment in the biofuel sector by 2005**. The same source estimated the farmers' total revenue from rape-for-biodiesel production alone at 46, 126, 219 and 328 mEURO in 2002, 2003, 2005 and 2007, respectively. These are – as it looks now – lost opportunities. No doubt, the cancellation of the Act has benefited the (fossil) oil lobby instead.

Unfortunately, the prospects of returning the act again on the legislative path are rather slim. The main proposer of the Act, representing the Polish farmers, the PSL, will most likely be no more much interested in resuming the effort, as the “domestic origin” clause cannot be kept valid any more after May 1<sup>st</sup>, 2004 (one should note in passing that such a clause would be highly justified once embedded GHG emissions are taken into account).

**The fate of the Polish Liquid Biofuels Act seems to provide an example of the lack of environmental concerns of the top-level decision-makers**, who – while exposing principles of free market and right to choose or be informed - ignore the global threats of Climate Change and peoples' rights to live in a cleaner and healthier environment. One may reflect that, along with the postulated awareness raising effort, directed at local administration people, some kind of awareness raising effort targeted at the very **top political and media decision-makers** should be devised, (assuming that the trainees are ready to listen to arguments).

## 11. Conclusions

### 11.1 Identified phenomena and tendencies

As mentioned in Section 2, in designing this case study one had to bear in mind that the problem of the energy use of biomass cannot be treated consistently in an item-by-item manor since the particular phenomena are correlated or influenced by each other. Having reviewed a range of issues and problems, an attempt is made below at identifying some common phenomena and tendencies of the development of the bioenergy sector in Poland. In the following these phenomena and tendencies are analyzed from the point of view of:

- Actual and forecasted outcomes
- Transferability
- Policy recommendations
- Research recommendations

In fact, the identified phenomena can be classified into two main categories (of course there is a degree of overlap). These are those pertinent to: (A) policymaking and (B) research

A. The phenomena of the first category are:

1. Growth of interest in production and use of biomass for energy purpose, still requiring a scientifically grounded guidance (Sections 8.4, 8.6 and 9.2, and Annex 4)

2. Growth of business activity in the bioenergy sector and related industries (Sections 7, 9.2 and Annex 1)
3. Growth of awareness of local decision makers, however insufficient and requiring continuous training/education/demonstration effort (Annex 5 and Section 8.6, as well as Section 10 in its negative dimension).
4. Actual and potential positive impact on country's economy business development (Annex 1), job creation (Sections 4,7 and 10)
5. Local energy planning as regards size of unit territorial area for which the RES are made (Section 8.5) and importance of local strategy (Annex 3)
6. The need of integration (coupling) of RES investments with energy efficiency (DSM) undertakings (section 9.1 and Annex 3).
7. The need of putting more emphasis on real "hardware" projects at the expense of "soft" projects, which do not provide examples to be followed in practice (section 8.1 and Annex 3)
8. Solution of the problem of small-scattered biomass suppliers (Section 8.3, Annex 3).
9. The impact of the EU-legislation on the improvement of the Polish legal framework related to the environment and energy, biomass inclusive (Sections 7 and 6)
10. The role of media, NGOs, and inertia of public opinion (Section 4.2 and 10)

Bearing in mind that most of the issued listed above are related also to research needs, one can include specifically in the second category:

1. Need to provide scientifically grounded guidance for the Market Force, as the market signals to business can be misleading
2. Creating model to support decision-making in energy planning as regards the optimization of the use of the locally available (or achievable) RE resources.
3. The need to support both applied and fundamental research in the development of new biomass technologies

## **11.2 Actual and forecasted outcomes**

It should be noted first that the present level of utilization of the biomass resources in Poland is rather small. However the growth rate is remarkable. The growth of interest in and the growth of business in the bioenergy sector is an observed phenomenon. Annex 1 illustrates this in particular, although other annexes give also support to this statement. These trends will most likely persist in the foreseeable future. The targets set forth in the "*Development Strategy of Renewable Energy Sources*," may be difficult to achieve in general, however it is rather obvious that, if the targets are to be approached at all, biomass will have to play a dominant role. Poland has a good chance to become one of the European leaders in the field of the use of biomass for energy purposes.

The energy-environment awareness of the local decision-makers is a crucial factor for development and implementation of bioenergy projects. This has increased significantly over the past decade, partly due to the financial support schemes such as offered by NFOS or ECOFUND and partly (in fact largely) due to determined awareness raising effort supported by domestic and foreign grant sources. (eg. Annex 5). However, bearing in mind that the term in office of those officials is typically 4-8 years the awareness raising (training, education, demonstration) should be maintained in the mid-term future. The difficulties that appear are best illustrated by an attempt of the Krakow Agricultural University, which has planned to offer postgraduate courses in forestry oriented at production of biomass for energy. The courses have been offered to people involved in forestry (primarily, state, provincial and local forest administration or local self-government representatives). However the response of the State Forest Administration was practically negative, while without their support, the course will raise little interest. On the other hand, if the courses were offered free and included visits to successful examples in the EU countries, the number of candidates would be certainly sufficient. In the past decade such projects were possible within the TEMPUS programme in particular, and turned out to be very successful in terms of producing long-term effects.

Without finding a solution to continue the awareness raising effort the tendency may decline. It may slow down the aforementioned growth of the bio-energy sector; however, it is unlikely that this may lead to its reversal.

No studies of the up to date impact of the development of the bioenergy sector on the country's economy are available. In fact, it would be difficult to disentangle the relevant numbers from the macroeconomic data. Nevertheless, some observations are obvious: Annex 1 illustrates the business growth effect while the job creation effect is quite real as empirical data indicate (one full time job for each 10 hectares of willow plantation). The government forecasts of 100000 jobs in the bio diesel production were based on a sufficiently careful analysis under the assumptions used. The tendency of job creation will most likely persist, as the energy plantations (of whatever energy plants) will no doubt grow at a rather rapid pace, considering the demand generated by the green electricity purchase obligation, in particular.

In general, local energy plans include the RES option in a highly unsatisfactory degree. This is one of the reasons why the present level of utilization of renewable energy resources is so small (still one should bear in mind the dynamics of the development). The failure of the local energy plans to include RES should be attributed to the structural deficiency, i.e. energy planning at the lowest administration level. It is difficult to foresee when and how this deficiency will be removed. Still shifting the responsibility to a county or NUTS 3 level would help optimize the use of the local biomass resource. In particular this would help finding optimal solutions for making an energy use of biomass produced by small-scattered suppliers via PPP ventures. At present, this phenomenon is only emerging. However, with some other new member states.

The present policy of the domestic financial assistance sources (ECOFUND NFOS/WOS) with the emphasis on hardware projects has, no doubt, a positive impact on the development of the bioenergy sector in Poland. Both sources put an increasing emphasis on biomass. It should be assumed that this tendency will continue in the future, partly due to the *“Development Strategy of Renewable Energy Sources”*. The



same tendency is observed concerning the support to “integration” of RES investments with DSM undertakings. It would be much more effective if this approach were institutionalized as a principle in giving support to the RES investments.

The impact of EU legislation has been indirect but essential for the development of RES in Poland. This phenomenon by its formal nature will be now enhanced. The impact of the national policies in support of biomass is noticeable, especially if one considers the financial support schemes. Again there are reasons to believe that this tendency will be continued.

The important observed phenomenon is the relative weakness of environmental NGO when it comes to a decisive political debate. The information policy of the majority of media as the biomass issue is concerned is lukewarm to say the least. Media seem to be influenced much more by business than by environmental organisations. This has an impact on public opinion, which became ambivalent as regards the environmental problems. This phenomenon does not seem to disappear quickly.

### **11.3 Transferability**

Some of the phenomena listed above are transferable at the national scale, some also at the EU level, particularly of the new MS. The latter would include the “hardware” oriented policies of ECOFUND and NFOS, as well as the tendency of integration of RES investments with DSM measures.

The same concerns the awareness raising efforts, which are most successful when it includes practical demonstration (visits in actually operating demonstration facilities).

Some of the listed phenomena are only potentially transferable: One may assume that once the PPP approach to manage the locally available biomass resources, possibly coupled with the shift of local energy planning to the NUTS 3 level are successfully demonstrated, they would find a great dissemination potential. The same concerns the effect-of-scale approach developed in Trzcianne, and – if implemented – the 400000 country-wide project.

Similarly, the concerns raised in Section 9.2 about the impact of co-firing biomass in large power plants, about insufficient attention paid to biomass as fuel for space heating should be analysed at the EU (especially the new MS) level.

However, some lessons learned should be transferred to other entities in Poland and abroad. These are: the experience of the failed Polish Liquid Biofuel Act and that of the project described in Annex 3. The latter shows that people who have sufficient engineering background and experience should manage technical „hardware” projects, rather than people whose knowledge of the technical substance of the subject is small or next to none.

