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ReRisk Regions at Risk of Energy Poverty

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Draft Final Report

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This report presents the interim results of an Applied Research Project conducted within the framework of the ESPON 2013 Programme, partly financed by the European Regional Development Fund.

The partnership behind the ESPON Programme consists of the EU Commission and the Member States of the EU27, plus Iceland, Liechtenstein, Norway and Switzerland. Each partner is represented in the ESPON Monitoring Committee.

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Table of contents

Figures

Tables

Maps

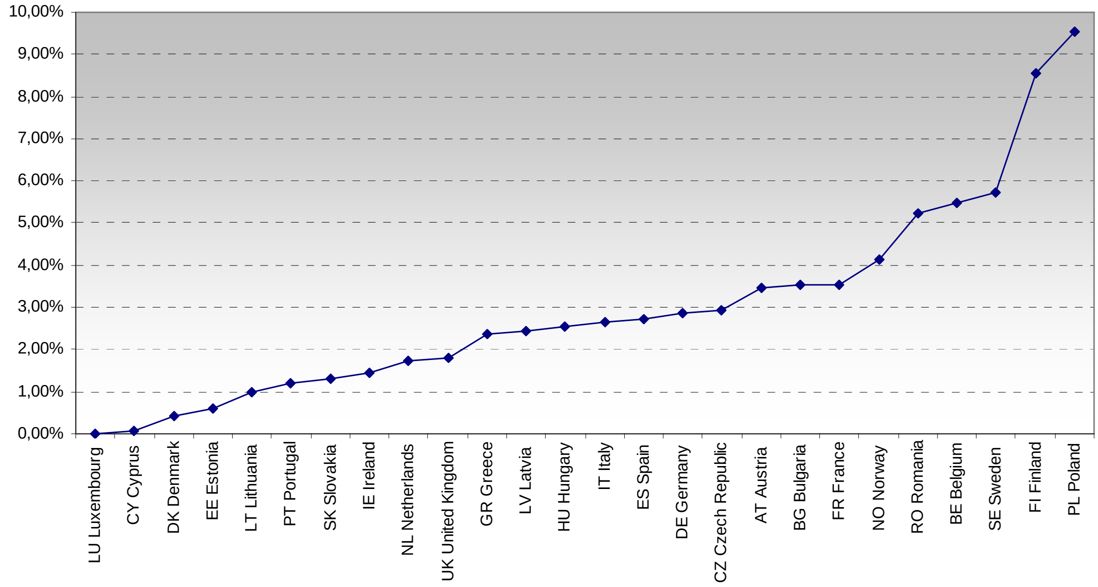
1. Executive Summary

Political pressure to fight energy poverty, at least at the household level, is mounting in Europe. However, policy initiatives in this field are hampered by the lack of basic data on how energy is used in Europe. This report presents the initial findings of the ReRisk project on the implications of energy poverty in EU regions for economic competitiveness and social cohesion. The original indicators used to measure economic and social vulnerability, as well as dependence on (motorized) transport have been completed with data on the climate characteristics in the regions (important for heating and cooling demand), and the potential to develop renewable energy resources (PV and wind).

The combined data has then been processed further in a clustering process in order to identify groups of regions with similar characteristics, which may be addressed by a common set of policies. The policy recommendations, which are the main output of the second phase of the project, have also taken into account the long-term planning framework in the energy sector, which is described in four qualitative scenarios. Further input was obtained from a survey of 40 regional administrations, from the case studies carried out in several EU regions (Samsø, Denmark; Navarra, Spain; Kalundborg and Landskrona, Sweden; and Freiburg, Germany) and from relevant EU policy documents.

As requested by the response to the Updated Interim Report, the analysis on regional competitiveness has been amplified to take into account the expected impact of carbon pricing on certain sectors and subsectors in Europe, based on the list of industries with risk of “carbon leakage”, which was published recently by the European Commission. “Carbon leakage” refers to the possibility that companies decide to transfer their production facilities to countries outside the EU if production costs rise as a result of carbon taxes. The analysis done by the Commission services complements the ReRisk results as it combines production costs with the intensity of trade with third countries. Based on employment data, it has been possible to identify the EU countries with the highest “risk of carbon leakage” and to indicate some regions that may face specific problems in this context.

Employment in sectors at risk of carbon leakage per country as a percentage of industrial employment



Source: Eurostat. Own elaboration.

In Poland, Finland, Sweden, Belgium and Romania between five and ten percent of industrial employment could be affected if companies decide to relocate their activities. By combining the data on regional economic structure and industrial employment, some possible “hotspots” of carbon leakage can be identified. However, regional employment data available from Eurostat is not detailed enough to carry out this analysis on the level of subsectors, so that the results presented in the next paragraph need to be confirmed based on regional data.

“Carbon leakage” seems to be a major threat to the Belgian provinces of Brabant Wallon and Antwerpen, which should analyse the situation in the subsectors *DG2414 Manufacture of other organic basic chem*icals and *DG2415 Manufacture of fertilizers and nitrogen compound*, since these spend more than the EU average on energy purchases. There could also be a problem, although minor, in the German region of Koblenz with regard to DI 263 Manufacture of ceramic tiles and flags and in Düsseldorf with regard to DJ271 Manufacture of basic iron steel and of ferro-alloys. The British regions of East Yorkshire and Northern Lincolnshire might be exposed to the risk of carbon leakage by companies dedicated to DG 2413 Manufacture of other inorganic basic chemicals, which do not perform well with regard to the subsector’s average energy expenditure.

Antwerpen and East Yorkshire and Northern Lincolnshire are two of the 52 regions, which face the greatest challenges in terms of competitiveness in a situation of rising energy prices. This group of regions with the most unfavourable industrial structure, due to their high levels of energy spending (cluster 3), has been identified during the clustering exercise. The clustering process used nine indicators reflecting the different factors which influence energy poverty (climate conditions, economic structure, transport dependency, social vulnerability and production potential of wind and solar energy). The final set of indicators used for the clustering process is the following:

- **Climate conditions**
  - Mean maximum temperature July: this indicator reflects the mean maximum temperature in July over the last 15 years. It is relevant for identifying the regions with high cooling demand in summer and will become more important as temperatures rise as a consequence of climate change. (Map 2, Annex 1)
  - Mean minimum January temperature is equivalent to regional demand for heating in the winter. All temperature-related data was facilitated by JRC Ispra - IPSC - MARS Unit.

- **Economic structure**
  - The percentage of employment in industries with high energy purchases indicates the regional dependence on industries with high energy spending. Values above 10% of employment in industries with high energy purchases were determined to be outliers. These are mostly located in Northern Italy and the Czech Republic (Map 4, Annex 1).

- **Transport dependency**
  - Fuel costs of freight transport: Regions in Bulgaria and Romania and generally regions in East Europe and Spain appear to exhibit significantly higher values in the proportion of fuel costs for freight transport than the average of EU Regions (2.53%). The cited regions thus have a higher vulnerability regarding fuel prices (Map 5, Annex 1).
  - % workers commuting: This variable measures the relation between the population commuting to other regions and population working in the same region. The spatial patterns show high levels of commuting in Central Europe and less in the peripheries (Map 6, Annex 2).

- **Social vulnerability**
  - Long-term unemployment rate: There is an apparent strong spatial inequality with regard to long-term unemployment in Europe. Map 7 shows the spatial distribution of the values of this variable for the 271 regions, for which data is available.
  - Disposable income in households: Map 8 shows that the East-West divide in Europe in terms of income persists.

- **Production potential of renewables**
  - Wind power potential: the original data on wind intensity in the regions was prepared in GIS format by the European Topic Centre on Air and Climate change (ETC/ACC), led by PBL the Netherlands, on request of the EEA (EEA, 2009). It has been converted to NUTS 2 level by the NTUA researchers, who collaborate in the ReRisk project and the help of the ESPON database project (ECT-LUSI from UABT). It measures the

production potential of wind power stations, taking into account environmental and other restraints (Map 9).

- o <u>PV potential:</u> The regional potential for electricity production from PV panels has been calculated and supplied by the Joint Research Centre's Sunbird data base, which forms part of the SOLAREC action at the JRC Renewable Energies Unit. The data refers to the yearly total yield of estimated solar electricity generation (for horizontal, vertical, optimally-inclined planes) [kWh] within the built environment. Map 10 in the annex shows the regional distribution of this indicator.

The indicators were then weighed based on expert judgement and allowed to identify four clusters of regions, as indicated in the table below:

	Mean	***Cluster Centres***			
		1	**2**	**3**	**4**
Maximum temperature July	31.62	31.70	31.12	33.43	26.73
Minimum temperature January	-8.26	-7.36	-5.99	-10.06	-17.23
% employment in industries with high energy purchases	4.42	3.44	3.69	8.59	6.38
Fuel costs of freight transport	2.53	2.31	1.74	3.89	2.57
% workers commuting	9.46	7.23	45.87	5.50	3.53
Long-term unemployment rate	39.22	40.11	37.54	43.39	21.58
Disposable income in households	13316.31	14036.55	15752.46	8595.01	11321.29
Wind power potential	142525.07	114226.80	81414.17	55296.27	809093.41
PV potential	979.24	982.25	902.82	1045.55	815.14
Number of Cases		191	27	52	17

Taking into account the information elaborated in the ReRisk project on the regions' vulnerability to rising energy prices, as well as data from previous ESPON typologies, the clusters can be described as follows:

Cluster 1 can be divided into two groups of regions, which represent European average: the first one is composed of Southern regions, with a high level of social vulnerability and therefore considered lagging, but with development potential, both for renewables and with regard to regional specialization. The second sub-cluster is characterized by regions with high disposable income, located mainly in the centre of Europe and belonging to the EU Pentagon, which are the regions considered to be the motor of economic growth in Europe.

Cluster 2 is mainly composed of central, non-lagging regions, which are, however, vulnerable in terms of transport as they show the highest commuting rates and – so far – spend a reduced percentage of their GDP on fuel costs for freight transport.

Cluster 3 is composed of the most vulnerable regions in terms of competitiveness, with low level of specialization, located mainly in the East of Europe, with high energy demand both for heating and cooling.

Cluster 4 has as its main advantage the high wind potential in non-lagging regions. Nevertheless, these are peripheral regions located outside the Pentagon, which is an important disadvantage in terms of transport dependence, and they have a high energy demand for heating.

Summarizing, the typology developed in the ReRisk project (based on pre-crisis data) adds value to those previously defined in ESPON research projects, indicating that, with rising energy prices:

1. A large group of so far lagging regions have options for growth by exploiting their potential for renewables, while others could become even less competitive and face growing social problems.
2. Some of the Pentagon regions, especially in Belgium, could benefit less from growth opportunities in the economic centres, thus dropping out of the circle of best-performing regions in Europe.
3. So far wealthy regions in the European periphery, especially the North, with a heavy industrial base, may have to analyze how increasing energy bills will affect companies' competitiveness.

This analysis shows that different sets of policies are needed to cope with the challenge of rising energy prices on a regional level. However, as the survey to regional administrations has shown, energy policies are to a large extent determined by national policies and are embedded in a long-term planning framework. Energy - like spatial - planning requires the development of infrastructure and therefore operates with a time horizon of 30 to 60 years. The energy sector is presently undergoing a far-reaching transition process, and the political and investment decisions that are now being made will shape the framework for regional competitiveness for time to come. It is for this reason that the policy recommendations presented in this report use information obtained from scenario building. Energy policies are still highly diverse in Europe, and the policy recommendations must be "robust", meaning that they must help the regions to reduce their vulnerability on the short term and improve their adaptive capacity in the longer term under different framework conditions.

The four ReRisk scenarios, which were elaborated with the help of external experts, are based on the common hypothesis that energy prices will remain at a high level, but where the political response to this challenge is different. Scenario 1 "Green High-tech" assumes a quick development of renewable energy sources, both large and small-scale, a situation in which the regions gain greater influence on energy policy. In this scenario, regions can specialize in certain types of renewable energy production and will gain from cooperation and shared networks.

The second scenario "Energy-efficient Europe" assumes a greater use of natural gas by 2030, while trying to keep Europe's energy dependency within limits through important efficiency gains in all sectors and a move towards more regionalized economies. In this situation, regions that depend on gas supplies from only one producer region, will have to deal with a higher risk of supply interruptions, but economic development will probably follow a fairly balanced and more sustainable path.

In the case that present plans to expand the use of nuclear energy are actually implemented in a large number of Member States, as assumed in "Nuclear Energy for Big Regions", it should be expected that the power sector will remain highly centralized, since few players are able to carry out the needed investment. The logical consequence would be to "go electric" both in industry and transport, but these decisions will be little influenced by local and regional policy makers.

Choosing (clean) coal to fill the gap of dwindling oil reserves, as described in "Business as Usual?", would obviously benefit the mining and some harbour regions and fits well into certain protectionist ideas in Europe. However, in most parts of Europe, (imported) coal is a preferred option not because of price, but because of availability of reserves. Production from coal power plants will become even more expensive when technologies for carbon capture and storage are widely deployed. This could lead to a situation, in which high energy prices provoke continued backlashes in a world economy that is not able to function "as usual". In this case, a large number of regions, and especially urban areas, will face severe social problems over longer periods of time, due to increases in consumer prices.

