ESPON 2006 PROGRAMME

FIRST INTERIM REPORT

IDENTIFICATION OF PROJECT:

ESPON PROJECT 2.1.4.
ESPON 2006 PROGRAMME under Interreg III, art. 53.

"Territorial trends of energy services and networks and territorial impact of EU energy policy".

COMPOSITION OF CONSORTIUM:

PROJECT LEADER:

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

MEMBERS OF CONSORTIUM:

CENERGIA – Energy Consultants, DENMARK
SOFTECH - Energia Tecnologia Ambiente, ITALY
CIRIUS – Centro de Investigações Regionais e Urbanas, PORTUGAL
IGP – Instituto Geográfico Português, PORTUGAL
UMM - University of Mining and Metallurgy, POLAND

March 2003

SUMMARY

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1. Introduction

According to the terms of reference and to the consortium proposal a first interim report is due for the 31st March 2003. This report must elaborate on the following points:

a) A proposal on indicators and necessary data after a precise analysis of the availability and comparability of data at Community level;

b) A definition of the appropriate geographical level and technology required for data collection, taking into account the availability of the data;

c) A first detailed and comprehensive list of main statistical and geographical data to be collected from Eurostat, the EEA and National Statistical Institutes and National Mapping Agencies;

d) A first outline on concepts and the methodology of the impact analysis;

e) a structure of the description of the EU energy policy (mainly energy internal market, security of energy supply and implementation of Trans European Networks – Energy (TEN-E)).

While drafting this report we are still dealing with incomplete information, because the research of available data and other relevant sources is not yet completed, namely in what access to European databases is concerned.

Until now all the energy balances of the countries involved have been collected which will enable country level analysis and comparisons.

For the macroeconomic and demographic data we rely on Eurostat databases and on information already available from other ESPON projects.

Energy's importance to regional development has not deserved enough attention. As a consequence, relevant literature on the subject is scarce making concept development and impact assessment methodologies key issues on project development.

From the information available we feel that it will be very difficult to go beyond NUTS2 level. And even for this level of territorial desaggregation we foresee that important difficulties may arise.

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2. Objectives of the research project

In line with the terms of reference, this research project must address five main issues:

1. To analyse the territorial trends of energy supply & demand and their spatial patterns, 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. To design and carry out a territory impact analysis of the energy policy, seeking to quantify impacts from energy-related spatial development policies and to identify a set of parameters that may apply to policy decision-making;
3. To 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. To identify ESDP options relevant to the energy policy and submit proposals to make them operational and ensure their territorial diversification;
5. To 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).

3. Energy and territorial development

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.

Although, evolution towards a new supra-national framework, the growing importance of new energy sources and the re-structuring of markets - with the presence of new operators - all contributed to clearly evidence the current disparities between European regions in terms of prices and conditions of access to energy, which has thus become a key driver for territorial development.

One can identify five different types of energy territorial impacts:

a) *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[1] the energy sector corresponds to 3% of GDP and about 230 000 (direct an 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[2]. 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 2001 average EU electricity prices for industry were € 5.48 per 100 kWh and the average natural gas prices were € 5.62 per GJ, Differences between countries were in the order of € 2.42 (S) to € 8.54 (I) in the case of electricity and in the order of € 3.55 (UK) and € 8.42 (S) in natural gas[3]

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Market liberalization and European energy networks integration will have significant impacts in prices[4] 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

All European countries but England are heavily dependent on imported energy[5] and there is, probably, no relationship among regions that produce and the

[1] Repères sur l'énergie en France. (www.industrie.gouv.fr/energie/statisti/se_stats.htm)
[2] www.statbel.fgov.be
[3] Excise taxes included (www.europa.eu.int/comm/energy_transport/etif/list_of_tables.html)
[4] 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 liberalisation and of the evolution of fuel costs.
[5] See Quinto, Javier and alii,- Second Report on Economic and Social Cohesion: the Role of Energy, December 2000.