### **11.4 Policy recommendations**

The main policy recommendation concerning the bioenergy sector follows from the fact that biomass is used most optimally in the area where it is produced. In Poland, due to the climate conditions, the major problem is space heating. This means that a bulk of the users is small energy consumers (individual households or farms, schools, small or

medium size DH systems). This in turn means that public support to such individual projects will have to be continued, which will benefit particularly rural communities, but also – indirectly – the country's economy at large.

The present policy of supporting such investment in their “hardware component” should be continued. The biomass co-generation projects should be given particular attention and should be analysed together and confronted with the no-cogen option.

The green electricity ordinance should be modified based on a careful analysis of its global environmental and local economic impacts.

The policy of integrating the biomass (RES in general) investments with the energy efficiency (DSM) measures, whenever possible and effective, should be “institutionalised” in the policy of awarding public support to fuel conversion (or new biomass) projects.

The level of local energy planning should be placed at the county or NUTS3 level at least as far as biomass use is concerned. At the same time the public support to training of local decision-makers in energy sustainability should become a constant component of the NFOS funding. The best solution would be to delegate the effort to a selected organisation or institution with sufficient experience in this area.

## 11.5 Research recommendations

Research in the area of the energy uses of biomass is greatly insufficient due to the lack of funding. This applies both to the technological development and more general related research. Therefore, the basic and most obvious recommendation is to increase the funding. In view of the rapid growth of the bioenergy sector in Poland, and the possibility of obtaining “stranded” effects, the most urgent need is to provide scientifically based guidance for investors and planners. This applies both the local and national level.

A particular task concerns the biomass-coal co-firing described in Section 9.2. A model taking into account the GHG emissions reduction (with embedded emissions included), the local economic factors and social effects (employment in particular) should be created.

Since the final forms of biomass-derived energy compete to the same **limited resource in a given territory**, a more general problem is identifying a spectrum of close to optimum solutions for the use of locally available (potentially available) biomass resources in a given territorial area. By its very nature such research is multidisciplinary and will require involvement of scientists representing different research areas. To keep the long-term perspective as guidance for the future, such research should be done parallel with the R&D work of a technological and fundamental character.

It is worth to emphasize again that as the Polish experience indicates **market is an important player, provided its signals are based on scientific research and demonstration**.

## Poland Case study - Annex 1

### List of boiler manufacturers and distributors who developed their business in the recent years (the list may not be complete)

<b>MANUFACTURERS AND DISTRIBUTORS OF BOILERS</b>	<b>APPLCATION</b>	<b>CAPACITY</b>	<b>FUEL</b>
<b>AGRO ENERGIA-</b> Poznan	<ul style="list-style-type: none"> <li>• central heating</li> <li>• hot water</li> </ul>	<ul style="list-style-type: none"> <li>• 25-100 kW</li> <li>• 25-115 kW</li> </ul>	pellets, wood
<b>AGROENERGETYKA-</b> Luban	<ul style="list-style-type: none"> <li>• public boilers</li> <li>• industrial boilers</li> </ul>	<ul style="list-style-type: none"> <li>• 750-3500 kW</li> </ul>	straw
<b>ASBUD</b>	<ul style="list-style-type: none"> <li>• central heating</li> <li>• hot water</li> </ul>	<ul style="list-style-type: none"> <li>• 6-45 kW</li> <li>• 10-24 kW</li> <li>• 35-1105 kW</li> </ul>	wood
<b>ATEX</b>	<ul style="list-style-type: none"> <li>• out of limitation</li> </ul>	<ul style="list-style-type: none"> <li>• 200-1500 kW</li> </ul>	straw, wood
<b>ATMOPOL -</b> Wroclaw	<ul style="list-style-type: none"> <li>• public buildings</li> <li>• houses</li> <li>• industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>• 8-100 kW</li> <li>• 14-75 kW</li> <li>• 10-50 kW</li> </ul>	wood
<b>ATMOS</b>	<ul style="list-style-type: none"> <li>• public buildings</li> <li>• houses</li> <li>• industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>• 15-80 kW</li> </ul>	wood
<b>BARRIER</b>	<ul style="list-style-type: none"> <li>• to heat surface above 300 m</li> </ul>	<ul style="list-style-type: none"> <li>• 46 kW</li> </ul>	straw, wood
<b>CICHEWICZ-KOTLY</b> Plonsk	<ul style="list-style-type: none"> <li>• houses</li> <li>• public buildings</li> <li>• industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>• 6.9-40 kW</li> <li>• 15-30 kW</li> <li>• 14-100 kW</li> </ul>	pellets
<b>EKOCENTR-</b> Pleszew	<ul style="list-style-type: none"> <li>• houses</li> <li>• industrial buildings</li> <li>• store</li> </ul>	<ul style="list-style-type: none"> <li>• 18-80 kW</li> </ul>	wood, willow
<b>EKO-VIMAR</b> <b>ORLANSKI-</b> Otmuchow	<ul style="list-style-type: none"> <li>• various central heating</li> </ul>	<ul style="list-style-type: none"> <li>• 4-85 kW</li> </ul>	solid fuels
<b>FERROLI</b>	<ul style="list-style-type: none"> <li>• wood industry</li> <li>• sawmill industry</li> <li>• technological boilers</li> <li>• public boilers</li> </ul>	<ul style="list-style-type: none"> <li>• 200-8000 kW</li> </ul>	wood
<b>FERRUM</b>	<ul style="list-style-type: none"> <li>• central heating- out of limitation</li> </ul>	<ul style="list-style-type: none"> <li>• 20-60 kW</li> </ul>	wood, coal, various solid fuel
<b>FINNMARCON</b>	<ul style="list-style-type: none"> <li>• central heating</li> </ul>	<ul style="list-style-type: none"> <li>• 300 kW</li> <li>• 600 kW</li> <li>• 1000 kW</li> <li>• 2000 kW</li> <li>• and other</li> </ul>	wood, biomass
<b>FU-WI PPHU-</b> Elblag	<ul style="list-style-type: none"> <li>• public buildings</li> <li>• houses</li> <li>• industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>• 10 kW</li> <li>• 20 kW</li> <li>• 30 kW</li> </ul>	wood
<b>GIZEX PPHU-</b> Pleszow	<ul style="list-style-type: none"> <li>• to heat a surface between 370-5900m</li> </ul>	<ul style="list-style-type: none"> <li>• 41-650 kW</li> </ul>	straw

<b>GRASO</b>	<ul style="list-style-type: none"> <li>to heat various rooms</li> </ul>	<ul style="list-style-type: none"> <li>60-1100 kW</li> </ul>	straw, wood
<b>GROS-POL- Poznan</b>	<ul style="list-style-type: none"> <li>public boilers</li> <li>industrial boilers</li> </ul>	<ul style="list-style-type: none"> <li>4000 kW</li> <li>2000 kW</li> <li>1000 kW</li> </ul>	straw straw and wood straw
<b>HAMECH Z.M- Hajnowka</b>	<ul style="list-style-type: none"> <li>houses</li> <li>industry buildings</li> </ul>	<ul style="list-style-type: none"> <li>50 kW</li> <li>100 kW</li> <li>250 kW</li> <li>500 kW</li> <li>1000 kW</li> </ul>	<ul style="list-style-type: none"> <li>wood-granulated max.30mm and humidity 30-50%</li> <li>wood-humidity 40-60%</li> </ul>
<b>HEF- Lubliniec</b>	<ul style="list-style-type: none"> <li>public buildings</li> <li>houses</li> <li>industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>17-50 kW</li> <li>25-1200 kW</li> <li>25-50 kW</li> </ul>	<ul style="list-style-type: none"> <li>wood, pellets</li> <li>coal, pellets</li> </ul>
<b>HEITZMANN POLSKA Milomlyn</b>	<ul style="list-style-type: none"> <li>out of limitation</li> </ul>	<ul style="list-style-type: none"> <li>20-110 kW</li> </ul>	wood, sliver, brushwood
<b>INVESTEAM- Lubowidz</b>	<ul style="list-style-type: none"> <li>houses</li> <li>structures below 1000m</li> <li>structures below 30.000 m</li> </ul>	<ul style="list-style-type: none"> <li>25 kW</li> <li>25-100 kW</li> <li>100-35.000 kW</li> </ul>	<ul style="list-style-type: none"> <li>pellets</li> <li>pellets, wood</li> <li>pellets, wood</li> </ul>
<b>KORTEX Sp. z o.o.</b>	<ul style="list-style-type: none"> <li>public buildings</li> <li>houses</li> <li>industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>11-500 kW</li> </ul>	coal, wood
<b>KOSTRZEWA- Gizycko</b>	<ul style="list-style-type: none"> <li>houses</li> <li>flats</li> </ul>	<ul style="list-style-type: none"> <li>25-300 kW</li> <li>23-95 kW</li> </ul>	<ul style="list-style-type: none"> <li>Straw, wood-granulated 5-25mm</li> <li>Straw, wood-granulated 5-10mm</li> </ul>
<b>KOTLAN Sp z o.o. Ciechanow</b>	<ul style="list-style-type: none"> <li>houses</li> <li>flats</li> <li>industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>14-70 kW</li> </ul>	wood, coal
<b>KOTLARZ</b>	<ul style="list-style-type: none"> <li>houses</li> <li>public buildings</li> <li>industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>18-80 kW</li> <li>18-110 kW</li> </ul>	waste(material),wood
<b>LECHMA</b>	<ul style="list-style-type: none"> <li>out of limitation</li> </ul>	<ul style="list-style-type: none"> <li>15 kW</li> <li>19 kW</li> <li>24 kW</li> </ul>	wood
<b>MAWI P.P.H.</b>	<ul style="list-style-type: none"> <li>houses</li> <li>public buildings</li> <li>industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>25 kW</li> <li>80 kW</li> </ul>	wood
<b>METALERG- Scinowa Polska</b>	<ul style="list-style-type: none"> <li>houses between 100-300m</li> <li>industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>15-32 kW</li> <li>40-700 kW</li> </ul>	wood, straw, energetic willow
<b>MODERATOR- Hajnowka</b>	<ul style="list-style-type: none"> <li>central heating</li> <li>hot water</li> </ul>	<ul style="list-style-type: none"> <li>12-600 kW</li> <li>25-120 kW</li> </ul>	biomasa
<b>PELIKAN</b>	<ul style="list-style-type: none"> <li>out of limitation</li> </ul>	<ul style="list-style-type: none"> <li>14-600 kW</li> </ul>	Biomasa, coal
<b>POLYTECHNIK DPU Sp. z o.o.- Strzegam</b>	<ul style="list-style-type: none"> <li>industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>40-1500 kW</li> </ul>	wood
<b>PGK SYSTEM- Osielsko</b>	<ul style="list-style-type: none"> <li>houses</li> <li>flats</li> </ul>	<ul style="list-style-type: none"> <li>22-250 kW</li> <li>50-200 kW</li> <li>30-50 kW</li> <li>12-14.9 kW</li> </ul>	<ul style="list-style-type: none"> <li>wood, coal</li> <li>biomass</li> <li>wood</li> <li>wood, coal</li> </ul>