Within this context of national energy policy, regions do have scope to act, especially with regard to policies promoting energy efficiency and the setting of environmental standards, which can go beyond European or national norms. According to the survey of policy makers, regional involvement is comparatively higher in the field of renewable energy and natural gas projects, while their influence regarding coal use and nuclear plants is reduced.

Regional competences vary with regard to energy research, since in only six Member States, plus Norway, regions are carrying out their own R&D programmes in the energy field. Experts in the field argue that there is a greater need for regional participation in energy research to promote the use of renewable energy sources: "Sustainable energy supply structures based completely on the importation of knowledge and technology do not seem to be favourable for countries and regions. Local or regional R&D constitutes a good basis to optimise energy systems and to reduce vulnerability. Besides, the yield of renewable energy sources and the types of optimal technologies depend, in part, on local (climatic) conditions. Thus, specific technologies have to be developed – mostly by means of local or regional R&D" (Luther 2004).

Taking into account the limitations of regional competences in the energy field, policy recommendations focus on the intersections with other policy domains, in which regions and municipalities *do* have a decisive influence and can be supported by EU actions, namely:

1. Governance models and regional cooperation
2. Spatial and urban planning
3. Environmental protection and risk prevention
4. Deployment of renewable energy sources
5. Promotion of energy efficiency
6. Social policies

With regard to good governance, the main attention should be paid to policies promoting energy solidarity between regions, in line with the Territorial Agenda, through different actions, including the extension of regional and local networks. The modernization of transport and energy networks is one of the actions to be reinforced by the "EU 2020 Strategy" and, according to the Association of European Border Regions (AEBR), should take into account the territorial dimension. The findings from the ReRisk project confirm that this is a central issue for reducing the vulnerability of regions with a high level of commuting and for the development of broader and complementary portfolios of renewable energy sources in neighbouring regions.

Spatial and urban planning provides innovative tools for promoting the integral development of solar energy use, for understanding how energy and other resources are being used in urban environments ("urban metabolism), and for the promotion of cooperation between regional actors, for example in the form of "industrial symbiosis".

In the field of environmental protection and risk prevention, the most pressing problems are related to possible climate change impacts on the regional energy infrastructure, as laid out in the discussion paper submitted along with the Updated Interim Report. Climate change impacts are likely to be most severe in the Southern regions belonging to Spain, Greece, Portugal and France, both in terms of energy production and demand. In these regions, summers are going to be complicated for energy companies, due to diminishing water reserves, higher average temperatures and heat waves, and consequently, forest fires. The supply problems will coincide in time with higher peaks of electricity demand, derived from a more extended use of air-conditioning. These issues could be addressed when implementing the national emergency plans for the prevention of heat waves, which have already been approved by some European governments.

Regional "maps of untapped energy reserves" could be of great use for developing longer-term plans in the regions. The data on PV and wind potential should be completed at the regional level with an evaluation of the "feasible" potential of the different technologies available, including concentrated solar, geothermal, wave / tidal technologies, biomass, and hybrid solutions.

Action is also urgently needed to reduce the vulnerability of those regions which rely heavily on air transport (i.e. peripheral territories and the big European transport hubs). The aviation industry is expected to face serious supply problems in the coming decades and alternative energy sources must be developed quickly. Unfortunately, in the opinion of the regional policy makers, the transport sector as a whole is the most problematic field of transition while actions promoting energy efficiency in the residential sector seem to be easier to implement.

In order to achieve greater efficiency in energy use, some basic steps need to be taken at the European level. Data on energy use and efficiency is collected in 61% of EU regions, but these need to be harmonized in order to measure and monitor progress in this area. Benchmarks are needed to determine companies' performance with regard to energy efficiency on detailed subsector levels.

Companies can furthermore contribute to reducing regional energy consumption through the improvement in office buildings, with new arrangements of space and working times, which would also reduce the need for commuting.

Regions can support the development of markets for energy efficiency on the basis of, for example, white certificates with pilot projects. Along with municipalities, the regional level is decisive for including energy end-users, including SMEs, into European research and demonstration projects, as well as in energy efficiency strategies in general.

User information, transparency and comparability of prices and energy bills, as well as education and training are considered key elements for fighting energy poverty at the household level. Little is known, however, on how this problem is being addressed in social policies. Therefore, much work still need to be done before the "European Charter on the Rights of Energy Consumers" can be implemented.

All the policy measures proposed in this report are considered important to fight the different forms of energy poverty in the regions, but some have a higher priority for certain clusters and under different scenario assumptions. In the final chapter on conclusions for policy making, this input to the debate with policy makers is presented in two tables, in which the recommendations are evaluated with respect to the regional clusters and the four scenarios.

Cluster 3, for example, groups the regions with the most unfavourable economic structure, so that industrial diversification strategies are vital to conserve competitiveness. Since this cluster is also characterized by high demand for heating and cooling, the construction of efficient networks is also a priority. Likewise, regions with high levels of commuting (cluster 2) or at the periphery (cluster 4), with an important dependence on air travel, have a greater need for action in the field of mobility and freight transport.
Social policies play a crucial role for regions in cluster 1 and 3 and under the assumptions of the "Business as Usual?" scenario and could be combined with innovative financing measures on the municipal level. For regions with low disposable income, but considerable PV potential, urban solar planning tools may provide the information necessary to achieve the greatest deployment of these technologies at the lowest cost possible. In Member States that opt primarily for building new nuclear plants and will therefore

have a large baseload capacity (electricity that is being produced 24 hours a day), overall energy efficiency may not be the determining aspect in the corresponding policies, but rather the shift from fossil fuel use to the constant consumption of electricity. A critical question in this context is acceptance and consumer preferences, for example for “green tariffs”.

European initiatives are especially important where benchmarks are needed, for example in industries with high energy spending, and for promoting regional cooperation through network extension, energy research and the development of a joint and more reliable renewable portfolio. The European framework will furthermore be decisive where major transition processes need to be implemented, mainly with regard to air and freight transport.

Detailed results on the indicators of energy poverty in the 287 regions included in the analysis can be consulted in Annex 2 of this report.

2. Introduction

"EU urged to prioritise tackling energy poverty"[1]. The NGO network INFORSE raised the voice of alarm at the end of December 2009, as it became obvious that more and more European households face difficulties paying their energy bills. The NGOs' concern is shared by the European Parliament, which, in June 2008, called on Member States to "to set up National Energy Action Plans addressing energy poverty" and to "invest as a priority in comprehensive energy efficiency measures for low-income households, thereby addressing in a strategic manner both the problem of fuel poverty and the '20 % by 2020' energy efficiency target adopted at the 2007 Spring European Council" [EP 2008].

The Parliament and Inforse are mainly concerned with the impact of rising energy prices and diminishing incomes on household level, while the Commission is presently analysing the possible consequences of carbon taxes (and higher production costs) on the European companies. In the comments on the Updated Interim Report, the ReRisk team was asked to consider this latter aspect in this Final Report, so some additional data has been elaborated and is presented in the following pages.

In the second chapter on the clustering exercise, the analysis of regional vulnerability, which was presented in the Interim Report, has been extended to include additional indicators on climate and development potential for renewable energy sources (wind and PV).

Grouping the regions in clusters that present different features of energy poverty is necessary to define policies, which help to reduce their vulnerability on the short term, while the scenario exercise in chapter 4 introduces a framework for longer-term energy planning, with the objective of improving the regions' adaptive capacity.

The information obtained from both exercises, as well as data gathered from the survey of regional decision-makers and the case studies is then condensed in a set of policy recommendations in the last chapter of this report.

3. Further Analysis on Competitiveness - Risk of "Carbon Leakage"

The Commission Decision of 24 December 2009 [EC 2009b] defined **a list of sectors and subsectors which are deemed to be exposed to a significant risk of "carbon leakage"**. These are sectors and subsectors, which could consider relocation as a consequence of the direct cost of the CO_2 allowances that the companies must purchase and the indirect costs from higher electricity prices. Since this analysis is also relevant for the competitiveness of the EU regions, the ReRisk team has compared the Commission's list with the project's own findings on industrial energy spending and has tried to identify the regions, which face the greatest risk of "carbon leakage".

[1] January 2010, http://www.euractiv.com/en/energy/eu-urged-prioritise-tackling-energy-poverty/article-188554

The Commission defines these sectors as follows:

“15. A sector or subsector shall be deemed to be exposed to a significant risk of carbon leakage if:

(a) the sum of direct and indirect additional costs induced by the implementation of this Directive would lead to a substantial increase of production costs, calculated as a proportion of the gross value added, of at least 5 %; and

(b) the intensity of trade with third countries, defined as the ratio between the total value of exports to third countries plus the value of imports from third countries and the total market size for the Community (annual turnover plus total imports from third countries), is above 10 %.

16. Notwithstanding paragraph 15, a sector or subsectors also deemed to be exposed to a significant risk of carbon leakage if:
(a) the sum of direct and indirect additional costs induced by the implementation of this Directive would lead to a particularly high increase of production costs, calculated as a proportion of the gross value added, of at least 30 %;or

(b) the intensity of trade with third countries, defined as the ratio between the total value of exports to third countries plus the value of imports from third countries and the total market size for the Community (annual turnover plus total imports from third countries), is above 30%”. [EC 2009a]

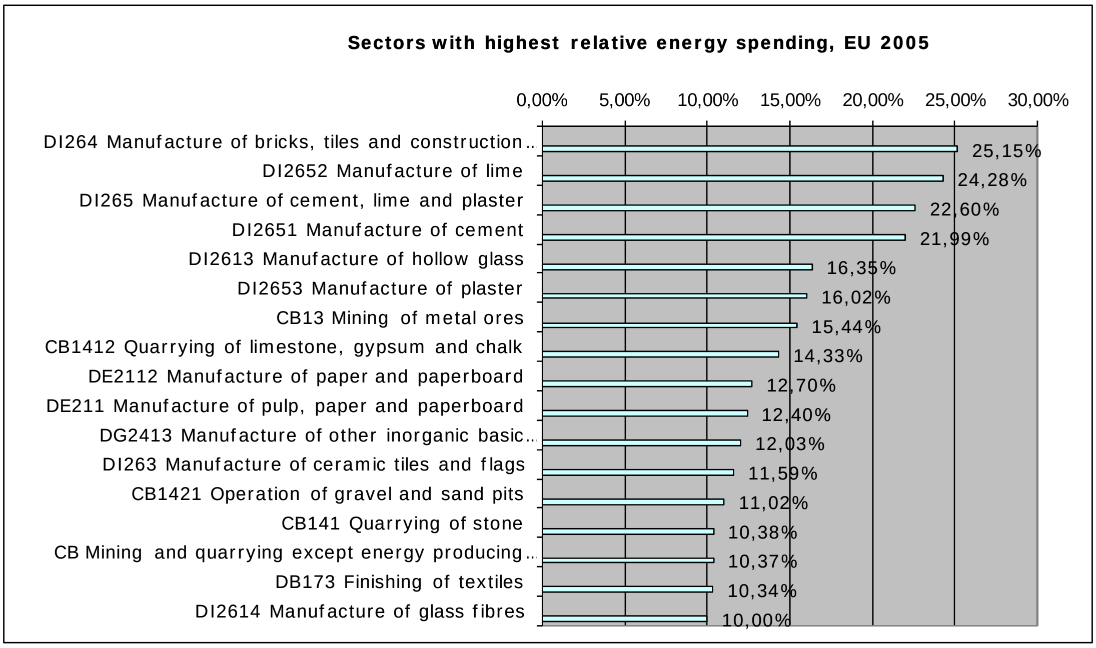
The analysis has been made by the Commission for the years 2013/14, assuming a carbon price of 30 € / t of CO_2. The resulting list comprises 16 subsectors on NACE 4 level, which would be exposed considering the criteria laid out in the paragraphs 15 **and** 16 of Article 10, as well as 11 subsectors corresponding to paragraph 15 and two subsectors corresponding to paragraph 16(a). The subsectors, which show a risk of “carbon leakage” only because of their intensity of trade (paragraph 16 b), but not as a result of increased production costs, have not been considered in our analysis.

The comparison of sectors with risk of carbon leakage and sectors with high energy spending (those which spend 10% or more of their total purchases on energy) shows that some of the sectors with the highest energy spending are not considered to be exposed to a significant risk of carbon leakage. These are activities such as *CB1412 Quarrying of limestone, gypsum and chalk, CB141 Quarrying of stone, CB1421 Operation of gravel and sand pits, DI2614 Manufacture of glass fibres* or *DI264 Manufacture of bricks, tiles and construction products*.

In addition, there are some sectors and subsectors exposed to a significant risk of carbon leakage, which have low levels of energy purchases, such as CB143 *Mining of chemicals and fertilizer minerals, DA 1583 Manufacture of sugar, DA1595 Manufacture of other non-distilled fermented beverages, DA1597 Manufacture of malt, DB181 Manufacture of leather clothes, DF231 Manufacture of coke oven products, DF232 Manufacture of refined* *petroleum products, DG2417 Manufacture of synthetic rubber in primary forms, DJ2721 Manufacture of cast iron tubes, DJ2731 Cold drawing, DJ2742 Aluminium production, DJ2743 Lead, zinc and tin production, DJ2744 Copper production, DJ2745 Other ferrous metal production and DK2931 Manufacture of agricultural tractors*.

The sectors, which have a high level of energy spending (more than 10% of total purchases) and are considered to be at risk of carbon leakage, are displayed in the graph below.