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 *redevance* paid to territorial communities for the use of natural resources.

d) Households behaviour and quality of life

Domestic and tertiary consumption accounts for 39% 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 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 tele-work opportunities.

e) Environment

In spite of a trend to lower energy intensity, CO_2 emissions will keep growing, along with an international commitment to stabilize, and after reduce, those emissions. 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 can 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.

4. Energy policy and ESDP options

ESDP states that energy production and transmission may impact on land use, while energy distribution and energy-use technologies may influence territorial development due to the changes induced in users' behaviour.

Although energy does not deserve much attention in the text of ESDP, one can expect an important contribution of energy to the ESDP options as they are approved in the Ministers' meeting of Postdam.

The implications of energy policies to ESDP options will be developed in the context of the work carried along the project. However some ideas may put in advance to be discussed and tested.

Energy options	**ESDP policy guidelines**		
	Development of a balanced and polycentric urban system and a new urban-rural relationship	**Securing parity of access to infrastructure and knowledge**	**Sustainable development, prudent management and protection of nature and cultural heritage.**
- Liberalisation and market opening - Completing internal energy market	▪ Sector restructuring: is there the risk of higher concentration of economic power in major urban areas? ▪ Lower differences in energy prices: it is not clear which regions/countries are winners or loosers ▪ Supply more responsive to the market: more advantages for more developed regions?	▪ The risk of reduced interest in supplying less developed and isolated regions is mitigated through the imposition of public service obligations. ▪ Higher benefits for major energy consumers	▪ Lower energy costs may reduce pressure to higher savings and efficient use of energy
- Overcoming bottlenecks - Security of supply - Need for new power plants - Interconnection capacity reinforcement	▪ Small impact on regional employment and regional income during the construction of energy infrastructures ▪ Major impacts on urban centres producing research and equipment	▪ Field for research and innovation	▪ TEN measures in the energy sector influence spatial organization through two main mechanisms: production and transmission of energy ▪ Possible difficulties linked to complex ratification procedures, varied technical and ecological constraints and acceptance on the part of the population.
- Lower dependence on traditional fossil	▪ Need for drastic measures in what	▪ Growing relevance of natural gas:	

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fuels - Reduction of emissions: fulfil the Kyoto commitments	concerns transport aiming to revitalise rail and inland water transport: towards more polarized development on major network nodes?	disadvantages for activities in less developed and isolated regions, with possible relocation of energy intensive industries	
- Energy efficiency - Intelligent energy management	▪ Promotion of a wise management of the urban eco-system. ▪ Support for effective methods of reducing uncontrolled urban expansion; reduction of excessive settlement pressure, particularly in coastal regions ▪ Pursue the concept of the "compact city" and concentrate new urban developments around public transport terminals	▪ There are technologies that permit efficient distributed generation.	▪ Internalisation of environmental costs: opportunity for new technologies ▪ Need for new energetic standards in building industry
- Renewable energies	▪ Rural areas have a considerable potential for renewable energy: solar energy; wind energy; hydroelectric power and tidal energy; energy from biomass; and even from urban waste near large towns and cities (methane production). ▪ Renewable energies may support economic diversification of rural regions and create new sources of revenue to agricultural explorations and to local communities (royalties, taxes, commercial income) ▪ Opportunity to introduce new agricultural productions (biofuels) ▪ Renewable energies may create a complementary relationship between cities and rural areas.		▪ Renewable energy sources cause very little pollution ▪ The objective is to duplicate the weight of renewable energies from 6% to 12% in 2010, and electricity from renewable sources from 14% to 22%

5. Constructing an energy database

One of the main objectives of this project is to **map the spatial pattern of energy** at a European level in a way that permits the assessment of territorial impacts of energy policies. Keeping in mind the different territorial impacts and the possibilities of different statistical sources[6], the first job to accomplish is the construction of a regional energy database covering all the European territory (15+12+2 countries).

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Energy is transportable and the degree of regional variability is not relevant in small territorial unities (for instance, electricity prices do not vary within the same national space). So, taking into account the project needs and the difficulties of feeding a coherent regional database on energy, efforts will be put in the construction of regional database at NUTS 2 level.