		<ul style="list-style-type: none"> <li>• 15-25 kW</li> </ul>	<ul style="list-style-type: none"> <li>• pellets</li> </ul>
<b>SHELLING POLSKA</b>	<ul style="list-style-type: none"> <li>• hotels</li> <li>• social buildings</li> <li>• individual buildings</li> </ul>	<ul style="list-style-type: none"> <li>• 110-859 kW</li> <li>• 1100-5000 kW</li> </ul>	wood+gas+fuel oil
<b>SM 21 ENERGETYKA Sp.z o.o.- Lodz</b>	<ul style="list-style-type: none"> <li>• wood industry</li> <li>• food industry</li> </ul>	<ul style="list-style-type: none"> <li>• 180-650 kW</li> </ul>	wood, paper, energetic willow
<b>UNICAL</b>	<ul style="list-style-type: none"> <li>• heating installation in self contained</li> </ul>	<ul style="list-style-type: none"> <li>• 6-45 kW</li> <li>• 10-24 kW</li> </ul>	wood, coal
<b>URBIS- Torun</b>	<ul style="list-style-type: none"> <li>• city</li> <li>• country</li> </ul>	<ul style="list-style-type: none"> <li>• 14-100 kW</li> <li>• 20-250 kW</li> <li>• 20 do kilku MW</li> </ul>	<ul style="list-style-type: none"> <li>• wood</li> <li>• biomass, coal oil</li> <li>• wood, pellets</li> </ul>
<b>VERNER POLSKA</b>	<ul style="list-style-type: none"> <li>• houses</li> <li>• flats</li> <li>• warehouse</li> </ul>	<ul style="list-style-type: none"> <li>• 7-25 kW</li> <li>• 25 kW</li> <li>• 25 kW</li> </ul>	<ul style="list-style-type: none"> <li>• pellets</li> <li>• wood</li> <li>• wood</li> </ul>
<b>WARYNSKI- Torun</b>	<ul style="list-style-type: none"> <li>• out of limitation</li> </ul>	<ul style="list-style-type: none"> <li>• 1000 kW</li> <li>• 3500 kW</li> <li>• 2000 kW</li> <li>• 750 kW</li> </ul>	straw
<b>WAT- Warszawa</b>	<ul style="list-style-type: none"> <li>• houses between 100-300m</li> <li>• industrial buildings</li> <li>• flats</li> </ul>	<ul style="list-style-type: none"> <li>• 15-32 kW</li> <li>• 40-700 kW</li> </ul>	<ul style="list-style-type: none"> <li>• wood, straw, energetic willow</li> <li>• wood, straw, energetic willow</li> </ul>
<b>WEISS A/S</b>	<ul style="list-style-type: none"> <li>• any</li> </ul>	<ul style="list-style-type: none"> <li>• 500-12.000 kW</li> </ul>	wood, straw
<b>ZAMER- Kraszewo</b>	<ul style="list-style-type: none"> <li>• industrial buildings</li> </ul>	<ul style="list-style-type: none"> <li>• 500-3000 kW</li> <li>• 500-8000 kW</li> <li>• 500 kW</li> </ul>	woods waste
<b>ZUK- Staporkow</b>	<ul style="list-style-type: none"> <li>• modernization of coal boilers in many kinds of buildings</li> </ul>	<ul style="list-style-type: none"> <li>• 1 MW</li> <li>• 2 MW</li> <li>• 4 MW</li> </ul>	wood
<b>ZUBR- Hajnowka</b>	<ul style="list-style-type: none"> <li>• houses</li> <li>• schools</li> </ul>	<ul style="list-style-type: none"> <li>• 6-700 kW</li> </ul>	biomass, wood, straw
<b>ZAR</b>	<ul style="list-style-type: none"> <li>• individual buildings</li> <li>• small industry</li> </ul>	<ul style="list-style-type: none"> <li>• 20-50 kW</li> </ul>	wood

## Poland Case study - Annex 2

### Straw-based heating in District Heating in Luban

#### Introduction

Luban is one of the newly created counties. It is situated in the West of the Lower Silesia (Dolnoslaskie) Province. The county belongs in part to the geographic macro-region of the West Sudety Mountains in South-West Poland. The capital of the county is the City of Luban town.

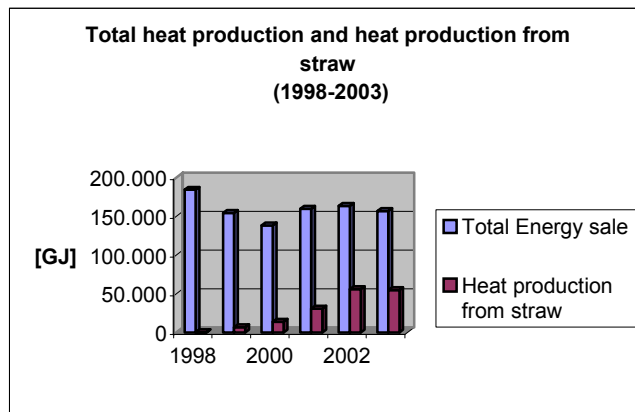
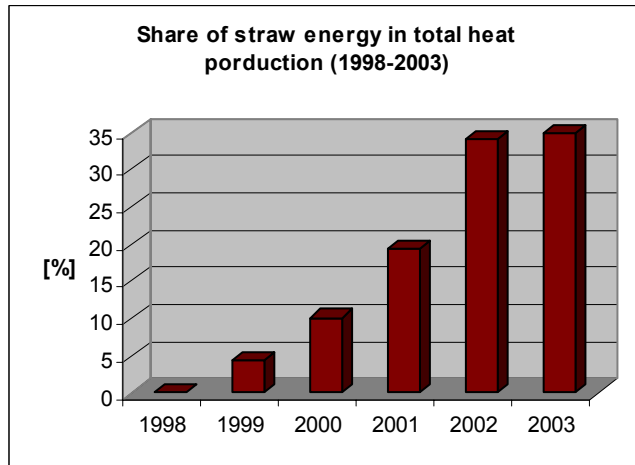
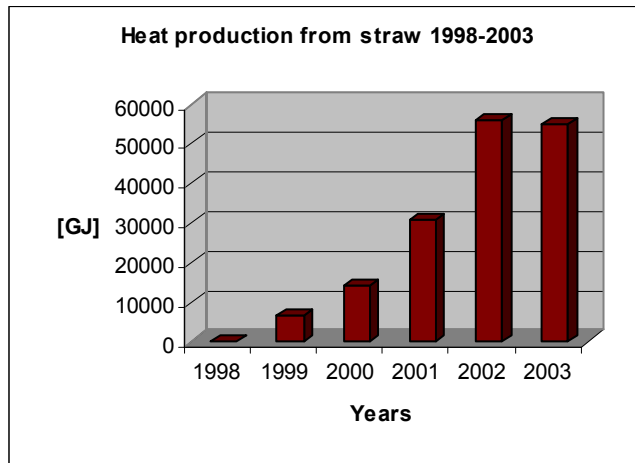
The settlement structure is: 3 towns and 54 villages with an area of 429 km<sup>2</sup>, of which the towns make 10.6%, while rural areas cover almost 90% of the area. The instance from the most important European cities: Berlin - 200 km; Prague - 150 km; Vienna - 400 km, Warsaw - 505 km.