Figure 1: Sectors with highest relative energy spending, EU level



Source: Eurostat. Own elaboration

Based on the ReRisk findings, we can highlight those countries where these industries spend more on energy purchases than the European average[2]. Consequently, these might be considered most vulnerable after the implementation of this Directive:

- *DI2652 Manufacture of lime*: this sector has the highest relative energy spending in Hungary, Germany, Spain, Greece and Portugal.
- *DI2651 Manufacture of cement:* energy purchases are a considerable production cost in this sector all over Europe, but the highest levels of purchases can be found in companies in Greece, Slovakia, Italy, Hungary, Germany and Austria.
- *DI2613 Manufacture of hollow glass*: energy costs are highest for companies in Romania, Slovakia, United Kingdom, Portugal, Greece, Hungary and Belgium.
- *DI2653 Manufacture of plaster*: the companies with the highest energy spending are located in Hungary, Germany, Spain, Greece and Portugal.

[2] Please note that the following countries have not been included in this analysis for lack of data: Albania, Bulgaria, Switzerland, Lithuania, Malta, Poland, Slovenia

- *DE2112 Manufacture of paper and paperboard*: again, energy purchases are generally high in this industry, but for companies in Belgium, Lithuania and Slovakia this cost is higher than average.
- *DG2413 Manufacture of other inorganic basic chemicals*: highest relative energy spending in United Kingdom, Austria, Spain and France.
- *DI263 Manufacture of ceramic tiles and flags*: energy purchases (as % of total purchases) are highest in Portugal, Greece, Hungary, Germany and Ireland.

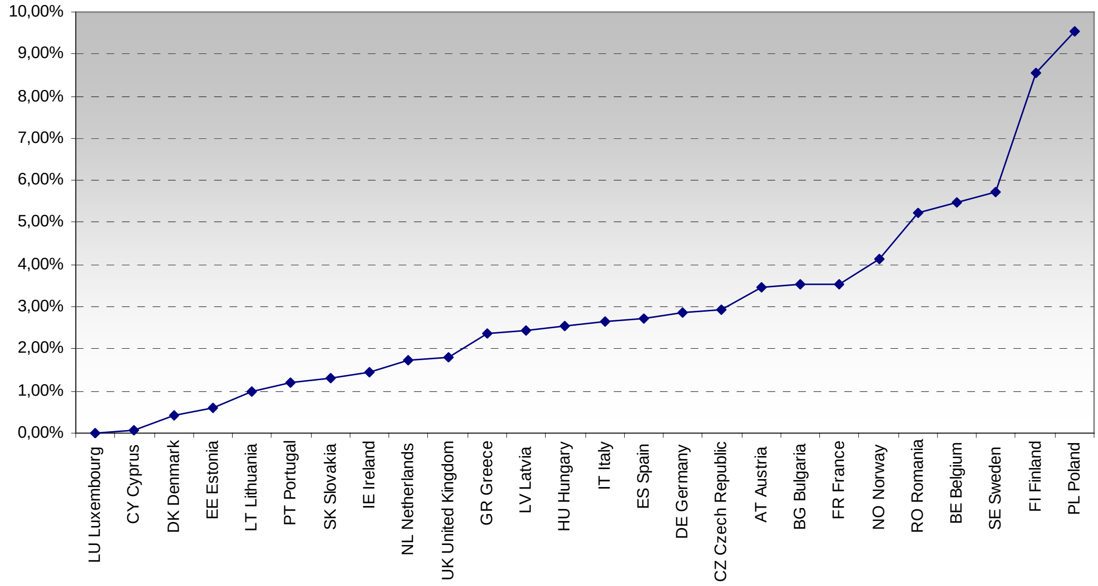
The analysis realized above and based on the European average must be completed with country-specific data in order to take into account also those national industries, which spend more than 10% of their purchases on energy, even if the sector in the EU on average remains below this threshold. The list of most vulnerable sectors can be completed as follows:

- *CA101 Mining and agglomeration of hard coal*: highest relative energy spending in Hungary, United Kingdom and Spain.
- *DA1592 Production of ethyl alcohol from fermented materials:* highest relative energy spending in Hungary and Romania.
- *DB1711 Preparation and spinning of cotton-type fibres:* highest relative energy spending in Austria, Hungary and Romania.
- *DG2414 Manufacture of other organic basic chemicals:* highest relative energy spending in Belgium, Latvia, Norway, Romania and Slovakia.
- *DG2415 Manufacture of fertilizers and nitrogen compounds:* highest relative energy spending in Hungary, Romania, Belgium and Netherlands.
- *DI2611 Manufacture of flat glass:* highest relative energy spending in Romania and Finland.
- *DJ271 Manufacture of basic iron and steel and of ferro-alloys:* highest relative energy spending in Romania, Austria, Hungary, Norway and Germany.

The data indicates that the Eastern European Countries (Romania, Hungary and Slovakia) and two Mediterranean Countries (Greece and Spain) are those with a highest energy relative spending in sectors at risk of carbon leakage.

Taking into consideration all sectors at risk of carbon leakage, it is possible to determine the possible impact of “carbon leakage” on industrial employment. As shown in the graph below, in Poland, Finland, Sweden, Belgium and Romania between five and ten percent of industrial employment could be affected, if companies decide to relocate their activities.

Figure 2: Employment in sectors at risk of carbon leakage per country as a percentage of industrial employment



Source: Eurostat. Own elaboration

These findings cannot be entirely transferred to the regional level, because data on employment is not available for the different subsectors (NACE 4 level), but only for the larger sectors (NACE 2 level). However, since most of the affected sectors belong to four NACE groups (DE 21 Manufacture of pulp, paper and paper products, DI 26 Manufacture of other non-metallic mineral products, DJ27 Manufacture of basic metals and DG24 Manufacture of chemicals and chemical products) an estimate can be presented here:

Table 1 Regions with more than 25% of total industrial employment in sectors at risk of carbon leakage

NUTS2_2006	NAME	%employment DE21	%employment DI26	%employment DJ27	%employment DG24	%employment total
BE31	Prov. Brabant Wallon	4,82%	0,00%	9,87%	41,25%	55,94%
DEB3	Rheinhessen-Pfalz	2,10%	4,09%	1,18%	34,78%	42,15%
NL34	Zeeland	0,00%	2,58%	18,47%	20,21%	41,26%
BE21	Prov. Antwerpen	2,00%	3,32%	14,69%	21,06%	41,06%
BE22	Prov. Limburg (B)	2,83%	7,35%	23,97%	6,83%	40,98%
SE31	Norra Mellansverige	11,62%	0,76%	22,12%	1,67%	36,17%
NL11	Groningen	9,81%	4,66%	13,72%	7,79%	35,98%
UKE1	East	3,56%	4,69%	16,63%	10,83%	35,72%

Table 1	**Regions with more than 25% of total industrial employment in sectors at risk of carbon leakage**					
NUTS2 _2006	**NAME**	%employment DE21	%employment DI26	%employment DJ27	%employment DG24	%employment total
	Yorkshire and Northern Lincolnshire					
BE32	Prov. Hainaut	2,17%	11,36%	10,36%	11,42%	35,31%
FI1A	Pohjois-Suomi	5,39%	2,38%	26,65%	0,00%	34,41%
NL13	Drenthe	2,06%	4,67%	13,71%	12,75%	33,19%
SK04	Východné Slovensko	1,68%	3,86%	24,56%	2,39%	32,50%
DEA1	Düsseldorf	2,26%	2,58%	14,31%	13,01%	32,16%
UKD2	Cheshire	3,87%	2,92%	1,12%	23,04%	30,95%
ES12	Principado de Asturias	1,17%	7,61%	17,19%	4,25%	30,23%
BE23	Prov. Oost-Vlaanderen	3,74%	3,37%	15,94%	5,79%	28,85%
NL32	Noord-Holland	2,07%	1,36%	17,28%	8,08%	28,79%
GR24	Sterea Ellada	0,00%	9,33%	15,97%	3,38%	28,68%
AT33	Tirol	0,00%	16,34%	5,10%	6,85%	28,29%
DEA2	Köln	4,89%	4,04%	3,75%	15,26%	27,96%
LU00	Luxembourg (Grand-Duché)		7,93%	16,43%	3,42%	27,79%
NL33	Zuid-Holland	1,47%	3,24%	12,56%	10,46%	27,73%
NO03	Sør-Østlandet	8,72%	4,93%	2,76%	10,76%	27,18%
DE41	Brandenburg - Nordost	5,21%	6,02%	12,33%	3,48%	27,04%
BE33	Prov. Liège	2,14%	4,83%	14,28%	5,06%	26,31%
SE32	Mellersta Norrland	15,51%	2,01%	4,03%	4,39%	25,94%
NL42	Limburg (NL)	4,10%	8,55%	3,10%	9,85%	25,60%
FR23	Haute-Normandie	3,22%	5,17%	2,66%	14,32%	25,37%
DE71	Darmstadt	1,40%	1,54%	1,90%	20,50%	25,33%
DEB1	Koblenz	4,82%	9,42%	5,62%	5,42%	25,28%

Source: Eurostat. Own elaboration.

Combining the available data, “carbon leakage” seems to be a major threat to the Belgian provinces of Brabant Wallon and Antwerpen, which should analyse the situation in the subsectors *DG2414 Manufacture of other organic basic chem*icals and *DG2415 Manufacture of fertilizers and nitrogen compound*, since these spend more than the EU average on energy purchases. There could also be a problem, although minor, in the German region of Koblenz with regard to DI 263 Manufacture of ceramic tiles and flags and in Düsseldorf with regard to DJ271 Manufacture of basic iron steel and of ferro-alloys. The British regions of East Yorkshire and Northern Lincolnshire might be exposed to the risk of carbon leakage by companies dedicated to DG 2413 Manufacture of other inorganic basic chemicals, which do not perform well with regard to the subsector's average spending on energy.

For the rest of the countries with high levels of industrial employment in sectors at risk of carbon leakage, it has not been possible to establish the relationship between higher than average energy spending and certain sectors and regions. Further analysis based on more detailed regional employment data will be needed to determine the actual risk of carbon leakage and it possible impact on regional competitiveness.

4. Clustering of Regions by Features of Energy Poverty

The indicators used for describing different features of energy poverty in the European regions have been submitted to a clustering process in order to identify groups of regions with similar characteristics, which could be addressed by policy initiatives. The calculations were carried out using the cluster algorithm called k-means procedure, which attempts to identify relatively homogeneous groups of cases based on selected characteristics. It is a quick algorithm and the results of the analysis can be easily mapped. [Kalogirou 2003]

In a first step, the indicators elaborated in the initial phase of the project (data collection) had to be checked with regard to their appropriateness for the clustering exercise. 20 indicators for 287 regions were available, but some had to be excluded, because they a) had small size, b) were correlated with other variables, c) had extreme values, or d) be much-skewed[3].

After this check of data quality, 11 indicators were considered appropriate for the clustering exercise. However, these indicators were not deemed to be equally important for measuring the regions' vulnerability to rising energy prices. Therefore, they were weighted based on expert judgement in a workshop held in Bilbao in October 2009. After this selection, 9 indicators reflecting the different features of energy poverty (climate conditions, economic structure, transport dependency, social vulnerability and production potential of wind and solar energy) were used in the clustering exercise.

The initial set of indicators is presented in Table 2 grouped in five categories. The indicators in bold fonts passed both the statistical and policy relevance tests, whereas those in italic fonts failed these tests. Indicators in standard fronts were found inappropriate for analysis, due to statistical flaws.

[3] For a detailed description of the methodology applied, please see the report on the clustering exercise, submitted as annex to the Updated Interim Report.

Table 2 Final set of indicators

Category	Indicators
Climate conditions	**Mean maximum temperature July (Max T July)**
	Mean minimum temperature January (Min T Jan)
	Mean annual temperature (Mean T)
	Mean maximum annual temperature (Max T)
	Mean minimum annual temperature (Min T)
Economic structure	**% of employment in industries with high energy purchases**
	% of GVA in industries with high energy purchases
	Private energy use
Transport dependency	**Spending on transport fuel for freight as % of GDP**
	Population commuting to other regions / population working in the same region
	Employment in the transport sector as % of total employment
	Age of car park (Average age of cars)
	Number of passengers travelling by air / total population
Social vulnerability	**Long-term unemployment rate**
	Disposable income in households
	Age dependency ratio
	Economic activity rate
Production potential of renewables	**Wind Power Energy Potential 2005**
	PV potential
Other	Region Area Size

The variables included in the clustering are, therefore, the following:

- **Climate conditions**
  - Mean maximum temperature July: this indicator reflects the mean maximum temperature in July over the last 15 years. It is relevant for identifying the regions with high cooling demand in the summer time and will become more important as temperatures rise as a consequence of climate change. (Map 2, Annex 1)
  - Mean minimum January temperature is equivalent to regional demand for heating in the winter. All temperature-related data was facilitated by JRC Ispra - IPSC - MARS Unit.