Five domains will integrate the database:

a*) Energy and regional economies*

Variables of this block will permit to identify the contribution of energy industries to regional (NUTS 2) economies, in terms of employment and GDP. It will contain:

- employment in energy industries (production, stocking, distribution), by energy type
- VAB in energy industries by type of energy;
- Community funded investment in the energy sector.

To obtain these variables we will explore Eurostat databases, namely data for the pertinent branches of structural business statistics by economic activity. Community funded investment in energy sector will be requested to DGTREN and DG REGIO.

b) Energy production

This block will organize data (whenever possible referred to NUTS 2) on physical energy production and energy potential. The following information will be collected to feed in the database:

1. Centralized energy production
   - Electricity
     Type of power plant (hydro, natural gas, coal, nuclear, ...), installed capacity (MW)
     Production in GWh
   - Refineries – Capacity (ton)
   - Oil
     Potential reserves, extracted volume
   - Natural gas
     Potential reserves, extracted volume
   - Coal
     Potential reserves, extracted volume

[6] For the moment, the analysis of the territorial level of the different sources of energy data is not yet definitive.

2. Decentralized energy production
   - Wind farms
     Production (GWh) and installed capacity (MW)
   - Cogeneration
   - Geothermal power plants
   - Solid waste power plants (with electricity production)
   - Small hydro
   - Biomass heat and power plants
   - Solar energy

3. Transmission (Networks) and energy storage
   - Natural gas networks
   - Electricity grids (per voltage level)
   - International connections
   - Terminals (coal, natural gas, oil and refined products)

Electricity production by energy sources (at NUTS 2 level) can be obtained from Regio database. For other energy types, Eurostat databases include information at country level and it must be tested if data at NUTS II can be made available. If not, we will try to obtain this data from national energy authorities[7] or national statistical offices.

c) Energy consumption

Two types of data are relevant to characterize regional energy consumption. By one hand, it is crucial to have data on energy consumption by energy type and consumption sector. On the other hand, prospects on energy consumption imply that we are aware of the regional economic structure in terms of energy intensity of different activities. So, we will try to feed database with the following variables:

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- Final energy consumption by type of energy;
- Final energy consumption by consumption sector (industrial sector, energy sector, transport sector, household sector, service sector);
- Employment by energy intensity of industrial sectors[8]

Data for electricity consumption by fuel power and electricity consumption by consumption sector (at NUTS 2 level) can be obtained from Regio database. For other energy types, Eurostat databases include information at country level. It must be tested if Eurostat can make available data at NUTS 2 level. If not, we will try to obtain this data from national energy authorities[9] or national statistical offices

d) Energy prices

[7] For instance, in France most of these data are available from the Observatoire de l'Énergie

[8] A first classification of industrial sectors according energy intensity may be: a) Energy-Intensive Manufacturing: bulk chemicals, petroleum refining, non metallic mineral products, steel; b) average energy-intensive manufacturing: food and paper; c) other manufacturing; d) transport; e) households; f) service sector.

[9] For instance, in Portugal we have data on energy consumption by energy type at *concelho* level.

Major spatial differences in energy prices will be among different countries. Often, States establish energy prices at a national level or, at least, at the level of the area of operation of different energy distributors.

Eurostat presents energy price data for some types of energy at country level and, in some cases, for major urban regions. In what concerns territorial impact assessment energy prices for major urban areas in European countries may be sufficient. We will build a database relative to energy prices for industry and energy prices for households for major European urban regions, if necessary from national energy authorities or energy distributors.

Alternative energy sources may be an important determinant of energy bill. Namely, access to natural gas is an opportunity to have a cheaper and cleaner energy. For all the European regions (NUTS 2) it will be included in database a dummy variable characterizing the industry access to natural gas.

e) Quality of electricity service provision

Energy costs in some regions are aggravated by the poor quality of energy provided: instability, interruptions, etc. We aim to build an indicator of electricity service quality (annual number of interruption hours). But, for the moment it is not clear that information is available at NUTS 2 level.

6. Defining a regional typology

Pertinent regional typologies, particularly those relevant to Structural Fund eligibility, will be a reference of our analysis.