The Case Study is based on the experience of District Heat Company in Luban (PEC-Luban) established in 1998. PEC-Luban operates one of the largest straw-based DH systems in Poland total straw-based capacity of 8,0 **MW** (2 x 3,5 MW and 1 x 1,0 MW boiler). Total DH capacity is 29,47 MW (8 MW- straw, 21,4 MW- coal, 0,17 MW- gas). The strategy of the Company is to maximise the fraction of biomass in the fuel mix. At present c.a. 40% total heat production is derived from straw. The whole investment cost was c.a. 6 433 100 PLN (c.a. 1.4 million EURO) and it was financed by three sources:

- 1) ECOFUND, supported project by a grant for hardware (47%)
- 2) Luban District Heating Company, own sources: 35% for project development, and design
- 3) WFOS- Wroclaw, one from 16 provincial chapters of National Fund for Environmental Protection (NFOS) soft loan for hardware

Tab 1. Technical data for Luban District Heating company

	unit	1997	1998	1999	2000	2001	2002	2003
Total Energy sale	<b>TJ</b>	<b>178,9</b>	<b>184,2</b>	<b>154,2</b>	<b>138,3</b>	<b>159,6</b>	<b>163,3</b>	<b>156,7</b>
Heat production from straw	<b>TJ</b>	-	<b>84</b>	<b>6,7</b>	<b>14,0</b>	<b>30,8</b>	<b>55,8</b>	<b>54,8</b>
Share of straw energy in total	<b>%</b>		<b>0,046</b>	<b>4,36</b>	<b>10,15</b>	<b>19,33</b>	<b>34,17</b>	<b>34,99</b>
Straw in Heat production	<b>1000 tones</b>	-	<b>0,009</b>	<b>0,718</b>	<b>1,34</b>	<b>13,09</b>	<b>11,19</b>	<b>12,80</b>



### Outcomes

The scope of the Case Study research includes assessment of the impact of the Programme on job creation and environmental and financial effects.

## Social impact

The most important for local economy and regional development is number of **jobs create or saved**. In the case of PEC it was 15-16 half-year jobs, which is now being increased by 5 more. In summer the M&O team was idle due to lack of the heat demand. They would be seasonally laid-off. Instead, once straw boilers were put in operation they have full year employment. In summer they collect after-harvest straw contracted with local farmers using the PEC special machinery and store it partly in the fields and partly in a special barn at the facility itself.

Indirect job creation impact is that, the first 1MW boiler was produced in Denmark, the other two 3.5 MW each were made by Polish companies

It should be also noted that the long term contracts signed with the local farmers have led to the increase of activity in rural areas.

The logistic problem is the fragmented agricultural structure. Large farms are obviously preferred. Still quite many are involved, which requires a special organisation system of acquisition of straw, storing and transportation. At present one observes a growing interest among farmers to manage this process themselves. It should be noted that initially when the Heating Company approached farmers to buy straw, farmers were not interested. Now, once the investment in the Heating Company became a fact, and the customer is stable constant for a long period. the situation has changed; now the farmers see that they can raise money in this business activity. It illustrates how strong there are mental and social barriers in implementing bioenergy activities in rural areas. This example shows also that awareness of farmers that they can make additional money is insufficient and should be increased in rural areas.

Obviously with the present system the crops of straw for fuel does not create jobs for them but creates supplementary income. Initially farmers were not convinced. This is an example which shows how bioenergy market is “working” in practice.

The facts presented above facts are crucial for successful development for bioenergy business activity and, more importantly for regional development. It means that such information should be aggregated by analysts in practical “data base knowledge” and, in consequence, should be used in developmental decisions by politicians.

This research has that this kind of information is one of the most important ones for regional development aspects because the scarcity of knowledge in this matter and social (mental) barriers are important. In the past few years since the operation of the straw boilers has begun, about 3000 people, among them local decision-makers, businessmen, NGO representatives, students and researchers visited the site. The PEC arranges a special well equipped lecture room and made video materials illustrating the principles and the case itself. It is remarkable to note that those visits inspired some of the visitors to follow the example. One can mention i.a. investments in straw boilers in: Skwierzyna (2MW), Ostrow (1 MW), Scinawa (1,5 MW), Milicz (1MW) Mikolow (0.4MW), the training tours which included also visits in willow plantation in Marzecin, north from Luban, inspired investments in wood chip DH systems i.a. in Nowa Deba, Trzcianka, Sepolno.



**The Luban case is very Apart from production and distribution of heat the Heating Company in Luban provides consulting and education services in the biomass area. This investment has the impact on biomass-energy education campaigns but it should be more efficient.**

**Financial aspect**

The cost of straw, as fuel, is lower than coal: approximately 20% including transport. The production of heat from straw lowered the cost of 1 GJ of heat (to approximately 20 PLN; 4,4 EUR compared to typical 35-40 PLN). At present, the cost of heat production from straw is lower than that from the worst kind of coal. According to this the Heating Company achieved significant savings on environmental payments (fees) approximately 40 000 PLN per year or 9 000 EUR). In addition, the work conditions for the employees have become significantly better.

**Environmental effect**

The use of straw as significantly reduced emissions to the atmosphere. This is presented in Table1 and Figure 1.

As can be seen the environmental impact is very significant.

**Conclusions**

The income of rural population from biomass-energy crops may increase thanks to better organisation and management in the biomass sector. The Case Study assumes that the rural labour market may become attractive in its diversity, and as such able to offer new job opportunities, thanks to among other factors: biomass energy plantations, development of the small business and tourist service sector.

**Table 1. Environmental effect (for production heat from straw: 21 000 MWh/year)**

	Annual Emission		Environmental effect	
	Before biomass investment [tonnes/year]	After biomass investment [tonnes/year]	Total reduction [tonnes/year]	Total reduction [%]
SO <sub>2</sub>	72,1	14,6	57,5	79,8
NO <sub>2</sub>	19,1	16,5	2,6	13,6
CO <sub>2</sub>	10 573	0 (photosynthesis effect)	10 573	100
Coal dust	68	5	63	92

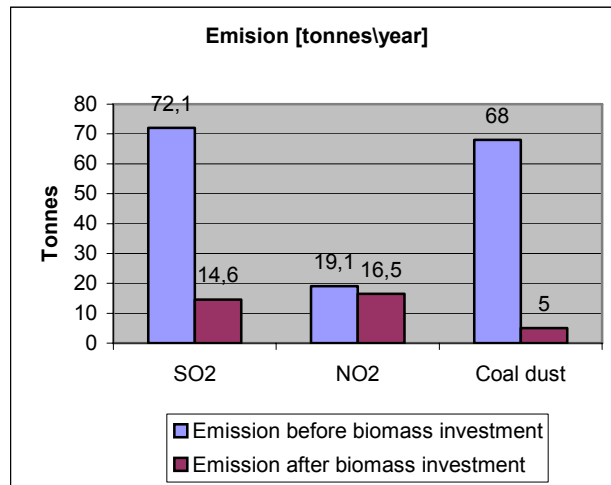


Figure 3. Emission before and after biomass investment

The alternative use straw crops have influenced the local farming conditions. In order to be economically efficient the farms cannot be too small. The logistics of straw collection are one of the factors may help restructure the farms. The average farm size is rising which is in accordance with EU CAP. It shows that bioenergy investments can influence implementation of EU policy. Larger, specialized farms (biomass production, energy plantation) may decrease the economic imbalance in the rural areas, increase energy self-reliance, decrease air pollution and lower the costs of energy supply for industry and households.

## **Poland Case study - Annex 3**

### **Integrated approach to biomass heating (Projects in Podhale and Slupsk)**

The present Annex describes two projects in which the RES investment has been coupled with thermal modernization of buildings. A description of a GEF supported wood-waste project in Podhale in southern Poland (A) and a short account of a similar approach in Slupsk (B) in the North are given. The first project also illustrates the problem of small-scattered biomass suppliers.