- **Economic structure**
  - The percentage of employment in industries with high energy purchases indicates the regional dependence on industries with high energy spending. Values above 10% of employment in industries with high energy purchases come out as outliers. These are mostly located in Northern Italy and the Czech Republic (Map 4, Annex 1).
- **Transport dependency**
  - Fuel costs of freight transport: Regions in Bulgaria and Romania and generally regions in East Europe and Spain appear to exhibit significantly higher values in the proportion of fuel costs of freight transport than the average of EU Regions (2.53%). The former regions have thus a higher vulnerability with regard to fuel prices (Map 5, Annex 1).
  - % workers commuting: This variable measures the relation between the population commuting to other regions and population working in the same region. The spatial patterns show high levels of commuting in Central Europe and less in the peripheries (Map 6, Annex 2).
- **Social vulnerability**
  - Long-term unemployment rate: There is an apparent strong spatial inequality with regard to long-term unemployment in Europe. Map 7 shows the spatial distribution of the values of this variable for the 271 regions, for which data is available.
  - Disposable income in households: Map 8 shows that the East-West divide in Europe in terms of income persists.
- **Production potential of renewables**
  - Wind power potential: the original data on wind intensity in the regions was prepared in GIS format by the European Topic Centre on Air and Climate change (ETC/ACC), led by PBL the Netherlands, on request of the European Environmental Agency. It has been converted to NUTS 2 level by the NTUA researchers, who collaborate in the ReRisk project and the help of the ESPON database project (ECT-LUSI from UABT). It measures the production potential of wind power stations, taking into account environmental and other restraints (Map 9).

- PV potential: The regional potential for electricity production from PV panels has been calculated and supplied by the Joint Research Centre's Sunbird data base, which forms part of the SOLAREC action at the JRC Renewable Energies Unit. The data refers to the yearly total yield of estimated solar electricity generation (for horizontal, vertical, optimally-inclined planes) [kWh] within the built environment. Map 10 in the annex shows the regional distribution of this indicator.

The following table displays the weights associated to each indicator during the clustering procedure. As there are two variables in each category except for the category of economic structure, the original weight applied to employment in industries with high energy purchases was doubled from 2.50 to 5.00.

Table 3 Indicators' weights

Indicator	Weight
Climate conditions	
Mean maximum temperature July	1.86
Mean minimum temperature January	2.00
Economic structure	
% employment in industries with high energy purchases	5.00
Transport dependency	
Fuel costs of freight transport	2.43
% workers commuting	2.21
Social dimension	
Long-term unemployment rate	2.64
Disposable income in households	2.36
Production potential of renewables	
Wind power potential	1.86
PV potential	2.14

Despite of the efforts made to achieve the broadest geographical coverage possible, there are still some data gaps that should be taken into account when analysing the clustering results. The data base is insufficient to actually characterise the following regions:

Iceland: No data available
Denmark: only temperature data available
Switzerland: only PV and wind potential
French overseas territories: only three variables available
Norway: only four variables available

The major uncertainties in the interpretation of results refer to the disposable incomes of households, because this variable is not available for Italy, Bulgaria, Malta, Switzerland, Iceland, Denmark and the French overseas territories.

In the next pages the results of the clustering exercise are discussed. The four resulting clusters and the centres of the original variables are presented in table 4 along with the number of regions that were assigned to each cluster. Figures 3-9 present the data of Table 4 for each group of variables in spider graphs. Map 1 shows the categorisation of each EU region in one of the four clusters in different colours.

Table 4 Final cluster centres

	Mean	***Cluster Centres***			
		1	**2**	**3**	**4**
Maximum temperature July	31.62	31.70	31.12	33.43	26.73
Minimum temperature January	-8.26	-7.36	-5.99	-10.06	-17.23
% employment in industries with high energy purchases	4.42	3.44	3.69	8.59	6.38
Fuel costs of freight transport	2.53	2.31	1.74	3.89	2.57
% workers commuting	9.46	7.23	45.87	5.50	3.53
Long-term unemployment rate	39.22	40.11	37.54	43.39	21.58
Disposable income in households	13316.31	14036.55	15752.46	8595.01	11321.29
Wind power potential	142525.07	114226.80	81414.17	55296.27	809093.41
PV potential	979.24	982.25	902.82	1045.55	815.14
Number of Cases		191	27	52	17

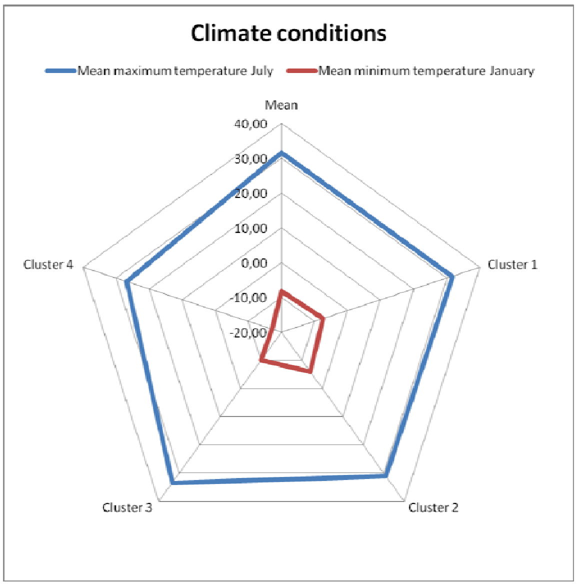


Figure 3: Cluster centres spider graph: climate conditions

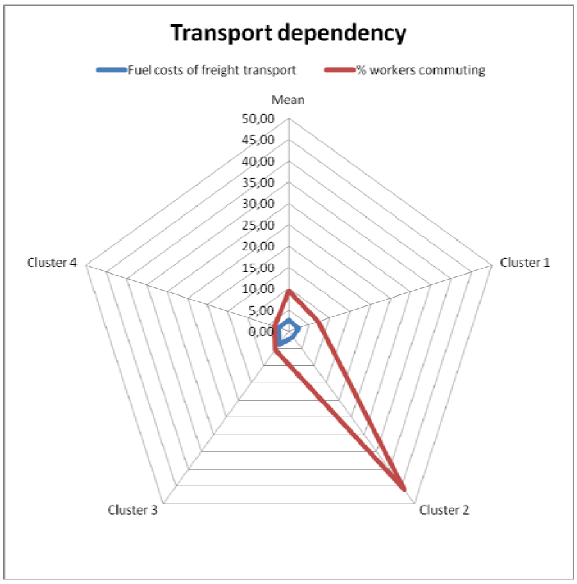


Figure 4: Cluster centres spider graph: transport dependency

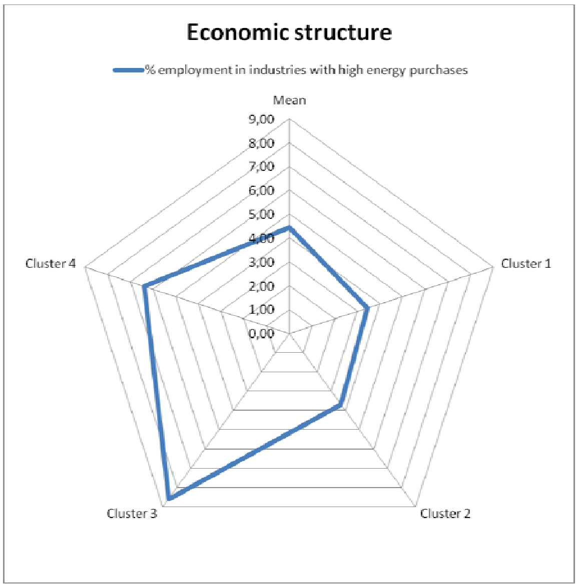


Figure 5: Cluster centres spider graph: economic structure

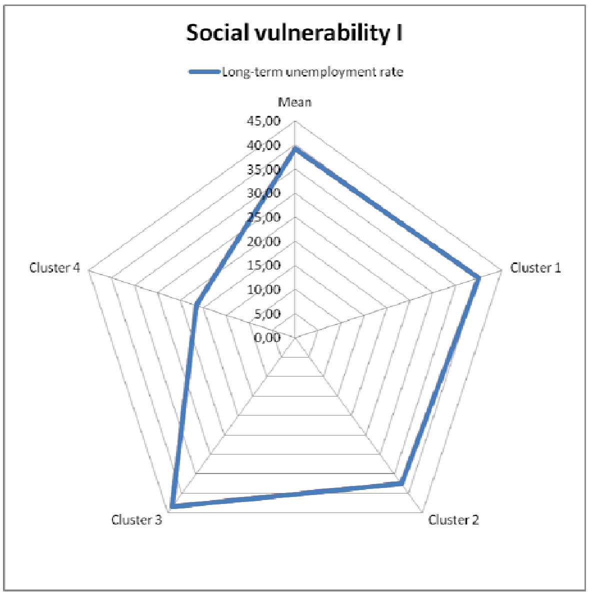


Figure 6: Cluster centres spider graph: social vulnerability (long-term unemployment)

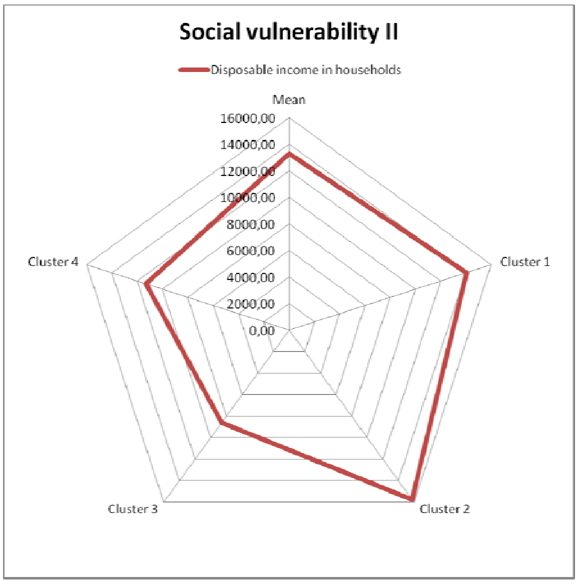


Figure 7: Cluster centres spider graph: social vulnerability (disposable income)

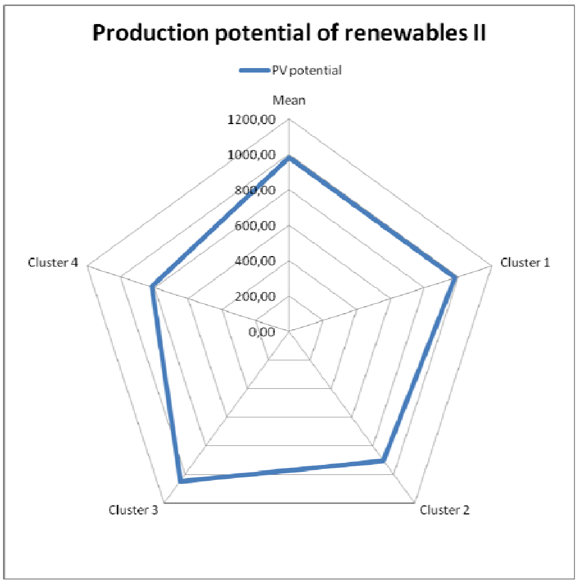


Figure 8: Cluster centres spider graph: production potential of renewables (PV)

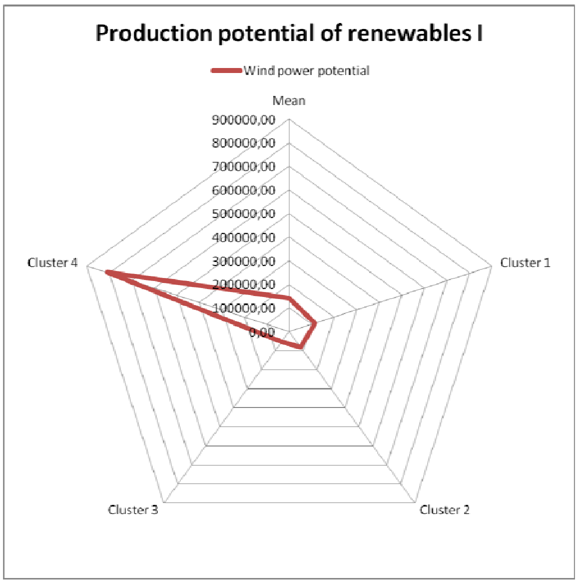


Figure 9: Cluster centres spider graph: production potential of renewables (wind)