But our proposed regional typology will have a prospective content referred to energy issues. This means that we want this typology, for example, to enable the identification of (i) economically dynamic and energy efficient regions, (ii) regions where energy is a bottleneck impeding development, (iii) regions with a strong potential for alternative energies, or (iv) regions that are more influenced (either positively or negatively) by energy trends. This typology will also take stock of territorial dynamics, particularly with regard to the question of polycentric dimension of territorial development.

To this effect, our regional typology will result from crossing at least three dimensions, i.e. spatial organisation, economic dynamics and energy. We want to use indicators that take into account the current situation and evolution of regions, namely indicators that concern:

a) spatial organisation
   - population density
   - urban fabric (percentage of population in metropolitan regions, urban areas, densely populated rural areas)
   - growth dynamics in urban areas

b) the regional economy

- GDP per capita
- GDP growth (convergence or divergence with the EU average)
- Manufacturing Added Value/ Km^2
- Growth of economic sectors, according to a typology that takes into account labour intensiveness, technology intensiveness and energy intensiveness
- The relative weight of the "energy sector" in regional economy (according with 5.a)
- Car ownership

c) the energy dimension

- Energy consumption/GDP
- Households energy consumption per inhabitant (according with 5.c)
- Percentage of inhabitants served with electricity
- Energy consumption by source of energy
- Energy consumption by consumption sector
- Environmental costs associated with the access to and use of energy
- Endowment of energy infrastructures and their weaknesses

NUTS 2 will be the reference of this typology. We shall use a methodology that combines data processing methods (cluster analysis, factorial analysis) with qualitative considerations, namely to consider energy interdependence among different regions.

The resulting typologies will be key tools for the assessment of energy territorial impact, in the sense that they will put in evidence the spatial relations between the different dimensions of underlying spatial data. The mapping of urban structures, economic dynamics and energy indicators will help clarify the impacts of energy on regional development. Additionally, typologies will be instrumental to:

- analyse the challenges facing each type of region and its dynamics, stressing the respective strengths and weaknesses;
- identify regions whose development is linked to specific energy-sensitive drivers;
- determine to which extent regions may be affected by foreseen energy scenarios;
- propose a further operationalisation and territorial diversification of the ESDP guidelines deemed pertinent in relation with energy.

7. Assessing territorial impact of energy

Energy is easily transportable and – both at worldwide as at European level or national level - the norm is a non spatial coincidence between energy production and energy consumption. In the other hand, technology opens several opportunities for energy saving, and the principal response to an increase in energy prices has been a decrease of energy intensity of GDP.

So, when we refer to Europe, it will be difficult to establish, nowadays, a cause-effect relationship between energy and territorial development. Data relative to European countries seems not to show any significant relation between development level, energy prices or energy intensity.

It seems that energy supply reacts to energy demand and we can't expect to clarify the impact of energy through the mere analysis of regional statistical relations between energy and economic structure and economic development.

Assessing territorial impact of energy means to answer three different questions:

a) what are the European spaces that win or loose in consequence of structural transformations in energy sector induced by Community policies (European scale)?

b) how energy impacts on spatial organization of people and activities at an urban, regional and national level (regional/national scale)?

c) what are the opportunities open to remote areas resulting from the trends identified in community energy policies.

The answer to these questions points to a methodology that combines the following steps:

a) Comprehensive and global analysis of the territorial impact

Ideally one could build a global regional model where energy and energetic relations are an explicit factor of regional development. The approaches concerning transport transeuropean networks are of this kind (SASI or IASON models). However there are no conditions to develop such an approach, nor are we convinced that results would be satisfactorily conclusive. We propose a much more simplified approach consisting on the investigation of significant relations between energy and territorial development.