#### **A**

### **Integrated Approach to Wood Waste Use for Space Heating GEF Project in Podhale in Poland – Some Political Aspects**

#### **Introduction**

One of the traditional industries in the region of Podhale in Southern Poland is wood processing, typically in small family-owned workshops or enterprises. The residues originating from the production process constitute precious environmentally neutral fuel, which is only partly used for the own needs by the workshop owner and the surplus is most often dumped in unauthorized land-fills or burnt at the production site without providing any useful energy service. On the other side, even if it is used for heating the premises of the enterprise or for timber drying, usually no attention is paid to energy efficiency of such processes. On the end-use side, one can estimate that about 15-25% of heat can be saved by simple, low-cost improvements of the building envelopes. If such saving measures were implemented, the disposable surplus of wood residues would increase correspondingly, without affecting the production process or heating comfort at the facility.

Therefore, in order to increase the benefits of using wood to replace fossil fuels for heat production, the idea of an integrated approach to the use of wood waste for heat production has been formulated, which combines fuel conversion (a Supply-Side Measure, SSM) with end-use efficiency (Demand-Side Measures, DSM). This has led to a project proposal, the main objective of which was to optimize the use of the existing potential of wood-waste for space heating in order to achieve maximum environmental and economic benefits from fuel conversion investments.

#### Demonstration of the integrated approach

Although the idea of integrating energy efficiency with fuel conversion is rather natural, it has been seldom applied in practice in Poland. Therefore, a project aimed at demonstrating such an approach in real field conditions has been formulated and submitted to the Medium Size Project grant scheme of the Global Environment Facility, GEF in September 1997. Originally the idea was to select 8-12 good candidates for an

SSM-DSM integrated fuel conversion investment. However, since large fraction of the “theoretical” work had been done already, the proposer decided to use part of the PDF-A grant for a “physical” demonstration project. A primary school in the city of Krapkowice was selected, where previously thermal improvements of the building had been made which lowered the required heat capacity from 340 to 270kW. The works were successfully completed and the wood-waste boiler is in operation the fourth heating season now. At the same time, fourteen very good candidates for the demonstration of the integrated approach were identified. The report from the PDF-A phase was submitted in January 2000 and soon approved together with the financial statement of expenditures.

The PDF-A phase have identified three main categories of potential fuel switch projects.

- Linking a small wood waste supplier (e.g. a carpenter workshop) with a small user (say a school). Such was the case in Krapkowice
- Linking a big supplier (e.g. a medium size or big timber mill) with many end users (say a village to be connected to a district heat boiler). Such was the case identified e.g. in Uscie Gorlickie in southern Poland.
- Linking many scattered (relatively) small suppliers with many end users, possibly via an intermediary. Such was the case identified in the city of Jordanow and communes Bystra and Sidzina in the Podhale Region.

The latter case presented a very challenging picture and in itself it could become GEF Medium Size Project, or even a Full Size Project (above 1m USD). Therefore, it has been decided that all other candidates will be put aside for other projects and only the latter one will be considered for the MSP application. The very intensive work began in February 2000 and lasted until Fall of 2001

Finally, the total cost of the project was estimated at ca. 3.6 m\$ (with 950 000 GEF contribution). The plan envisages establishing a wood-waste storing/reprocessing facility and building three district heating network systems with the respective boiler capacities: 4.7, 0.9 and 0.7 MW in the city of Jordanów (population ca. 5000) and neighbouring villages Bystra and Sidzina. All buildings connected to the grids are presently heated by burning coal (as are most of the buildings in the area), usually in inefficient old boilers.

#### **A PPP venture**

Another innovative feature of the project, as far as Polish conditions were concerned, was the plan to establish a Private-Public Partnership (PPP) company as a common venture of the involved municipalities and a capital investor (in the approved Project Document it was a state owned company Pumped Storage Power Plants, ESP S.A. which had covered the costs of project development. The PPP company was to enter long term contracts with wood waste suppliers on one hand, and customers buying heat for about 40 housing blocks of flats, schools and other public buildings. Prior to the connection to the grid the buildings will be thermally retrofitted.

#### Some political aspects of project development and implementation

As mentioned above the work on the selected project began in February 2000. It required collection of a huge amount of data (detailed data were collected from 670

enterprises in the area from among ca. 900). At the same time a prefeasibility and feasibility study have been commissioned by ESP S.A., which also covered the cost of the studies as their contribution to the Project. ESP S.A. invested so heavily in the project because it was earmarked to become the capital investor in the planned PPP venture. The company has had huge experience in such projects and promotion of renewable energies was part of its mission. ESP was also ready to become a shareholder of the PPP Company, offering to take equity on very soft, preferential conditions. The final approval came on 18 March 2001, upon a number of consultations with UNDP Warsaw, Regional UNDP/GEF Office in Bratislava and the New York GEF Headquarters. According to the GEF procedures a meeting of the so called Local Project Appraisal Committee (LPAC) should take place before formally signing an agreement between UNDP, the Executing Agency (EA), representing the Polish Government and the Implementing Agency (IA), then assumed to be ESP. Formal difficulties in identifying the EA (responsibility of UNDP) caused a significant delay in convening the LPAC. The difficulties were mostly due to the parliamentary elections, which took place in September 2001, and uncertainties about who would stay in the offices after the elections. The initial date of starting the Project in June 2001 passed. The LPAC convened only on 13 August 2001. The content of ProDoc was discussed, and practically no changes had been requested. It was decided to set the date of the commencement of the project for 3 September 2001.

However, due to the elections, which brought about a major reshuffle of the government, the whole process had been stalled. The consecutive dates were shifted, October 2001, December 2001, finally June 2002. In January 2002 the department of Investments and Technology Development of the Ministry of Environment was chosen as the Executing Agency (EA) to supervise the Project on behalf of the government.

#### A troubled development

Meantime an unexpected development took place: the ESP S.A, the expected Implementing Agency, has been eliminated from the Project, for reasons that were never communicated to the Project proposer or to ESP. The minister of environment has appointed members of the Steering Committee of the Project in February 2002. The EA selected to play the role of the IA a small NGO, Foundation Partnership for Environment for CEE, based in Krakow working largely with youth and children in environmental, tourism and social development related areas. Soon after the project proposer, who conceived, designed and developed the project was also eliminated from further work on the project. Its tasks and responsibilities were transferred to the new IA. The aspect, which is rather puzzling, is that the IA appointed by the government had had no experience in any kind of the engineering projects, not to say in projects of this size. Apparently this is the main reason why no real progress has been made in the physical implementation of the Project so far, although the project started on 21 June 2002. Two heating seasons have been lost, although all documentation was ready in 2001. This has created serious anxiety of the municipal governments who made their boiler refurbishment plans with the GEF project taken as one of the components.

The problems due to the delays have been further aggravated by the fact that waiting in vain some potential wood waste suppliers have signed contracts with other recipients. Also some potential heat customers have switched from coal to oil, because they could not wait any longer with their dilapidated boilers.

The fate of the Project is uncertain at the moment. It is anyhow given here as another case study of a failure caused by political factors or actors.

**The conclusion is that a very needed and well-designed demonstration project can fail if its management is given to people who have no relevant knowledge or experience.** In this case the engineering knowledge was crucial, while the project was given to an organization whose experience in this field was next to none.

## B

### Integrated Approach Project in Slupsk

#### Introduction

This project illustrates the usefulness and relevance of the Integrated Approach, if it is professionally managed. Slupsk commune is situated in the north of Poland (Pomorskie Province). The Slupsk county is an example of biomass use in public schools. During the period 2001-2003 a programme was implemented, in which heating systems in a number of schools were converted from coal to biomass.

#### Outcomes of the research

At the beginning the fuel will be based on industrial wood waste because there exists a surplus of unused post-production residues. The next stage of the programme is to use biomass fuel from local energy plantations. The programme is linked with active effort of the local authorities to create new jobs for local people.

The programme was divided on two stages:

- Thermal modernization of buildings
- Replacing 10 coal boilers of total capacity **1673 kW** by biomass ones of total (reduced) capacity of **1147 kW**.

The project was initiated in 2001 and completed in September 2003.

In effect, the whole programme resulted in:

- effect of the reduction of heat demand
- environmental pollution reduction effect and
- financial effect

#### Reduction of Heat Demand

In the first stage the programme gave the 30-35% heat savings which (reduction of heat demand from 1673 kW down to 1100 kW). This was achieved mainly by thermal modernization of the buildings.

The second stage of the programme was elimination of ineffective old coal boilers. The old boilers' heat efficiency was as low as 60%.

Due to the reduction of heat demand the investment costs on the biomass boiler side became lower. It also meant lower costs of fuel purchases.

#### Environmental effect

The environmental effect was achieved by reduction of gaseous emissions, which are presented in Table 1 and Figure 1.