4.1. Description of the Characteristics of Each Cluster

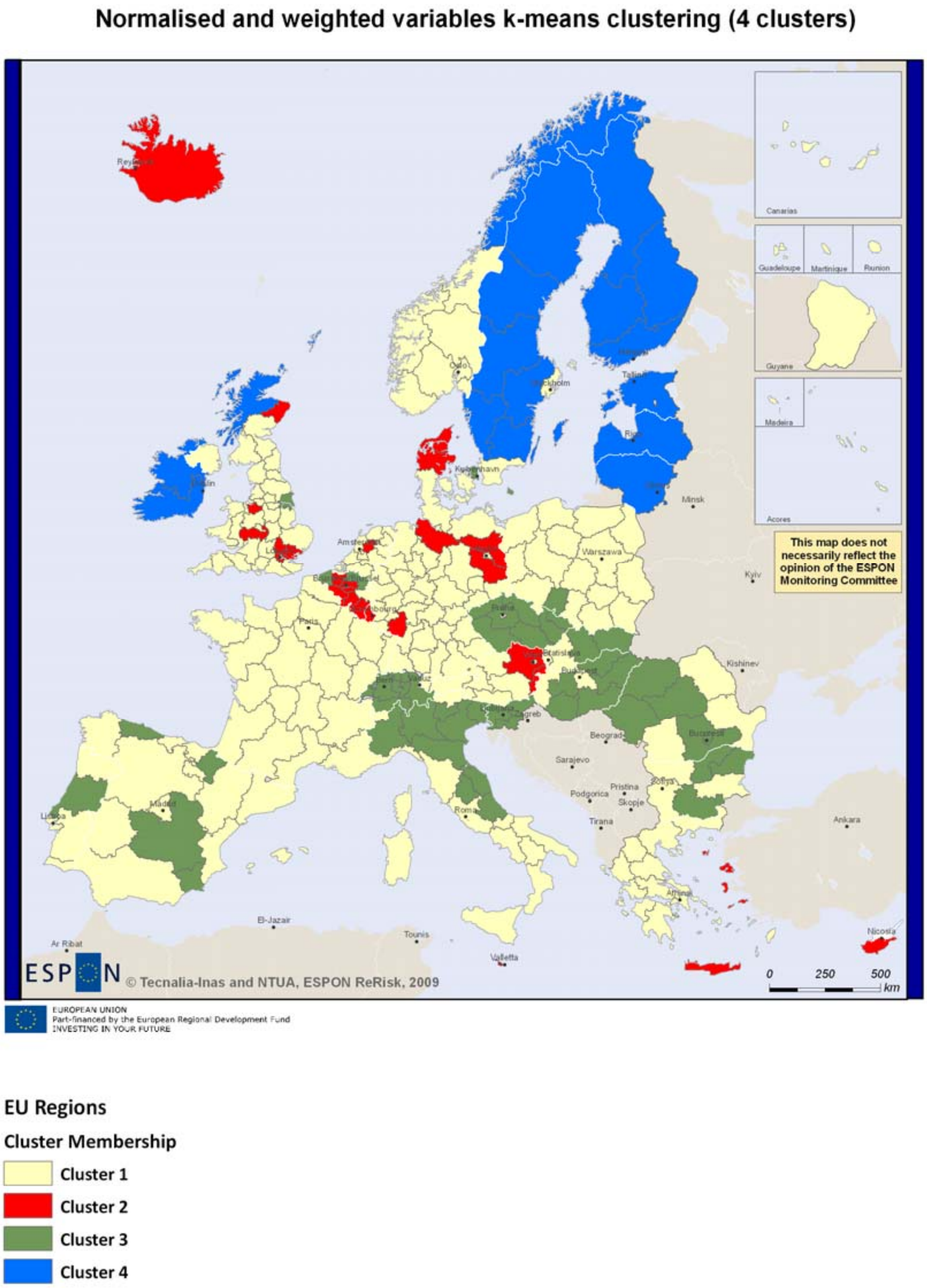
Based on the graphs, we can describe the clusters according to the variables introduced in the clustering process.

Cluster 1, which includes 191 EU regions, depicts two common situations, representing European average. One is characterized by high long-term unemployment (some East German, as well as Bulgarian or Polish regions), while the second group covers regions with a high level of disposable income. These regions are located in the United Kingdom, Austria and some parts of Germany. Part of the regions included in this cluster and located in Spain, Portugal and Greece have a higher than average PV potential. The wind potential is the second highest of the four clusters.

Cluster 2 includes the regions in which the percentage of workers commuting is the highest. These regions are mainly those located in Central Europe (Netherlands, Belgium, and Germany). Fuel costs in this cluster are the lowest in Europe. High disposable income is another factor that describes this cluster, including regions in United Kingdom and Austria. The climate in these regions in terms of medium temperatures is rather benign, with relatively warm winters. Wind potential is, nevertheless, lower than average and the potential for PV use in these regions is the lowest in Europe.

Cluster 3 is the most vulnerable with regard to rising energy prices. It includes the regions with the highest long-term unemployment rates (regions in Slovakia and Bulgaria, for example) and the greatest dependence on industries with high energy purchases (regions from Italy, Spain and Eastern Europe as Czech Republic, Latvia, etc.) as well as important fuel costs (Eastern Europe). However, this cluster also includes regions with a high PV potential (some regions from Italy, Spain and Portugal). The cluster is further characterized by very high summer temperatures and by lower than average winter temperatures, which indicates a high demand for both heating and cooling.

Cluster 4, includes a number of peripheral regions with a very high wind potential, located in Finland, Ireland and Sweden, Highlands and Islands in the UK, as well as Lithuania and Latvia (with data limitations). They are also dependent on industries with high energy purchases but they show the lowest unemployment rates. As most of them are located far north, medium summer and winter temperatures are the lowest of all clusters.



Source: Own elaboration based on Eurostat data

Map 1 K-means clustering membership of EU regions (NUTS II): 4 Clusters, Normalised and weighted values

Although the established typology can be considered a broad view of regional characteristics, it provides a valid framework for analysing both the present and the future regional vulnerability, linking the typologies to the scenarios. Additionally, it is useful for the comparison with findings from previous ESPON projects on regional typologies, on the base of which adjustments to regional policies addressing regional competitiveness and cohesion can be proposed.

4.2. Comparison to Previous ESPON Typologies

Among the previous ESPON typologies, the following have been considered most useful for comparison:

1. Lagging regions: this typology is based on GDP per inhabitant (EURO) and unemployment rate. Lagging regions, mainly those from Eastern Europe are included in the ReRisk clusters 1 and 3. The difference between the two groups of lagging regions consists in the potential for the development of renewables (higher in cluster 1 regions) and their economic structure (more vulnerable in regions belonging to cluster 3).
2. Multimodal Accessibility Potential: this is a five class typology ranging from central to very peripheral regions. Among these, we can identify most of the remote regions included in cluster 4, while the central regions are distributed between ReRisk cluster 2 and 3, depending on the extent of commuting (cluster 2) and their dependence on industries with high energy spending (cluster 3). According to the ReRisk analysis, Southern and Northern peripheral regions have little in common with regard to energy vulnerability, due to the different climate conditions and development potential of renewable energy sources.
3. Regional Specialisation: It provides a view of the deviation from the EU average of GDP/capita growth rate and from the EU average of change in the regional specialisation index. There are 4 categories of regions, ranging from the most specialized and with a GDP per capita growth higher than the EU average to the least specialized with lowest GDP per capita growth. The best-performing regions are concentrated in clusters 4 and 1 (some regions in France and Spain), while the worst-performing regions belong to cluster 3 (Southern and Eastern Regions).
4. Regions in the Pentagon: the Pentagon is shaped by London, Paris, Munich, Milan, Hamburg and their surrounding areas. Pentagon regions are considered to be the motor of economic growth in Europe. Most of these regions belong to the ReRisk cluster 1, but there are some differences that should be noted. The major part of the Belgian regions is more vulnerable to rising energy prices than the rest of the Pentagon regions. And so are Lüneburg and Rheinland-Pfalz in Germany, Nord - Pas-de-Calais en France, Flevoland (NL) and Essex (UK). This second, smaller group of Pentagon regions belongs to cluster 2, due to the high level of commuting.

4.3. Conclusions on Regional Clusters

Attending to these previous typologies and their coincidence and differences with the ReRisk results, the following profiles can be drawn:

Cluster 1 can be divided into two groups of regions: the first one is composed of Southern regions, with a high level of social vulnerability and therefore considered lagging, but with development potential, both for renewables and with regard to regional specialization. The second sub-cluster is characterized by regions with high disposable income, located mainly in the centre of Europe and belonging to the EU Pentagon.

Cluster 2 is mainly composed of central, non-lagging regions, which are, however, vulnerable in terms of transport as they show the highest commuting rates and – so far – spend a reduced percentage of their GDP on fuel costs for freight transport.

Cluster 3 is composed of the most vulnerable regions in terms of competitiveness, with low level of specialization, located mainly in the East of Europe, with high energy demand both for heating and cooling.

Cluster 4 has as main advantage the high wind potential in non-lagging regions. Nevertheless, these are peripheral regions located outside the Pentagon, which is an important disadvantage in terms of transport dependence, and they have a high energy demand for heating.

Summarizing, the typology developed in the ReRisk project (based on pre-crisis data) adds value to those previously defined in ESPON research projects, indicating that, with rising energy prices:

5. A large group of so far lagging regions have options for growth by exploiting their potential for renewables, while others could become even less competitive and face growing social problems.
6. Some of the Pentagon regions, especially in Belgium, could benefit less from growth opportunities in the economic centres, thus dropping out of the circle of best-performing regions in Europe.
7. So far wealthy regions in the European periphery, especially the North, with a heavy industry base, may have to analyze how increasing energy bills will affect the companies' competitiveness.

The complete results for the 287 regions included in the clustering exercise can be consulted in annex 2 of this report.

5. Long-term Scenarios

The four scenarios, which were elaborated in the context of the ReRisk project in two workshops with outside experts from the fields of energy policy and spatial planning, describe how different development paths in the energy sector may affect the European regions and cities in the medium and long term, both in terms of competitiveness and cohesion. This approach is necessary, since energy - like spatial - planning requires the development of infrastructure and therefore operates with a time horizon of 30 to 60 years. The energy sector is presently undergoing a far-reaching transition process, and the political and investment decisions that are now being made will shape the framework for regional competitiveness for time to come.

The scenarios are based on the common hypothesis that energy prices will remain at a high level, but political response to this challenge is different. Scenario 1 "Green High-tech" assumes a quick development of renewable energy sources, both large and small-scale, in which the regions gain greater influence on energy policy. In this scenario, regions can specialize on certain types of renewable energy production and will win from cooperation and shared networks.

The second scenario "Energy-efficient Europe" assumes a greater use of natural gas by 2030, while trying to keep Europe's energy dependency within limits through important efficiency gains in all sectors and a move towards more regionalized economies. In this situation, regions that depend on gas supplies from one producer region only, will have to deal with a higher risk of supply interruptions, but economic development will probably follow a fairly balanced and more sustainable path.

In the case that the present plans for expanding the use of nuclear energy are actually implemented in a large number of Member States, as assumed in "Nuclear Energy for Big Regions", it has to be expected that the power sector will remain highly centralized, since few players are able to carry out the needed investment. The logical consequence would be to "go electric" both in industry and transport, but these decisions will be little influenced by local and regional policy makers.

Choosing (clean) coal to fill the gap of dwindling oil reserves, as described in "Business as Usual?", would obviously benefit the mining and some harbour regions and fits well into certain protectionist ideas in Europe. However, in most parts of Europe, (imported) coal is a preferred option not because of price, but because of availability of reserves. Production from coal power plants will become even more expensive when technologies for carbon capture and storage are widely deployed. This could lead to a situation, in which high energy prices provoke continued backlashes in a world economy that is not able to function "as usual". In this case, a large number of regions, and especially the urban areas, will face severe social problems over longer periods of time, due to the increase of consumer prices.

Scenario 1: Green High-tech

The development and utilisation of renewable energy technologies is a top priority in Europe in 2030. Although economic growth has prevailed in Europe, total energy demand has declined considerably, achieving CO_2 emission reductions of more than 40% compared to 1990 levels. Energy production from renewable sources has grown most extensively, while the demand for coal and oil has been reduced considerably in the industrial, residential and energy sectors. The demand for natural gas has shown a moderate decrease while a progressive reduction of energy supply from nuclear reactors has taken place. International GHG emissions quotas have been agreed on and a global Emissions Trading Scheme (ETS) is in place. This has strengthened both the scale and scope of the European ETS.

The new renewable energy system is highly decentralized and many production areas are located in places distant from urban areas, a development which has been accompanied by the enlargement and modernization of the power grid and the integration of the European energy markets. Europe shows now a new balance between centralised and decentralised sources, which are adapted to different territorial needs. Energy markets are comprised of many actors at all scales, and particularly individuals with residential energy production systems that sell their surplus of energy to the grid. Across Northern Europe a new network of ocean and land-based power grids is interconnecting wind parks, hydroelectric plants and tidal and wave energy installations. In the South, wind power is complemented by photovoltaic (PV) and solar-thermal power plants. The presence of renewable technologies has changed the rural, coastal and urban landscape of Europe as they have become accepted by the population in general. Regions and municipalities have gained increased autonomy with respect to energy policy and this has resulted in the integration of local approaches in energy planning.

Consumer response to high energy prices and the availability of energy-efficient technologies has resulted in reduced energy consumption in all sectors. This process has also been accompanied by programmes, incentives and regulations on the modernisation of industries and old building stocks. Industries have gone through a process of modernisation through the substitution of fuel-based processes by electric driven technologies, better reactors and motor designs, the optimisation of processes, the internal recycling of spill energy, the use of recycled raw materials, and the establishment of industrial symbiosis networks among neighbouring companies, urban settlements and energy producers and distributors. Households and businesses have lowered their energy bills due to the widespread availability of efficient heating and cooling systems, energy efficient appliances, as well as an increased use of PV, solar-thermal and geothermal installations.

The continued economic growth in 2030 is dominated by the service sector and the knowledge economy because of increased competitiveness in technological consulting and high-tech manufacturing. Due to high transportation costs and a well-functioning global ETS system, manufacturing industries have been retained in Europe. Stronger emphasis on self-sufficiency and local production in many regions has also contributed to this development. Recycling industries now act as large producers of energy and materials to industries, farmers and households.