As a hypothesis to be tested, we assume the existence of a relationship among the following five "blocks":

(i) The *energy supply* block:
- energy sources;
- energy infrastructures;
- operators and market framework

(ii) The *quality and type of service* block, including
- price
- reliability of supply

(iii) The *environment* block, inasmuch as the conditions of energy production, distribution and use are concerned

(iv) The *economy* block, including
- GDP (level an growth)
- Business location decisions
- Business conditions for competitiveness

(v) The *household* block, including the family residential options and the impact of energy policy on household's well-being

The proposed methodology assumes that a relationship between the spatial evolutions of these five blocks can be tested. What we will try to find is a relation like

$$Y_i = F(E_{i1}, E_{i2}, \ldots E_{in}, O_i),$$

Where Y_i is an indicator concerning economy or household behaviour and E_{i1}, E_{i2}, $\ldots E_{in}$ are indicators concerning energy accessibility and energy quality of service and O_i is an indicator or a set of indicators for the other development factors of the region.

We are aware of the weakness of this approach, as energy reacts to the growth more than the inverse[10]. We will try to minimize this weakness by:

a) considering for Y_i differential of growth from the region *i* to European average;
b) distinguishing Y_i by sectors in accordance with energy intensity (if energy is to have some effect, regions with major energy endowments will be more attractive for the energy intensive activities);
c) performing the analysis not considering each region *per se*, but contrasted, in what energy is concerned, groups of regions;
d) enabling that energy factors can be composed indicators (for instance the result of a factorial analysis) that enforces contrasts among regions.

Special attention will be paid to the relations between supply, service and enterprises, assessing

- the impact on energy supply of community investments, by checking (namely by means of statistical regression methods) if there is a relationship between investments made with EU funds, on the one hand, and the evolution of prices, energy reliability and the share of renewable energy sources, on the other hand.
- the relationship between energy supply and territorial re-structuring, by checking if there is a spatial relationship between the growth of energy-intensive sectors of the economy and the conditions of supply (mainly price) in different regions.

[10] This may point to the use of auto-regressive models for the estimation of the relevant statistical relations.

- the impact of energy on location decisions, by checking if at least there is a relationship between the location of some types of FDI with different levels of energy intensiveness and the regional distribution of energy prices.

b) Energy and spatial organisation

Given the unclear feedback relation between energy and development, energy impacts on territory can be clarified only by well suited case studies concerning controlled situations where we can put in evidence what are the results imputable to energy dynamics.

Case studies are envisaged to answer five orders of questions:

(i) How investments in energy sector are translated into more favourable conditions of energy supply to industry and to households? What are the relations between the development of energy sector and the growth of regional economy? What is the potential impact of renewable energies to revitalise rural and less developed areas?

(ii) Can we devise changes of behaviour of households and businesses in consequence of changes in the conditions of energy supply? What can we say about impacts of energy changes on transport sector? What is the nature of energy environmental impacts?

(iii) What is the real degree of regional disparities concerning access to energy? What are the real disadvantages of business in regions lacking access to some types of energy (for instance, natural gas)? At what level of disparities in energy access can we expect relocation movements of industrial activities?

(iv) The introduction of a cheaper energy has implied processes of consumers' adjustment? In what sense: modification of global demand, choosing new technologies (vg. different modes of transport)? The cost of adaptation: there is a need of some sort of incentives to accelerate the adoption of new forms of energy?

(v) How energy facilities are planned and developed? Is there some relation between energy market structure and energy supply? What is the role of infrastructure in quality of energy service? How energy infrastructures take into account environment and the needs of lagging territories?

Five case studies from the European Space will be selected for an in-depth analysis of impacts resulting from change occurred at three levels, i.e. (i) changed market organisation, (ii) interconnection of the Trans-European Networks, and (iii) reduction of energy prices. Case studies to be made, in the light of regional development, will be the following

i) renewables, emissions control and self reliance
ii) TEN-E impact, namely natural gas availability
iii) market liberalization
iv) networking reinforcement

v) distributed generation and its impacts on infrastructures management

We are identifying the best case studies in view of some generalisation. Portugal, Spain and England may be a reference for these case studies but other countries/regions may be chosen for analysis.

c) Opportunities to remote areas

Market liberalisation, introduction of new forms of energy (the growing relevance of natural gas) and the emphasis on the development of renewable energies impact differently on remote rural areas. There is a risk for these regions becoming even less attractive in what concerns energy. But, in the opposite sense, they have clear possibilities for the development of alternative energies.