Financial effect

The financial effect is 900 000 PLN (ca 200 000 EUR) per year for an average year i.e. for ca. 30000 GJ of heat annually. This means the lower costs of maintenance of the schools, managed by the public authority.

**Table2. Reduction of emission for the whole Slupsk commune**

	Total Annual Emission		Environmental effect	
	Before biomass investments [tonnes/year]	After biomass investments [tonnes/year]	Total reduction [tonnes/year]	Total reduction [%]
<b>SO<sub>2</sub></b>	<b>17,6</b>	<b>0,7</b>	<b>16,9</b>	<b>96,2</b>
<b>NO<sub>x</sub></b>	<b>2,7</b>	<b>0,6</b>	<b>2,1</b>	<b>76,3</b>
<b>CO<sub>2</sub></b>	<b>3 746,2</b>	<b>23,5</b>	<b>3 722,7</b>	<b>99,4</b>
<b>Coal dust</b>	<b>58,1</b>	<b>1,3</b>	<b>56,8</b>	<b>97,7</b>

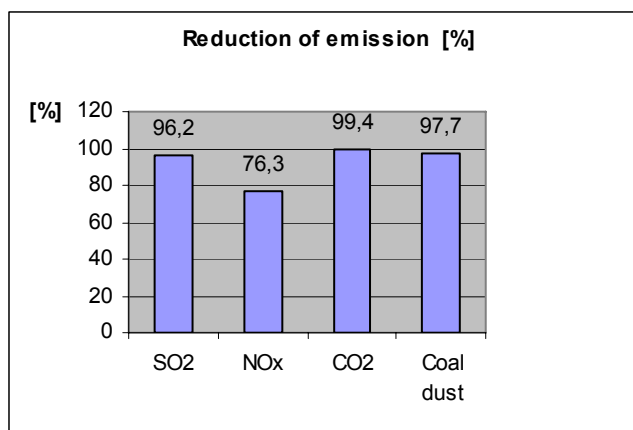


Figure 2. Reduction of emissions

Conclusions

The Slupsk example shows the possible impact of biomass investments in public buildings in the environmental and socio-economic areas. Jobs are created in the retrofit business and wood supply. .

The achieved financial results show that biomass programme can also be financial effective. This is a positive example of rational use of public financial sources and efficient use of energy.

It also demonstrates high awareness of local public authority and their influence on implementation the energy policy.

It also demonstrates the importance of the county level energy planning as the whole project has been implemented in accordance with the “Strategy of social and economic development of the county of Slupsk for 2001-2011”



## Poland Case study - Annex 4

### REGIONAL BIOMASS PROJECT IN SOUTHERN POLAND

#### JOINT INITIATIVE OF KRAKOW UNIVERSITIES

##### Background

Experts often enumerate barriers hindering the development of RES in Poland. The barriers usually enumerated are: **(i)** legal and financial barriers, **(ii)** insufficient information, **(iii)** difficult access to new technologies, **(iv)** lack of education and training programmes.

However, if one looks at the prospective development of biomass-based energy in Poland or its particular regions, one more barrier should be mentioned, which is lack of a comprehensive approach to the problem and lack of co-ordination of actions and initiatives, which so far are rather *ad hoc* and sporadic.

When considering any coordination or planning attempts in the area of the energy use of biomass one should bear in mind that the forms of biomass-derived energy compete to the same **limited resource in a given territory**, which is basically determined by: **(i)** available land area, **(ii)** soil characteristics and **(iii)** climatic conditions such as insolation or rainfall levels. Therefore, the natural problem that emerges is the problem of **optimization** of the use of the (potentially) available resource given the constraints outlined above which, basically constitute boundary conditions in searching for a minimum or maximum of a given function (total final energy in that can be derived, total GHG emission reduction, cost of unit GHG reduction, total local revenue etc.). The task that emerges is to provide a model that would support decision-making especially concerning the allocation of public money to promotion of biomass or Renewable Energy Sources in general.

##### Urgency

At present one observes an explosion of interest in planting the fast growing willow (*salix viminalis*) for direct combustion in boilers or production of pellets or briquettes. Given the local agro-technical conditions this needs not to be an optimum solution - there are other plants that often can give more final energy yield or financial revenue per hectare. A systemic approach to the problem is lacking and there is practically no co-ordination of actions and initiatives, which are mostly of an “at random” character. A scientifically verified data are needed to provide the guiding information for investors and local or regional authorities responsible for development and planning. This, however, requires adequately trained specialists, which are too few to meet the needs; notably:

- the ambitious targets set for “green electricity” which have already created practically unlimited demand for wood chips of *salix viminalis*
- the increasing demand for biomass for heating - particularly district heating – which creates a significant and constantly growing demand for biomass. This biomass may

originate from the agricultural residues, particularly straw, other energy plantations, such as *topinambur*, *sida hermaphodita* or *miscantus giganteus*, as well as for forest wood waste or post-production wood residues.

- The targets set for the fractional shares of liquid biofuels for motor vehicles which have already led to enormous interest among farmers and investors in planting crops for ethanol production and rape for biodiesel, as well as created a huge controversy concerning the state policy in this area].

#### **Joint research project**

Considering these circumstances four Krakow Universities

- Jagiellonian University,
- AGH University of Science and Technology,
- Krakow Polytechnic and the
- Krakow Agricultural University)

decided to undertake a common effort to provide scientifically based information for investors, utilities or local administrations to enable them make optimal decisions to maximize parameters of their interest. .

The project is of a multidisciplinary character and covers a broad spectrum of scientific research: biotechnology, genetic engineering botanic, agriculture, boiler and combustion engineering and chemistry.

The project has both research and demonstration components. It covers the whole chain of processes:

- biotechnology research
- selection of plants,
- agricultural technology (from planting to harvesting)
- processing into the final form of fuel (solid, liquid or gaseous)
- combustion, heat exchange etc up to
- treating the final combustion products (solid and gaseous)

So far, **32 research teams joined** the programme. A map of research plans, equipment and human resources has been made to avoid doubling of efforts and costs.

#### **Training and Demonstration**

Another dimension of the project is awareness raising and education by demonstrating the equipment or solution in field conditions. Therefore, one of the first steps is creation at AGH-University of Science and Technology of an **Education-Demonstration-Research Centre**, the target audience of which would be representatives of local administrations and SMEs.

The investment will be realised in several phases, starting with a straw boiler of capacity of 180 kW in the laboratory hall of the Foundry Faculty. The produced heat will be used initially for heating of the hall itself, which at present is heated by electricity. Since electrical heating is very expensive, the operation costs of the biomass boilers will be much smaller than the present costs of electricity.

Since installation of much higher capacities in the hall is possible, gradual connection of other objects is planned. As long as the adjacent AGH facilities are considered, connection of up to 3.5 MW heat via the existing grid can be accomplished at a relatively low cost.

It is tentatively estimated that once the system is expanded above 500 kW, it will become cost effective compared with the DH option. Still one should remember that, as mentioned above, the facility will also be used for teaching students and research, so that demonstration will present an additional value. One should also mention that the facility will be made available to students of other universities, and such is the understanding of the co-operation between universities of the AKCENT Consortium.

## ITALY

### **The Italian policy for decentralising energy planning at the regional and local level**

#### **How it all began**

There are more than 300 energy laws in Italy at the national level. A compendium prepared for the National Conference on Energy and Environment in 1998 sums up the evolution of energy legislation and planning in Italy with this statement: "Too many laws, some well done, others less so, often in contradiction with one another: what is needed are simplification, coherence, flexibility and separation between the legislation and the technical regulations."

The Ministry of Industry, Commerce and Handicraft (MICA) is the main body responsible for implementing Italian energy policy. Italian energy policy has changed dramatically since 1988, the year in which the last National Energy Plan (PEN) was issued. The issues that are in the forefront of Italian energy policy today include energy deregulation, environmental protection, energy security, taxation and economic growth. Before each of these issues is discussed individually, however, it is worth highlighting a few unique aspects of Italian energy policy.

#### **Energy and the Environment**

Italy signed the Framework Convention on Climate Change (FCCC) in Rio de Janeiro during UNCED in June 1992. Parliament approved Italy's agreement FCCC by Law No. 65 of 15 January 1994. The National Programme for Limiting Carbon-related Emissions to 1990 levels by 2000 was approved by the Interministerial Committee for Economic Planning (CIPE) in the session of 25 February 1994. This National Programme describes, inter alia, existing measures for energy efficiency and sets out in broad terms additional actions that Italy could take. The First Italian National Communication of January 1995 is based on the information and programmes contained in the National Programme for Limiting Carbon-related Emissions which gave high priority to energy efficiency through the following steps:

- Financial incentives in the industrial and transport sectors.
- Efficiency standards in transport, industry and residential sectors.
- Voluntary government-industry agreements on energy efficiency.
- Demand reduction programmes in the residential sector.
- Information dissemination and expanded product labeling and certification in the transport and residential sectors.