Economic and social growth is still concentrated in large urban areas due to the abundance of job opportunities in these areas, particularly in the context of the growing knowledge-based economy. High energy prices also motivate the population to live within proximity to public transport infrastructure and jobs resulting in compact and polycentric urban structures. Nevertheless, a process of decentralisation is also taking place as energy-independent regions have emerged, in which settlements have benefited from investments in infrastructures and services. Private and governmental interests in developing these regions have in many cases led to the foundation of innovation centres and of companies specialised in the manufacture and deployment of renewable energy technologies. Due to increasing transport costs and higher prices of raw materials, regions rich in natural resources have become economically more important. Tourist areas, on the contrary, have been negatively affected by high transport prices. Some of these areas have experienced an influx of the elderly and distance workers seeking comfortable living conditions away from cities.

The transport sector has become notably less energy-intensive and reduced its oil dependence, mainly due to a considerable increase in the use of public transportation. Preference towards public transport has partly been a consequence of high oil prices and taxation on fossil fuels alongside the increased awareness of climate change. Considerable investments in urban areas and implementation of participatory planning concepts and processes have generated new infrastructures and services that facilitate the use of public routes by pedestrians, bikers and public transport users. Affordable hybrid and electric cars have substituted petrol cars as the norm. The accessibility of ICT in rural areas, in addition to a general acceptance of distance working, has further reduced dependency on commuting. Contrary to urban areas, residents in rural areas are still dependant on private cars for short distance travel, and on high-speed trains for travelling long distances.

The total number of airline passengers has dropped, especially on short distance flights, as a consequence of high oil prices and increasing competition from high-speed trains. Freight transport, particularly regarding marine and truck transport, has been seriously affected as it continues to be highly dependant on fossil fuels. In this regard, optimisation in logistics has played a key role in compensating these costs.

Scenario 2: Energy-efficient Europe

Due to a political emphasis on energy efficiency, the energy intensity of Europe has decreased significantly, but, despite of further deployment of renewables, demand for fossil fuels is still dominant. Renewables have mainly served to compensate the closure of nuclear power plants. This development has resulted in a reduction of the total energy demand while reductions of CO2 in 2030 have been limited to 30% relative to the 1990's.

Large renewable energy projects have been built, but further development was hampered by lack of public support, declining innovation capacity, conflicts of interest, lack of investments and lack of proper information. Scepticism towards nuclear energy has also prevailed due to its high costs and perceived risks. Global GHG agreements have not been reached, and Europe is still facing fluctuating energy prices because of the high dependency on natural gas. New deposits of natural gas have been discovered and major transmission infrastructure investments have taken place as political relations with Russia have improved. The demand for coal has declined because of national and European climate change policies. Where coal is still used, it is consumed more efficiently in modern CHP plants and new industrial processes. The use of oil as primary energy has also been greatly reduced and demand is now mainly limited to the transport sector.

Governments have adopted support mechanisms, standards and directives to stimulate energy savings among consumers in all sectors by adopting energy efficient technologies. Creative and effective information campaigns have raised awareness on the negative consequences of high energy consumption and the potentials for reducing energy expenditure. Electricity conversion and transmission technologies have become highly efficient, thereby reducing energy losses from the generation and distribution of electrical power. Other important factors for change have been the increased incorporation of recycled materials in industrial production and the wide-spread extension of industrial symbioses projects. While the capacity for retrofitting old buildings is still underexploited, energy intensity in the residential sector has improved due to the acquisition of more efficient electrical appliances and lighting, intelligent heat and electric systems, as well as new district heating and cooling networks.

Economic growth has continued during the last 20 years but losses in the service sector and high-tech industries have resulted in a slow-down of the economy. The innovation capacity of countries such as China and India has increased rapidly, thereby surpassing Europe in this regard. This implies that Europe is facing heavy competition in the knowledge-based industries. Higher energy, food and transport prices have resulted in overall decreases in consumption. However, increased wage rates overseas have also made local manufacturing and agriculture more competitive. The recycling industry has particularly shown marked growth due to higher prices of raw materials and the adoption of efficient production processes. These circumstances have led to structural changes in the economy towards a more balanced, efficient and regionalised economy that has started to replace the predominant growth of the service and knowledge-intensive sectors.

Urban socio-economic growth in Europe is still unavoidable, but is now more polycentric and aiming at mixed-use and properly planned dense urban environments with reduced energy demand. In lieu of this it is increasingly important that urban spatial and land-use planning is integrated with energy planning to produce spatial arrangements and built environments that meet high efficiency standards. Accordingly, city planning now includes binding energy and environmental protection policies that govern energy use across multiple sectors.

Growth in the industrial and agricultural sector has been an important component in the revitalization of some rural economies. Peri-urban areas, especially those with good accessibility to natural resources have particularly benefited, while new rural functionalities have increased the demand of skilled working force. Similarly, ICT developments allow more people to live predominantly in attractive rural areas while being able to work from distance. Remote and insular tourism regions have, on the contrary, experienced important economic and population losses due to the high cost of flights. Therefore, tourism is now concentrated in attractive costal and mountain regions in the proximity of urban areas.

While the overall transport intensity has decreased, the dependence on the private car has increased, which is particularly related to the growth of rural environments that do not have the populations of scale to rationalise public transit infrastructure. Due to high oil prices and important technological advances, hybrid and electric cars are now economical and efficient, and thus constitute the largest share of car purchases in Europe. The higher costs associated with car ownership have led to a situation, in which numerous individuals and families that cannot afford a private car. However, this has led to the growth of innovative solutions such as co-operative vehicle ownership and carpooling networks.

Scenario 3: Nuclear Energy for Big Regions

Nuclear energy is the main priority for energy development in many European countries. Programmes driving the construction of nuclear reactors have been carried out as planned in the 2010's, and they have been accompanied by intensive information campaigns aimed at improving public acceptance of nuclear energy.

Despite the fact that some of the most energy intensive economies in the world have not signed the proposed global agreements on GHG quotas, Europe has maintained its energy and climate change goals. While the new generation of nuclear plants was under construction, renewable energy deployment witnessed a significant expansion; primarily large-scale renewable energy systems such as offshore wind, solar farms, and CHP networks. However, renewables have encountered a phase of stagnation due to increasing allocation of funds toward the construction of nuclear reactors, a lack of public acceptance and decreasing innovation capacities. The demand for fossil fuels has been reduced significantly in 2030, as nuclear energy and renewables have replaced coal use in industries and thermoelectric plants. Also, the use of oil for heating has almost been entirely replaced by electricity and district heating. Consequently, the transport sector is the primary consumer of fossil fuels. Thus, in this scenario, CO_2 emissions have been reduced by 30% in comparison to the 1990's but overall energy demand has increased.

The energy sector is dominated by a small number of big producers. The continued centralisation of the energy system has provoked both technical and economic vulnerabilities. On one hand, Europe is vulnerable to large blackouts caused by failures in the transmission network and, on the other hand, national governments have acquired important debts resulting from the large capital investments necessary for the construction, operation and maintenance of nuclear energy infrastructure.

Increases in energy demand are regarded as the consequence of the relative growth of manufacturing and primary industries and the abundant availability of electricity. Persistent energy efficiency improvements have also been difficult to achieve due to the lack of incentives, lack of dissemination of information and the limited availability of energy efficient technologies. However, reductions in the energy intensity in some sectors have been achieved due to consumers' responses to higher oil prices; especially in the transport sector.

The prolific growth of nuclear power generation after 2020 has made renewable energy and efficient technologies less competitive. The deployment of medium and small scale renewable energy technologies has also failed in urban areas due to inadequate information about their benefits and reliability.

The innovation capacity of Europe in creating high-value products and services has been moderate in comparison to Asia, which now is the leader of high-tech R&D. At the same time, political emphasis in Europe has been placed on improving the conditions for manufacturing and primary industries, and on providing incentives to large companies to deploy heavy industries.

While the service sector is still dominant in the European economy, primary and heavy manufacturing industries have grown faster than other sectors. Increasing transport costs have opened the opportunities for local industries to recover European markets. Industrial production has also benefited from the increase of electricity production from nuclear power plants added during 2020's while production costs have been notably reduced through automation and efficient industrial processes. Spatially, industries are now organized in compact industrial complexes in order allow the exchange of waste materials and reducing transport costs. The agricultural sector has also witnessed growth due to higher demand of locally produced food crops as well as improvement of agricultural practices performed by large farming companies.

Immigration and economic growth has continued to be concentrated in urban areas where most working opportunities are found. Urban regions have benefited from continued investments in infrastructure and services, including the electrical power supply. Most of the industries are concentrated in compact complexes located in peri-urban areas or neighbouring regions. Increasing population densities coupled with industrial concentration in urban regions has put pressure on land and water resources. Housing prices have risen in attractive areas, while other areas have witnessed a reduction in quality of life and increasing public expenditure on social aid. Also, signs of poverty are tangible in these areas due to the recession of the local economy and the increased costs of basic products.

Rural regions rich in natural resources, especially those with good access to large cities have witnessed economic growth. Here the population is concentrated in compact settlements where investments have been made to deploy and improve public and private services. Conversely, remote and isolated regions lacking natural resources have experienced sever depopulation; caused not only by the disappearance of economic activities but also by the lack of investments in local distribution grids. Due to the fact that nuclear waste has accumulated quickly during the last ten years, inter-regional disputes on which regions should carry the burden of processing and storing nuclear waste have become tenuous.

As a result of the high price of oil, progressive efforts are made to electrify transport systems, especially in urban areas. However, the balance between public and private car transport from the 2010's has been maintained as developments in public transportation are still insufficient. High speed trains connect main urban nodes in Europe while trams and subways are predominant in the urban core of major cities. Also, a rapid transition towards hybrid and electric cars has taken place which is dominant in peri-urban and rural areas where the availability of public transport is limited. The freight and air transport sectors continue to be heavily dependant of fossil fuels and therefore face difficult economic conditions. This has had profound repercussions on the tourism industry in remote and insular areas as tourism has now shifted to areas closer to large cities.

Scenario 4: Business as usual?

In this scenario, only a moderate transition to renewable energy sources has taken place. Energy systems are dominated by centralised solutions and coal use for electricity generation has increased. Central Asian, Russian and Arctic gas deposits have become increasingly important for Europe's energy supply. This has meant major capital investments in natural gas pipelines and storage. The construction and operating costs associated with nuclear power, the public concerns about waste storage, insecure uranium supply, and security concerns have all contributed to the phase-out of nuclear energy programmes.

Multi-national energy corporations now dominate the energy sector more than ever, despite protectionist schemes of several European countries. The market power gained by large energy producers has limited the number of actors able to invest in energy production and the effective lobbying of energy corporations has strangled the market for small-scale energy alternatives.

Efforts to reduce GHG emissions have been hindered by the lack of political commitment from the USA and China, which has negatively affected Europe's willingness to cooperate internationally. This has made other countries hesitant to make large concessions during periods of economic stagnation or recession. Accordingly, precedence to protect local jobs over climate control is the common trend. The absence of international agreements on GHG emission, high energy prices and the prolonged economic crisis, has also resulted in the removal of the EU-ETS.

Improved energy efficiency was achieved mainly during early 2010's, but further improvements have not been persistent. The loss of political will to combat climate change, along with a lack of investment capital for retrofitting industries, houses and the transport system has resulted in marginal efficiency gains. Overall, energy consumption has decreased as a consequence of a reduction of GDP since the national economies cannot sustain the burden of high energy costs and their negative impact on private consumption.

Stagnant economic conditions have also hampered the development of affordable clean energy technologies. Consequently, technologies on the market are expensive, implying that economies of scale have not been achieved. The shortage of free capital has also resulted in minimal retrofitting of existing building stock and poor deployment of efficient energy generation systems. As such, no new district heating systems have been built since early 2010's. Large scale renewable projects have also been hampered by the "not in my backyard" attitude of the public.

The stagnation of GDP growth has been mirrored by a lack of investment in R&D. European scientists are now moving to China, India and Brazil, where income possibilities are better. Smaller companies that closed after the economic crisis in 2008 never reopened and their workforces went into unemployment rather than contributing their tacit knowledge to new opportunities for growth. Now, very few companies can afford to invest in R&D, and public stimulation schemes are few and poorly funded. The outcome has been a pervasive structural economic problem rooted in dependency on costly energy. Industrial growth has been hampered by outdated infrastructure and high prices for scarce raw materials.

Start-up enterprises have failed at a high rate due to lack of affordable venture capital and poor framework conditions. The "buy local" movement from the early years of the century has taken hold, but now the motivation is based on protectionism rather than environmentalism. The only blossoming business ventures can be found in the second-hand market, as many people cannot afford to buy new goods.

The protectionist stance is also apparent in the attitudes of cities and regions. Cooperation is weak and competition is strong. In spite of the decline in the quality of urban life due to unrest, poverty, crime and homelessness, the urban areas represent the only economic opportunities now available; and therefore, are still growing. Moreover, high transport prices have severely affected the rural economies. The demand for housing in urban areas is rising as rural settlements have been abandoned. The hardest hit regions are those which are tourist-dependent and far from urban centres. These regions cannot compete for the fewer tourists that can still afford to travel longer distances. The only rural areas that are doing well are those with recreational amenities that are quite near large population centres, as short vacations replace international trips.

Urban planning has stagnated, and the response to growing population has been inadequate. New construction has not kept up to demand, so crowding and sprawl to the surrounding suburbs is apparent. There are some "islands" of wealth and innovation, but these are not integrated into the urban fabric, but instead are "outposts" of international companies. Income and price levels have been de-coupled; some consumer goods are cheaper due to lack of demand, but food and basic goods are expensive due to high transport and production costs.