To clarify the prospects of these regions, we propose to select 6 remote regions, including insular regions, and to conduct for each of them a SWOT analysis, supported on interviews to key players in the energy and regional development field, relating to energy trends in Europe.

First list of main statistical data to be collected (*)
(spatial dimension: NUTS II)

Variables	1995	2001 (or the most recent year)
Spatial organisation		
Area (km^2)		x
Population	1991	x
Degree of urbanisation	1991	x
Population in major urban areas (>500 000 inhabitants)	1991	x
Population in densely populated areas	1991	x
Population in intermediate urbanized areas	1991	x
Population in sparsely populated areas	1991	x
Regional Economy		
GDP per capita (PPP)	1991, 1995	x
GDP (Euro), by sector (17)	x	x
Employment by sector (17)	x	x
Employment in energy industries (electricity, gas, petroleum, …)	x	x
Value added of energy industries (electricity, gas, petroleum, …)	x	x
Value added of industry intensive sectors (DF, DG, DI, DJ)	x	x
Car ownership	x	x
Energy production		
Electricity production by power source	x	x
Oil refining	x	x
Gas	x	x
Coal	x	x
Decentralized energy capacity: installed capacity, by type of power source		x
Decentralized energy production, by type of power source		x
Transmission infrastructure: length of networks, by type of energy	x	x
Storage capacity		x
Terminals (coal, natural gas, oil and refined products)		x
Energy consumption		
Percentage of inhabitants served with electricity	1991	x
Percentage of households expenses in energy and transport	1991	x
Final energy consumption, by energy type	x	x
Final energy consumption by consumption sector	x	x
Energy consumption of transport sector by mode of transport		x
Energy prices and service quality		
Energy prices for industry (electricity, gas, petroleum products/net prices and taxes included)	x	x
Energy prices for households (electricity, gas, petroleum products)	x	x
Annual number of electricity interruption hours	x	x
Energy and environment		
CO_2 emissions	x	x
Investment in energy sector		
Investment in energy production	1995-2001	
Investment in renewable energies	1995-2001	
Investment in energy networks	1995-2001	
Community funded investment in the energy sector	1995-2001	

(*) Depending on data availability.

8. Key energy indicators

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

In what follows a proposal will be made for subsequent research on data availability.

With the indicators the main characteristics of the reality to be studied are supposed to emerge. The indicators battery to be reliable 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 level and at country level have nowadays some common goals: security of supply, competitive energy markets, environment sustainability.

A range of indicators to measure and compare the different aspects of the energy sector in the regions concerned is proposed.

A. Economy, society and energy

A.1 TPES/population (toe per capita)

TPES – total primary energy supply

A.2 Electricity consumption/Population (kWh per capita)

A.3 TPES/GDP (toe per 000 Euro)

A.4 Electricity consumption/GDP (kWh per 000 Euro)

A.5 Household energy use per person

A.6 Number of private cars per 1000 inhabitants

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B. Reliable supplies of energy

B.1 Electricity generating capacity (GW) and average load factor (%)

B.2 Electricity generation capacity (GW) by source

B.3 Shares and diversity (Shannon-Weiner measure[11]) of fuels used for electricity generation

B.4 Proportion of electricity generated by renewables

B.5 Gas capacity (kWh/day) and actual maximum demand

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[11] **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.

B.6 Ratio of energy production to primary energy consumption

B.7 Fossil fuels dependency (fossil fuels as a percentage of primary consumption)

B.8 Annual electricity failures (hours/year)

B.9 Refining capacity and quantities refined

B.10 Grid density (high and medium voltage)

C. Competitive energy markets

C.1 Fuel price indices for the industrial sector

- heavy fuel oil, gas, electricity, coal

C.2 Fuel price indices for the domestic sector

- gas and electricity

C.3 Fuel price indices for the transport sector

C.3 Competition in electricity generation (The Herfindahl-Herschmann measure[12])

C.4 Competition in electricity sales to industry (The Herfindahl-Herschmann measure)

C.5 Competition in electricity sales to the commercial sector (The Herfindahl-Herschmann measure)

C6 Competition in electricity sales to the domestic sector (The Herfindahl-Herschmann measure)

D. Environmental objectives

D.1 Greenhouse gas emissions (emissions, Kyoto targets)

[12] **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.