A report was prepared by CIPE (Governmental Economic Planning Committee) for the Second National Communication to the FCCC and released on 3 December 1997. The report envisaged several measures to be taken, i.e. regulatory measures, economic investments, promotion of renewables and voluntary agreements with industry.

### **Region's responsibilities**

Responsibility for energy policy lies primarily with the Ministry of Productive Activities (formerly Ministry of Industry, Commerce and Crafts), in co-ordination with other Ministries (including the Ministry for the Environment), interministerial Committees, government organizations and independent agencies. The Interministerial Committee for Economic Planning (CIPE) co-ordinates national energy policy with economic policy. It issues deliberations which give a framework to energy policy.

As far as energy is concerned, the Legislative Decree of 31 March 1998 (No. 112/1998) as modified by the Legislative Decree of 29 November 1999 (No 443/1999) shares the responsibilities among the state, the regions and the local authorities.

The State is still responsible for the elaboration and definition of energy policy objectives and guidelines, and for action to address and co-ordinate energy planning at the regional level. The new text of article 117 of the Constitution, introduced by the Constitutional Law of 18 October 2001 (No. 3) has inserted, among the subjects of current legislation, the production, transport and national distribution of energy: this means that the State sets the policy, the main guidelines and the general objectives by law, while the Regions concur to determine specific laws and rules for the realization of the objectives.

The Region's main responsibilities are as follows:

- The drafting and adoption of programmes aimed at promoting energy efficiency and renewable energy sources.
- Funding energy savings and controlling energy efficiency of industrial plants.
- Assisting local authorities responsible for the control of energy savings, rational use of energy and other rules lay down by regional legislation.
- Licensing for the building and management of electricity plants below 300 MW th.
- Granting licenses for onshore hydrocarbon production.

A Programme Agreement between the Regions and ENEA (the National Agency for New Technology, Energy and Environment) was designed to provide a framework for co-operation. A Regional Co-ordination Group for Energy was created in which ENEA acts as a secretariat to deal with issues under the regions' jurisdiction.

## **Improving energy planning capabilities of Regions**

The basic law on energy efficiency is Law No. 10/1991, entitled Regulations for the implementation of the National Energy Plan with regard to the rational use of energy, energy savings and the development of renewable energy sources. It is a framework law to introduce regulations aimed at the efficient use of energy sources in all end-use sectors including the specific reduction of energy consumption in production processes, especially in buildings and heating plants. The law provides for tax relief and the payment by local authorities of incentives to support the adoption of the most efficient technological solutions.

Laws n.9 and n.10 in 1991 and law 412 in 1993 represented the first concrete acts in the direction of promoting energy saving and renewable energy diffusion.

Law 9/91 stated a set of fiscal incentives for investments voted to save energy in the domestic and industrial sectors and for the first time allowed electric energy production by private generators.

Main issues of law 10/91 and its connected public acts are:

- all municipalities with more than 50.000 inhabitants must have an Energy Plan;
- all energy users consuming more than 1.000 toe (10.000 toe in the industry sector) per year must be provided of an “energy manager”;
- economic incentives are provided to projects devoted to energy saving;
- in all buildings belonging to the Public Administration the use of renewable energy is compulsory if its inapplicability could not be demonstrated;
- energy certification of buildings must be introduced to define new rules for the design of buildings and heating plants.

## **New energy planning methods and tools**

Within the Law 10/91 framework, the Italian Regions and most of the Local Municipalities with more than 50,000 inhabitants have started developing energy planning studies.

This effort, which has already 10 years of development, had an important role in defining new regional energy planning methods and tools.

Some of these methods were also cultivated within the burning interest of the European Commission (early '90s) towards the local energy planning and the decentralized planning promoted by local authorities.

One of the most reputed example of a generation of methods and tools in the Italian scene is represented by the planning activity promoted by the Italian Region of Umbria that is illustrated in the following summary.

## Regional Energy Policies and Building Retrofitting: the Towns of Umbria (Italy)

### 1. General Information

Having a population of about 800.000 inhabitants, a surface of 8.456 km<sup>2</sup>, Umbria is one of the smallest region of Italy. Its territory is covered for 94% with mountains and hills; its economy is basically founded on small industries, artisanal activities, and services. The high density of historical towns - like Perugia, Assisi, Gubbio, Spoleto and Orvieto - is a peculiarity of this region, affecting its image, the beauty of its lands and its touristical economy.

In the last fourty years, following the industrialization process of the Italian economy, Umbria suffered of a vigorous trend towards the abandonment of rural villages and houses, with disordered population growth for the nine bigger towns. This contributed to a further decrease of inhabitants in the most peripheral areas of the region, with major problems in maintaining the broad silver and forestal heritage of Umbria. Now, it is plausible that, without consistent policy in favour of the marginal areas of the region, the actual demographic trends could persist, with further population concentration, particularly in Perugia. The residential building stock figure is substantially favourable: a large quota of dwellings are in property, with adequate construction standards and comfortable living space per person. Less favourable is the housing condition of some historical towns, where rehabilitation projects are under implementation.

The energy figure of the residential sector in Umbria shows the following main characters:

Energy Sources	Consumption (MWh/y)
Natural Gas	1,750,471
Petroleum derivates	915,900
Biomass	661,479
Electricity	664,155
TOTAL	3,992,005

Energy Supply- Residential Sector - 1990

#### **Electricity**

The percentage of dwellings connected to the electric grid and the actual distribution, between resident and non-resident users, approaches the Italian average. The electricity consumption per dwelling averages the 2,200 kWh/year.

#### **Natural gas**

In 1990, the natural gas network was covering 47 towns over 92, where lives the 88% of the population. At present, the 46% of the regional dwelling stock is connected to the

gas network, while the 54% of the dwellings of the region use other types of fuels (petroleum derivatives and wood). In many towns of the region, such as Perugia, the natural gas is supplied to more than 75% of the houses. The average gas consumption per dwelling corresponds to 1,436 m<sup>3</sup>/year, in the colder province of Perugia, and equals 808 m<sup>3</sup>/year, in the warmer province of Terni. The natural gas consumption in the region is still increasing.

### Petroleum derivatives and wood

In 1990, the consumption of petroleum derivatives was 80,000 TOE, corresponding to the 23% of the domestic energy supply. Particularly high was the estimate of the contribution of biomass resources: 57,000 TOE, the 17% of the share.

REGIONE DELL'UMBRIA		CODICE ENERGIA		121
<b>CARATTERISTICHE GENERALI</b>				
EPOCA	1	<1919		
N. ALLOGGI	2	2-8		
CONTIGUITA'	1	contiguo		
<b>CARATTERISTICHE ENERGETICHE</b>				
POTENZA INSTALLATA	kcal/hm <sup>2</sup>	224.2		
	W/m <sup>2</sup>	260.1		
CONSUMO SPECIFICO	kWh/m <sup>2</sup> a	1.4		
PERDITE INVOLUCRO		73.4%		
PERDITE IMPIANTO		26.6%	± 12.7%	
INDICE DI CONSUMO	Tep/m <sup>3</sup> dd	29	± 7.2	
	Wh/m <sup>3</sup> dd	25	± 6.2	

## 2. Main Objectives

The energy study had a very pragmatical, but very ambitious goal: to provide to the Region and to the towns of Umbria the guidelines of a multi-annual energy and environmental planning for the residential sector, which shall encourage energy substitution and emission reduction, by promoting local investments, marketing of energy technologies and new employment. Priority was given to the substantial reduction of fossil fuel utilization for the residential sector, where oil or gas burning is extremely inconsistent due to the low temperature of the end-use. A major reference was provided by some recent international agreements, grouped in the AGENDA 21 programme, in which the governments involved declared that major efforts would be made in order to maintain the CO<sub>2</sub> emissions at the 1990 levels. The aim of the Umbria Region was to promote its governmental role, by respecting the international conventions, which have many consequences on land use, resources exploitation, structural and infrastructural change.