High oil prices and decreasing disposable income have also had a negative impact on the transport sector. The lack of investment in efficient and competitive public transportation options makes the use of private cars often unavoidable, but the car-stock is growing older. Even though high fuel costs make hybrid cars attractive, a considerable part of the population cannot afford the initial investment, thus making hybrids a viable option only for the rich. The shift to electric cars that seemed to be in the offing some years ago has not materialised due a lack of public investment in infrastructure that may have stimulated their adoption. This situation has resulted in the substantial use of bicycles as a mode of transportation in urban areas.

6. Policy Recommendations for Reducing Regional Exposure and Increasing Adaptive Capacity

The policy recommendations elaborated in the context of the ReRisk project take into account the main findings from the initial analysis of regional vulnerability, and the clustering and scenario exercises, as summarized in table 5.

Table 5 General overview of scenarios and clustering process

General overview of scenarios and clustering process	Scenario 1 "Green High Tech"	Scenario 2 "Energy-efficient Europe"	Scenario 3 "Nuclear Energy for Big Regions"	Scenario 4 "Business as Usual?"
Winning regions	Regions with PV and wind potential Urban regions	Regions with energy intensive industries but with clean technologies and access to gas sources; agricultural regions	Regions with energy-intensive industries and central urban regions Rural regions with natural resources and access to large cities	Medium-sized cities surrounded by resource rich areas Coal regions and regions with ports
Loosing regions	Regions with high fuel costs Regions with industries with high energy purchases (need for adaption)	Regions dependent on long-distance freight transport (islands, mountainous, remote..) and commuting	Regions with high l/t unemployment rates and/ or low disposable income Regions dependent on transport	Urban regions with l/t unemployment rate and lowest income Energy-intensive regions Tourism-dependent regions
Energy-related policies	Large and small-scale renewables connected by the European grid Energy and waste recovery from recycling	Energy efficiency all along the chain Nuclear phase-out Large-scale renewables Increased gas imports	Infrastructure (grids) High level of investment in nuclear energy and security Renewables take off, but stagnate	Increased use of coal and gas for electricity generation Phase-out of nuclear Lack of investment in the retrofitting of buildings and local networks
Other policy domains	High investment in R&D and education ICT and infrastructure policies International climate change agreements on GHG Participatory planning processes	Technological development in efficient technologies (R&D) Regionalisation of economies, polycentric development Hybrid / electric cars and car-sharing Binding environmental policies in planning	Moderate investment in R&D and education No international agreements on GHG but European climate change policies Electrification of the transport system	Low R&D Low investment in education No agreements on GHG, removal of European ETS Inadequate urban planning

General overview of scenarios and clustering process	Scenario 1 “Green High Tech”	Scenario 2 “Energy-efficient Europe”	Scenario 3 “Nuclear Energy for Big Regions”	Scenario 4 “Business as Usual?”
Governance	Increased autonomy for regions with regard to energy policy priorities	National energy efficiency strategies implemented on local level	Centralized (national and EU level)	Protectionist (national and EU)
Clusters affected	Cluster 1: Winning regions: those with PV potential and high disposable income. Loosing regions: those with l/t unemployment	Cluster 1: loosing regions with l/t unemployment rate. Winning regions: high disposable income	Cluster 1: loosing regions those with high l/t unemployment rates and regions not connected to the grid (islands, mountainous, remote..)	Cluster 1: loosing regions: those with high l/t unemployment rates and those with high disposable income, which will be reduced
	Cluster 2: Loosing regions due to commuting	Cluster 2: winning regions: high disposable income	Cluster 2: loosing regions: commuting, winning regions: central, with high disposable income	Cluster 2: loosing regions due to high level of commuting
	Cluster 3: Loosing regions due to l/t unemployment and industries with high energy purchases; Winning regions: PV potential	Cluster 3: loosing regions: those with l/t unemployment rate and regions with high fuel costs. Those dependent on industries with high energy purchases	Cluster 3: loosing regions with l/t unemployment rate. Winning regions: those with energy intensive industries.	Cluster 3: loosing regions those with l/t unemployment rate and dependent on fuel cost; some opportunities in regions with renewable potential
	Cluster 4: Winning regions: those with high wind potential	Cluster 4: winning regions: energy intensive industries perform better Loosing regions: those dependent on transport	Cluster 4: loosing regions: regions not connected to the grid (isolated)	Cluster 4: loosing regions: with energy intensive industries and without fossil fuel reserves

The recommendations also draw on the inputs obtained from the case studies and the responses from regional policy makers to the questionnaires[4] on competences in the energy field and the expected impact of rising energy prises.

The policy recommendations results do not focus on energy policy only, since energy is a cross-cutting issue and therefore has to be approached from many different angles. The recommendations are addressing decision-makers on regional level with the objective of

1. reducing the regions' vulnerability on the short term
2. improving the regions' adaptive capacity on the medium and long term

6.1. General policy recommendations (good governance)

According to the responses received from more than 40 regional administrations, competences with regard to the three pillars of energy policy (security of supply, energy efficiency and environmental protection) in the EU are distributed unevenly. The state is perceived as being the government level that places the most emphasis on security of supply, while the regions play a greater role in relation to energy efficiency and environmental protection.

Responses to the questionnaire also indicate a marked division of labour between the national and the regional energy policy level with regard to the use of energy sources. Whereas national energy policies are clearly identified as treating each energy source with similar importance, the regional involvement is comparatively higher in the field of renewable energy (66%) and natural gas (41%) and less important with regard to coal use (24%) and nuclear (10%).

Reinforcing the supply perspective, the role of renewable energy solutions has been also analysed. While none of the regions consider decentralized energy solutions as insignificant, only 14% consider it as a top priority. The key perspective in this connection, however, is the question of centralized versus decentralized solutions. Even though one can think of renewable energy solutions in relation to small scale and decentralized conditions, most regions view the development of these renewable in connection to centralized decisions. Therefore, the answer appears to be more or less the recognition of the status quo.

In six Member States, plus Norway, regions are carrying out their own R&D programmes in the energy field. Additionally, some regions from countries with centralized energy research, participate in R&D activities in the framework of European programmes[5]. Experts in the field argue that "Sustainable energy supply structures based completely on the import of knowledge and technology do not seem to be favourable for countries and regions. Local or regional R&D constitutes a good basis to optimise energy systems and to reduce vulnerability. Besides, the yield of renewable energy

[4] ReRisk Updated Interim Report: Case studies and Scenarios, chapter 5, Nordregio, 2009.
[5] See, for example, the PITER (Platform for Integration of Transregional R&D Activities) project, financed by Regions of Knowledge http://www.fp7-piter.eu/index.php?id=146

sources and the types of optimal technologies depend, in part, on local (climatic) conditions. Thus, specific technologies have to be developed – mostly by means of local or regional R&D" (Luther 2004). It would therefore be interesting to analyse on the basis of benchmarks if regions with competences in energy R&D perform better with regard to the development of renewable energy sources and energy efficiency than regions that are not involved in energy R&D.

Further valuable information about the EU regions' present activities in the field of energy efficiency and renewables might become available in the context of the First Action Programme for the Implementation of the Territorial Agenda and the "Thematic Group on Energy Efficiency and Renewable Energy", which has been carrying out a survey on these issues in the Member States. "The purpose of the questionnaire is to examine how and to what extent MS have incorporated EERE [energy efficiency and renewable energy] considerations in their planning. It focuses on the tools that MS use in order to embed their considerations for EERE to their spatial development planning, on the one hand and on the processes of decision making on the other."[6] However, it has not been possible for the ReRisk team to access the survey results and integrate them in the policy recommendations presented here. According to the results from the survey carried out in the ReRisk project, regional autonomy in terms of energy policy seems to be relatively limited in two thirds of the regions. The regions in this group are, to a relatively large extent, representatives of situations where national strategic energy planning seems to be dominating, while the other group, representing one third of the respondents, is dominated by regions where renewable resources have been developed more than average. However, and despite of not being the main responsible level for energy policy, 41% of the regions are able to implement binding policies beyond the standards set at the national level. This puts the question above regarding regional autonomy in relation to energy development issues in another perspective, and accordingly, should be scrutinized further.

The first set of policy recommendations addresses measures, which could increase their influence on decision-making in the energy field, by strengthening the ties between regions and reducing their vulnerability through "energy solidarity".

- Promote energy solidarity between regions and territories

Energy solidarity between regions and territories is in line with § 3 and § 8 of the Territorial Agenda. The adoption of this principle reinforces solidarity between states [EC 2005] and regions and expresses the commitment to apply a cohesive and integrated approach adapted to territorial diversity when influencing or deciding on the priorities and funding of territorial and urban development policies at European Union, national, regional and local levels. Such interregional agreements are especially important for the development and the improved compatibility of infrastructures.

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[6] DG Meeting on Territorial Cohesion, Greek Intervention http://www.mop.gov.si/fileadmin/mop.gov.si/pageuploads/predsedovanje/territorial_cohesion_directors_meeting/tc_greece.pdf

- Strengthen regional and local networks

The modernization of transport and energy networks is one of the actions to be reinforced by the "EU 2020 Strategy" and, according to the Association of European Border Regions [AEBR 2010], should take into account the territorial dimension. The findings from the ReRisk project confirm that this is a central issue for reducing the vulnerability of regions with a high level of commuting and for the development of broader and complementary portfolios of renewable energy sources in neighbouring regions.

Local energy networks, both for district heating and cooling, would help to make a much more efficient use of energy. Financing and organisational models for promoting these networks should be made available. There is also a need for modernizing infrastructures and the inclusion of innovative technologies. Even in non-industrial cities or neighbourhoods, planning concentrated but decentralized heating and cooling facilities is the best means for making a more rational use of energy efficiency in the medium and long term.

- Fund and stabilize transnational research agencies

Regional "research-driven clusters" are an important means to promote and boost solid and solvent regional research activities. They also help to bring together the public bodies, sector collectives, research institutions and other stakeholders, and to strengthen their cooperation. They are useful for identifying policy needs in the field of renewable and alternative energy sources and for overcoming the gap between theory and practice. Particularly in regions with obsolete industrial sectors, this form of cooperation can help attract necessary investments. These research-driven clusters should be lead by the less vulnerable regions and those having the strongest adaptive capacity to face the impact of increasing energy prices.

There is also room for regional specialization within the SET Plan (European Strategic Energy Technology Plan), but most of the technologies promoted presently by the SET plan are large-scale.[7]

- Promote awareness among regional policy makers on the impact of rising energy prices and the need for economic diversification

According to the survey, 51% of the respondents consider economic growth in their region as dependant on energy intensive sectors. However, it is interesting to note that 22% of the respondents are either undecided or unaware of the nature or extent of the linkage between these two variables.

The survey of regional decision-makers also looked into the potential impact of higher energy prices on consumer decisions and energy demand. Three levels of future oil prices were suggested: USD$100, $150, and $200 per barrel. In the first case, only 12% view the price level as having serious

[7] http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/493&format=HTML&aged=1&language=EN&guiLanguage=en

and/or very serious impact on consumer decisions and energy demand, and in the second case only 20% consider a price of $150 as having very serious impact. However, almost 70% of the regions consider an oil price of $200 per barrel to have a very high impact, while less than 10% consider it to be of limited or moderate importance. Accordingly, there is a close connection between the choice of basic energy system and oil price development, where the regions with high emphasis on renewable and other alternative energy resources are those least worried about substantial increases in energy prices. Also, most of the regions believe the effects of such price increases will provide a strong impetus for change in specific sectors of the economy. The best measure to address this issue is to actively promote diversification of the regional economic structure towards economic activities with lower levels of energy consumption and spending.

- Define a vision for a regional energy model 2050

The transition towards regional economies, which are less vulnerable to rising energy prices, requires long-term planning on regional level. Visions and scenarios can be helpful tools for regional policy makers both to make better-informed decisions and to help communicate and attract citizens, involving society into a shared plan. However, such exercises, which could be financed in the context of the National Energy Efficiency Plans, should be carried out on a sound methodological basis and as a participatory process.

- Push municipal leadership in public-private partnerships

PPP help encourage investment in alternative energy production, increase public awareness and promote the involvement of private companies and society. This is particularly interesting in regions with high potential for the development of renewable energy sources. Some experiences already exist at neighbourhood level, where citizens have joined and made private investments thanks to public support. For example, roofs of public buildings can be made available by the administration so that residents from large apartment buildings or tenants in rented flats also have an opportunity to support the deployment of PV installations. However, financing schemes must be revised to account for the diminishing investment capacity of households after the prolonged economic recession.

6.2. Spatial planning policies and strategies towards a more sustainable territorial management

- Develop integrated spatial planning instruments

The integration of cross-sector policies of land use, energy and water management into a single planning instrument at regional level, based on an understanding of territorial dynamics, will help regions to advance towards a more sustainable territorial management, in line with § 10, § 11, § 23 and § 27 of the Territorial Agenda. The adoption of this principle expresses the acknowledgement of the specific responsibilities of sectoral policy-makers and the will to cooperate with and influence them in order to ensure a stronger territorial and urban focus when conceiving and delivering the thematic policies. The goal is to better fine-tune specific thematic actions, to facilitate their coordination and to reduce undesired externalities. Initiatives with this perspective have already been established, for instance the ICZM (Integrated Coastal Zone Management)[8]. This is a necessary tool for planning the development of coastal areas, where conflicts may arise when planning off-shore wind parks or other ocean technologies, which may interfere with security issues, fishing interests, cargo traffic, tourism or protection of marine biodiversity.