9. Structure of the description of the EU energy policy (mainly energy internal market, security of energy supply and implementation of Trans European Networks – Energy (TEN-E)

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9.1 REVIEW OF EU ENERGY PROFILE

TRENDS and ISSUES

Energy sector in the national and regional economies	**By NUTS 2 (if possible)**
	Analysis of the main physical and institutional issues related to the energy sector Sectors' gross added value (by product over the last 10 years) Importance of energy sector in the GDP (by energy product) Importance of investment in the energy sector by region (if possible) Investment Employment in the energy sector by product and region Impact of the energy sector in the trade balance Access of the population to the energy products (coverage of the territory: electricity and gas)

Analysis of demand	**By NUTS 2 (if possible) over the last 10 years**
	Consumption of primary and final energy by region Consumption of primary and final energy by economy sector -services sector -domestic sector -buildings sector -transport sector -industry sector Energy intensity by sector and by regional economy (e.g. energy intensity of GDP) Energy efficiency by sector and by regional economy National and regional demand management programmes

Analysis of supply	**By NUTS 2 (if possible) over the last 10 years**
	Analysis of regional situation by product -electricity -natural gas -oil & derivates -coal -nuclear Installed capacity (main power plants: conventional + renewables + cogeneration) Main energy resources by region (fossil fuels and renewable) Energy prices Import dependency Infrastructures Electricity networks -high voltage lines -submarine links -protection, monitoring and control systems Natural gas networks -high pressure gas pipelines -underground storage facilities - reception, storage and re-gasification facilities for liquefied natural gas -protection, monitoring and control systems Technological developments Opening up of markets Public funding Security Environmental protection

NOTE: Need for integration of energy indicators (e.g. energy intensity of GDP) and regional development indicators.

9.2 REVIEW OF CURRENT EU POLICY SITUATION

NEEDS and OBJECTIVES

Sustainable development in EU policy	
	Treaty: Art. 2: Sustainable development Art. 6: Integration of environment Sector priorities (Gothenburg 2001) Equal attention to economic, social and environmental aspects (Barcelona 2002)

Implementation of Internal Energy Market

Reinforcing Community Cohesion	
	Energy in rural areas and ultra-peripheral regions Energy city-environment

	Cross border
Reinforcing Security of Energy Supply	
	Green Paper: Towards a European strategy for the security of energy supply (2000)

Strengthening of relations with third energy producing / transit countries

Integration of networks on the scale of the European continent and the areas bordering it
Preparation of enlargement of EU

MAIN POLICIES and MEASURES

Single energy market development

Energy infrastructure TEN-E	
	Electricity sector -Connection of isolated electricity networks -Development of interconnections between the Member States -Development of interconnections with third countries ***Natural gas sector*** -introduction of natural gas into new regions -connection of isolated gas networks -increase reception and storage capacities -increase in transport capacities (supply gas pipelines)

Multi-annual programme “Intelligent Energy for Europe” (2003-2006)

Energy efficiency in buildings	
	Energy efficiency in buildings (Directive 2002/91/EC, 16.12.2002) -to promote the energy performance of the buildings; -to contribute to reach the savings potential of around 22% of present consumption in the residential and tertiary sector which accounts for more than 40 % of final energy consumption in the Community. -CO_2 emissions avoidance: about 150 Mt/year or 40 % of the EU Kyoto commitment.
Combined heat and power production (CHP)	
	Combined Heat and Power production (CHP) Proposal COM(2002) 415, 22.7.2002 -to improve energy efficiency and to reduce CO2 emissions -framework for MS to promote co-generation, common definitions and methodologies -Energy labelling of domestic appliances; objective: energy saving 10% by 2020; measures: minimum