REGIONE DELL'UMBRIA		CODICE ENERGIA		111
<b>CARATTERISTICHE GENERALI</b>				
EPOCA	1	<1919		
N. ALLOGGI	1	1		
CONTIGUITA'	1	contiguo		
<b>CARATTERISTICHE ENERGETICHE</b>				
POTENZA INSTALLATA	kcal/hm <sup>2</sup>	135.6		
	W/m <sup>2</sup>	157.3		
CONSUMO SPECIFICO	kWh/m <sup>2</sup> a	2		
PERDITE INVOLUCRO		77.4%		
PERDITE IMPIANTO		22.6%	± 8.1%	
INDICE DI CONSUMO	Tep/m <sup>3</sup> dd	26.2	± 7.0	
	Wh/m <sup>3</sup> dd	31.2	± 6	

REGIONE DELL'UMBRIA		CODICE ENERGIA		122
<b>CARATTERISTICHE GENERALI</b>				
EPOCA	1	<1919		
N. ALLOGGI	2	2-8		
CONTIGUITA'	2	isolato		
<b>CARATTERISTICHE ENERGETICHE</b>				
POTENZA INSTALLATA	kcal/hm <sup>2</sup>	145.4		
	W/m <sup>2</sup>	168.6		
CONSUMO SPECIFICO	kWh/m <sup>2</sup> a	1.3		
PERDITE INVOLUCRO		70.9%		
PERDITE IMPIANTO		29.1%	± 3.0%	
INDICE DI CONSUMO	Tep/m <sup>3</sup> dd	25.2	± 5.2	
	Wh/m <sup>3</sup> dd	21.7	± 4.5	



### 3. Regional Energy Planning

#### 3.1. Energy System Analysis

In this area, an innovative tool, purposely developed for this project, is the so called dwelling energy code, which allows to classify the regional building stock in various categories, each of them representing a particular building type.

The dwelling energy codes could be seen as energy labels worked out for each building category.

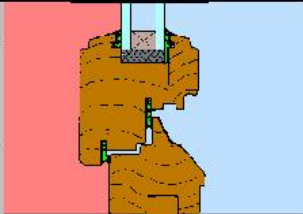
They are the basic references for implementing the energy balance of the residential sector and to evaluate different energy strategies.

The activities worked out in this area of the study are the following:

- detailed information on energy supplies for each of the 92 towns of Umbria;
- data set on the Umbria residential building stock from the Italian Census Data-Base, categorized through the dwelling energy code;
- comprehensive sectoral energy demand/supply model.

#### 3.2. Energy&environment policy simulator

Once developed the energy balance for the residential sector, a new tool for energy policy simulation, at the regional and town level, was implemented. The simulation pointed out the energy conservation and substitution potential, taking into account: investment costs, local resources exploitation, and environmental benefits. Energy conservation and substitution strategies were selected and implemented through the energy code method: every dwelling energy code was matched with the most compatible package of Energy Conservation and Substitution Opportunities, so that the effects of any policy could be easily estimated for the whole building stock. The TEP environmental data-base, then, was appropriately linked with the energy supply data, providing for each town the environmental balance. The balance of atmospheric emissions related to energy utilization can be regarded as a basis for the assessment of alternative energy policies, in order to estimate the environmental improvement related to different scenarios.

REGIONE DELL'UMBRIA	INTERVENTI DI RISANAMENTO ENERGETICO										
<b>Tipo:</b> INSTALLAZIONE/RIPRISTINO DELLE GUARNIZIONI DEI SERRAMENTI  <b>Sede:</b> CHIUSURE VERTICALI ESTERNE <b>Codice:</b> 2.3											
<b>DESCRIZIONE</b> Installazione o ripristino delle guarnizioni o riporto di materiale di battuta sui serramenti, per ridurre le perdite di energia dovute alle infiltrazioni d'aria.		<b>Conv. Economica</b> <b>Comp. Operative</b> A                              **									
<b>REQUISITI MINIMI</b> Riduzione della permeabilità all'aria (a 100 Pa e per metro lineare di giunto) a valori inferiori a 6 mc/h; durata minima garantita degli elementi di tenuta: 15 anni.		<b>Interazione</b> <table border="1" style="width: 100%;"> <tr> <td style="width: 25%;">3.4</td> <td style="width: 25%;">3.5</td> <td style="width: 25%;"></td> <td style="width: 25%;"></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> </table>		3.4	3.5						
3.4	3.5										
<b>APPLICABILITA'</b> Tutti gli edifici con serramenti ancora in buone condizioni ma privi di guarnizioni o con le stesse deteriorate.		<b>Costi stimati</b> <table border="1" style="width: 100%;"> <tr> <td style="width: 50%; text-align: center;">1500</td> <td style="width: 50%; text-align: center;">5000</td> </tr> <tr> <td style="text-align: center;">min.</td> <td style="text-align: center;">max.</td> </tr> </table>		1500	5000	min.	max.				
1500	5000										
min.	max.										
		<input type="button" value="Pacchetti"/> <input type="button" value="ESCI"/>									

### *3.3. Result of energy and building maintenance strategies*

Energy&building policies were implemented at the local level, to determine appropriate guidelines for each town.

The regional territory was subdivided in various homogeneous territorial units, which better reflect the land peculiarities and the local characters.

The following results are available for the regional policy makers:

- energy conservation/substitution potentiality on the local and regional scale;
- costs related to different energy policies for the residential sector;
- environmental assessment of the alternative energy conservation /substitution policies.

More than this, an interactive tool is available for decision making. TEP Model allows the full adaptation of the policies currently implemented, as well as the assessment of specific programmes of investment in the housing sector.

### *3.4. TEP Model configuration*

The 92 towns of the Umbria Region were grouped into Homogeneous Territorial Units (HTU), with reference to:

- socio-economic characteristics;
- climatic conditions;
- asyismic risk of damage for the building stock as well as its current fuel utilization.

Each HTU (Homogeneous Territorial Unit) summarizes the basic energy-building data, such as: total number of dwellings; global dwellings surface and volume; annual thermal energy consumption; electricity consumption; global emissions; etc.

The building stock of each town is aggregated and subsequently processed by means of the dwelling energy code method.

The 32 dwelling energy codes are indexed in a series of forms, reporting on their basic energy characteristics.

For each HTU is likely to associate a variety of Energy Conservation Opportunities, included into the TEP catalogue. These are measures that could be subsidized by the local Government within the Ten-year Energy Planning. The catalogue is the result of a selection among the most recurrent energy conservation and substitution techniques. Through the appropriate choice of a mix of Energy Conservation Substitution Opportunities, one can compare various energy-building policies at the town level, to yield the "energy-policy making" on a very detailed scale.

The actual energy balance, as well as the emission balance, could be displayed in conjunction with the results of alternative energy supply scenarios, in order to estimate the potential energy saving, the global cost of the policy, and the environmental benefits.

## 4. Impact and application

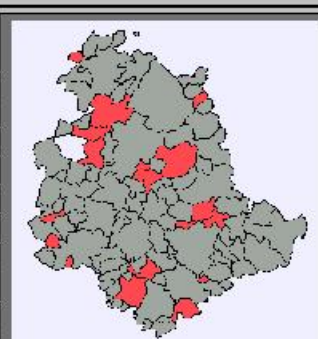
The result of the Ten-year Energy Policy for the residential sector in Umbria Region consists of a global budget to be invested of more than 600 million Euro. In order to appreciate the entity of such investment a term of reference is useful: the current Italian expenditure in building renovation is 15,000 million Euro per year, so that the provisional energy policy budget amounts to the 12-15% of the annual building renovation investment in Umbria.

Such a very effective policy could reduce of more than 38% the global energy dependency of the residential sector on conventional fossil fuels. In fact, the amount of energy saved or substituted with renewable sources, through the full implementation of the ten-year strategy, corresponds to almost 2,000,000 MWh/year.

The environmental benefits of the fossil substitution strategy are also significant in the medium term: the abatement of CO<sub>2</sub> totals 400,000 tons per year, while 2,500 tons per year is the equivalent of particulate pollutants reduction, and 332 ton/y that of nitrogen oxides. Finally, the plans of investment must rely on private financial resources, while the regional energy policy will assist the start up, by allocating the funds of the Italian law 10/91.

## 5. Project Outcomes

- a. The dwelling energy code methodology, a key aspect of the current study, has produced excellent results and would be substantially the same in case of replication.
- b. Since the goal was to provide "tools for action" to the Regional Energy Policy, a detailed (town based) and easy to access data-base for energy-building planning was essential.
- c. The interaction among the Technical Services of the Region and the Consultants was deep and fruitful.

REGIONE DELL'UMBRIA			COMUNE DI:				ASSISI
Codici Energia	Numero abitazioni	Superfici abitazioni (m <sup>2</sup> )	Pareti esterne (m <sup>2</sup> )	Coperture (sup. oriz.) (m <sup>2</sup> )	Serramenti esterni (m <sup>2</sup> )	Potenza installata (kW)	
111	192	17177	15116	6527	1202	2006	
121	554	44084	25128	13666	3086	5993	
121	91	7548	5812	2793	528	1155	
122	525	42293	21147	12688	2115	4697	
131	15	1023	501	266	72	55	
132	10	728	269	197	29	79	
141	0	0	0	0	0	0	
142	2	205	49	49	62	16	
211	166	15290	12538	6422	1376	993	
212	170	12891	12246	4770	1289	987	
221	89	7849	7457	2669	706	1209	
222	164	13779	10610	4271	965	2443	
231	6	540	427	119	49	13	
232	0	0	0	0	0	0	
241	1	94	78	24	8	8	
242	0	0	0	0	0	0	

Piano
Codici Energia
Esci

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