	energy efficiency requirements
Energy labelling of domestic appliances	
Renewable energy use for electricity production	
	Promotion of Green Electricity; Directive 2001/77/EC **RES: wind, solar, hydro, biomass, landfill gas, biogas, wave, tidal, geothermal. Legal basis: Art 175** -to establish a framework to increase the share of green electricity consumption from 14% to 22% by 2010 -to support the Green Paper objective of doubling the share of renewable energy consumption from 6% to 12% by 2010 -to support compliance with the commitments under Kyoto Protocol on reducing GHG emissions. -quantified indicative national targets for electricity consumption from RES -national support schemes -simplification of national administrative procedures for permits -guaranteed access to transmission and distribution of electricity from RES

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Nuclear package	Three technical measures: -Nuclear safety (1) and decommissioning (2) of obsolete installations: -Proposal (30/01/2003) for an EP and CS Directive on the safety of nuclear installations during operation and decommissioning; - Management of waste (3): -Proposal for an EP and CS Directive on radioactive waste One market measure: -Trade in nuclear materials with Russia: A draft Decision from the EP and the CS authorising the Commission to negotiate an Agreement between Euratom and the Russian federation on trade in nuclear materials. Proposal for a Directive on the safety of nuclear installations during operation and decommissioning Objective: - to guarantee common legally enforceable methods and criteria throughout the enlarged Union; - to guarantee adequate financial resources for the decommissioning funds required. Measures: - common safety standards; - monitoring mechanisms; - independent safety authority in each MS. - Community rules for the constitution, management and use of funds required with own legal personality distinct from the nuclear operator. ***Proposal for a Directive on radioactive waste management*** Objective: to produce a clear, transparent response to the radioactive waste management issue. Measures: -adoption of national programmes for the storage of radioactive waste in general and deep geological disposal of highly radioactive waste in particular; -decision by MS on geological disposal sites for highly radioactive waste no later than 2008, operational by 2018 at the latest; -low activity / short-life waste storage sites operational by 2013 at the latest.

Energy stocks	Proposals COM(2002) 488-1/5, 11.09.2002. Current status: transmitted to EP and Council on 13.09.2002 -to guarantee the security of external supplies of oil and natural gas means: Community mechanisms ensuring unity and solidarity in the event of problems with the supply of oil and gas, i.e -coordinated and efficient use of oil stocks - minimum measures to guarantee the gas supply -to set energy dialogue between producer and consumer countries -to acquire/ensure technical expertise to apply the measure Proposals COM(2002) 488-1/5, 11.09.2002 Communication entitled "The internal market in energy: coordinated measures on the security of energy supplies". - EP and Council Directive on measures with regard to security of supply of petroleum. -EP and Council Directive on measures with regard to safeguard security of gas supply. -Council Directive repealing CS Directives 68/414/EEC and 98/93/EC on minimum stocks obligation of crude oil and/or petroleum products and CS Directive 73/238/EEC on measures to mitigate the effects of difficulties in the supply. - Council Decision repealing CS Decision 68/416/EEC related to minimum stocks and consumption reduction when oil supply difficulties
Biofuels in Transport	Greenhouse gas emissions strongly growing in transport Communication COM(2001)547, 7.11.2001 including proposal for a Directive on biofuels Quantified targets for gas, biofuels, hydrogen to achieve 20% by 2020

9.3 WAY FORWARD TOWARDS SUSTAINABILITY IN ENERGY

Completion of the single markets for electricity and natural gas

Energy taxation

Energy efficiency improvement in demand and equipment

Combined heat and power production (CHP)

Renewable energy sources and nuclear energy

Trans-European network extension to Accession Countries

Alternative fuels

Reduction of CO_2 emissions

Environmental performance - Kyoto	
	Clean energy efficient vehicles; Alternative fuels including H_2; "Directive" Energy efficient public procurement; "Framework directive" on minimum standards for energy efficiency; "Directive" on the promotion by energy suppliers of end-use efficiency; Thematic strategies on sustainable use of natural resources and prevention/recycling of waste; "Directive" on mining waste; Air quality: "daughter directive" on heavy metals and PAH.