- Establish urban planning principles for solar energy use

Experimental instruments are available to plan the deployment of solar energy applications more effectively on municipal level [Gadsden et al 2003]. Planning tools need to predict the baseline energy consumption of domestic properties and to determine the potential for using the three key solar technologies of passive solar design, solar water heating and photovoltaic (PV) systems. A new dwelling classification system needs to be developed to address the major problem of data collection for city-wide domestic energy modelling.

- Implement Urban Metabolism procedures

"Urban metabolism" is a new way of describing the functioning of modern cities and could be an interesting tool for local energy planning. "The concept of an urban metabolism provides a means of understanding the sustainable development of cities by drawing analogy with the metabolic processes of organisms. The parallels are strong: "Cities transform raw materials, fuel, and water into the built environment, human biomass and waste" (Decker et al. 2000). In practice the study of an urban metabolism (in urban ecology) requires quantification of the inputs, outputs and storage of energy, water, nutrients, materials and wastes. "[9]

Procedures related to urban metabolism assess urban dynamics, services, functions, flows and cities' capacity of response with two purposes: a) to avoid alteration of the ecological, social and economical conditions of a city and also b) to reduce vulnerability by optimizing energy consumption. This is particularly interesting in highly urbanized regions with severe ecological footprints.

- Promote industrial symbiosis and/or industrial eco-parks

Industrial symbiosis refers to loop cycles, in which energy consumption, production and waste management are integrated in industrial developments aiming at using the residues from one industrial process for the production of other products. By-product synergy is then exchanged in a circular flow, which, in the best cases, provides settlements with energy surpluses through district heating. This is particularly interesting when renovating older industrial sites, usually linked to other obsolete urban areas, but it is also a valuable tool when planning new industry parks. As the two case studies on industrial symbiosis have shown, such projects are easier to implement and have greater success if the companies involved

[8] See, for example, DG Environment News Service 2/2010, Special Issue on "Coastal Management"·

[9] Encyclopedia of Earth http://www.eoearth.org/article/Urban_metabolism

have or develop a relationship of trust and recognize the mutual benefits, so project design is an important element in this policy.

All these initiatives require **good governance** understood as a) horizontal coordination of sector administrations and policies b) vertical coordination of different levels of responsibilities and also c) public participation which in term will increase regional capacity of response. Extended bottom-up participation processes are necessary to guarantee the efficiency of many long-tem developments. A responsible and involved neighbourhood is also a key response capacity when facing risks and hazards.

6.3. Environmental Protection and Risk Prevention

The importance of a regional perspective in relation to environmental protection is very clear, as environmental problems usually have regionally dispersed effects. The determination of the political agenda at European level with clear environmental objectives is of particular relevance in the area of energy and sustainability. The current lack of sustainability of the European and World energy models, and specially their climate change consequences, require an urgent action in this field with a long term vision in order to prevent the exhaustion of local and regional energy sources.

- Sustainable use of biocrops

Making extended use of biofuels in the region could lead to social and ecological problems [EEA 2005]. Biocrops compete with other uses for scarce resources, such as land and water, in agriculture, forestry or natural sites. Specializing on certain types of plants with high energy yield could jeopardize other objectives of agricultural policy, such as that of promoting a higher level of regional sufficiency with regard to food production (by growing subsistence crops). Large-scale biomass plants could accelerate deforestation or endanger the local biodiversity. Apart from choosing technologies and crops that are appropriate in a given regional context and robust with regard to possible climate change impacts (droughts), attention must also be paid to the parallel development of local social and educational skills, which will be needed to manage and maintain the installed facilities.

- Prepare for climate change impacts in the regional energy infrastructure

Climate change will vary from region to region - with coastal and mountain areas and flood plains particularly vulnerable – and therefore many of the adaptation measures will need to be carried out regionally[10]. Impacts are likely to be severe in the Southern regions belonging to Spain, Greece, Portugal and France, both in terms of energy production and demand. In these regions, summers are going to be complicated for energy companies, due to diminishing water reserves, higher average temperatures and heat waves, and consequently, forest fires. The supply problems will coincide in

[10] For further information, please see the discussion paper on climate change impacts in the energy sector, submitted along with the Updated Interim Report

time with higher peaks of electricity demand, derived from a more extended use of air-conditioning.

The need for new, expensive and under-used peak load capacities for electricity production will be greatest in regions, which have not yet reached full market saturation of air-conditioning appliances. However, much of this may be avoided by promoting passive cooling techniques or solar-based appliances in buildings and cities or by defining a minimum threshold for their installation in offices and public buildings. It is important to design sustainable, low-energy buildings which provide thermal comfort. The main focus should be on buildings that are 'free running' for some part of the summer, either being entirely naturally ventilated or mixed-mode (where mechanical cooling is only used when thought to be essential). Solar cooling technologies will play a decisive role for energy demand development in these regions [Holmes et al 2007]. Actions in this field could also be considered when the national emergency plans for the prevention of heat waves are extended to the regional and municipal level.

6.4. Policies to Accelerate Deployment of Renewable Energy Sources

Only 17% of the regions consulted state that investments in non-renewable energy resources are prioritized over investments in renewable energy technology. This clearly shows that renewable sources are emphasized as a priority for most regions. The portfolio of renewable sources promoted in the regions varies considerably and there are vast differences in the level of involvement of regional authorities, depending on the type of renewable resource exploited as the top priority. Three out of four regions have established support instruments to help the development of renewable energy technologies.

Further steps that could be taken to accelerate the deployment of renewable energy are listed below.

- Evaluate the feasible potential of all renewable sources in the region

Regions should thoroughly evaluate the "feasible" potential of the different technologies available, including concentrated solar, geothermal, wave / tidal technologies, biomass, and hybrid solutions. Regions with different types of potential for renewable energy can cooperate to improve the reliability of energy supply from these sources. The generation of "maps of untapped energy reserves" can be of great use for developing longer-term plans in the regions.

- Incorporate solar and wind facilities in urban areas

In densely populated urban areas, wind and solar applications should increasingly be incorporated in the built environment. Small-scale technologies are already available to be installed on roofs and at various wall orientation and façades. Bioclimatic urbanism has a solid set of measures to assist designing urban areas having in mind these natural resources.

- Accelerate the transition to non-fossil fuels in the aviation industry

The aviation industry is expected to face serious supply problems in the coming decades, even if the present level of air traffic is maintained and efficiency improvements of 5% per year to 2026 are achieved [Nygren 2008]. Peripheral and island regions with a high dependence on air traffic, as well as regions specialized in air transport will be hardest hit by these developments. They should cooperate with the aeronautic industry to prepare the transition from fossil fuel use in air transport to alternative sources (biofuels not competing with food production such as algae, jatropha, babassu, synthetic fuel from coal, etc), both in terms production of these fuels and the needed infrastructure adjustments.

6.5. Policies to Promote Energy Efficiency

Energy efficiency is becoming an important policy issue at regional level. Several European policies are already in place, like the "Action Plan for Energy Efficiency: Realising the Potential", the Green Paper on energy efficiency, the "Intelligent Energy for Europe" programme, etc.[11] However, there are serious concerns that the Member States are not implementing their National Energy Efficiency Action Plans (NEEAP) on time and that the 20/20/20 objective might not be reached [EESC 2009a].

Responses from the regional stakeholders reveal that international agreements and international relations are the main drivers behind both renewable energy deployment and energy efficiency at the regional level. This connection is quite interesting and should be taken into account when defining new policies in this area, for example when creating a level playing field for an "energy efficiency market". And it is important that energy efficiency policies must be implemented at both industrial and residential level, as well as in the transport sector, but through different sets of action. For the regional decision-makers, the residential sector is the field of action with the greatest potential for energy saving, with 59% of the regions viewing it as having the most straightforward path to higher energy efficiency. The transportation sector is seen as the most problematic, while challenges are considered to be lower in the industrial and energy sectors.

The following recommendations can be made based on the findings in the ReRisk project and other relevant policy documents:

- Improve the data on energy use and efficiency in Europe

The European Social and Economic Committee (EESC) is "disappointed and concerned at the shortage of homogenous, detailed information and data on end-use energy efficiency", which hinders the development of appropriate strategies for improving energy efficiency. The lack of data also makes it difficult to measure and monitor progress and, ultimately, to enforce policies in this area.

However, more detailed information on energy consumption is being gathered in 61% of the regions, which responded to the questionnaire (29% of the respondents indicate that it is not, and 10% do not know whether they keep this type of data). The main problem is therefore not data collection, but harmonization of the data and the selection of the right indicators for European comparison.

- Involve end users in energy efficiency programmes and policies

The EESC also gives a series of recommendations on how to "enhance energy efficiency policies and programmes by end users".

The first set of measures proposed by the Committee refers to the relevant EU programmes (CIP, and particularly IEE), which need to be simplified to make them more accessible to very small businesses and their representative associations and to administrations in disadvantaged areas (mountainous and peripheral regions). Moreover, it is worth encouraging public-private partnerships and ESCOs (energy service companies), in particular at European, national and local levels, by facilitating the involvement of SMEs in the actual implementation of the European Green Public Procurement policy. In addition, as part of the simplification and better regulation process, it is necessary that the European Commission, along with representatives of European and national end-user bodies, looks into which procedures and practices are most effective to support end users and stakeholders when it comes to implementing energy efficiency policies.

- Create a market for energy efficiency (White certificates)

The EESC also points to white certificates [EC 2005] as a means of enhancing energy efficiency. "White certificates" and similar regulations, which oblige energy companies to either invest in energy efficiency or buy "certificates", have already been introduced in some Member States. The analysis carried out on the implementation of this policy in Italy[12] shows that as a consequence of this regulatory change, the number of energy service companies (ESCOs) offering services aimed at reducing energy consumption increased considerably and the market for energy efficiency services became much more dynamic. However, the implementation and monitorization of these programmes is complex and requires a high level of institutional cooperation. Pilot projects could be launched on regional level to evaluate the energy savings which can be achieved through white certificates and to identify the most efficient interventions for different types of industrial and residential markets.

- Improve efficiency of office design and work arrangements

Changes that are occurring in work arrangements may present an opportunity for making a more efficient use of energy in offices and reduce the need for transport by extending the opportunity to work at home. The average office worker spends 30 percent of the workday at a workstation—be it the corner office with a skyline view or an interior cubicle. Changes to

[12] Lorenzoni, A. (2008), " The Italian Experience. White certificates in electricity and gas. A regulatory review". http://www.catedrabp.upcomillas.es/Documentos/Actividades/Foro/2008/Lorenzoni.pdf

how, where, and when we work have led current office design to the "networked office." The majority of workspaces still emulate older versions of the building type, dedicating a lot of space, lighting, and climate control to increasingly mobile and immaterial work that does not really need it. [13]

- BAT (Best Available Technologies) for industrial energy efficiency

Solid knowledge and sound technologies are available for improving energy efficiency in certain industries, but their implementation might be quite complex when looking at the entire production process. The next table shows the technologies with the highest efficiency potential in some of the industrial sectors with highest energy consumption, assuming only technical improvements. The "current best practice" values indicated below should be completed for all NACE subsectors and constantly updated, as they can serve as a reference benchmark for companies in the same sector / subsector. This measure is especially important for regions, in which energy spending in some sectors – and therefore the risk of carbon leakage – is higher than average.

Table 6 Technologies with the highest efficiency potential in some of the industrial sectors

		Specific energy consumption (GJ/tonne)	Current best practice	Thermo-dynamic minimum	Technical potential in [r]evolution scenario			Refer-ence scenario
Sector	**Unit (specific final energy**	**2005**	**2005**		**2020**	**2030**	**2050**	**2050**
Iron and steel	Primary steel BF/BOF route (GJ/tonne crude steel)	10	6.4	1.3				
Iron and steel	Primary steel OHF route (GJ/tonne	23						
Iron and steel	Secondary steel EAF route (GJ/tonne crude steel)	2.2	1.6	1.3				
Iron and steel	Hot/cold rolling (GJ/tonne crude steel)	2.9	2.2	0.05				
Iron and steel	Share secondary steel	35%	35%		41%	48%	60%	
Iron and steel	**GJ/tonne crude steel**	**12.5**	**5.5**	**1.3**	**10.3**	**8.0**	**3.5**	**8.0**
Iron and steel	***Index (GJ/tonne crude steel)***	***100***	***44***	***10***	***82***	***64***	***28***	***64***
Non-metallic minerals	GJ/tonne clinker	4.2	3.1	1.8	3.9	3.5	2.8	
Non-metallic minerals	Clinker to cement ratio	80%	25%	<25%	75%	70%	60%	
Non-metallic minerals	Electricity use grinding/blending (kWh/tonne cement)	110	105	<100				
Non-metallic minerals	**GJ/tonne cement**	**3.7**	**1.2**	**<0.5**	**3.2**	**2.7**	**1.7**	**2.4**
Non-metallic minerals	***Index (GJ/tonne)***	***100***	***31***	***<14***	***86***	***73***	***45***	***64***
Aluminium	Primary aluminium (MWh/tonne aluminium)	15.3	12.5	6.4	13.85	12.4	9.5	
Aluminium	Secondary aluminium (GJ/tonne aluminium)	0.8	0.8	<0.8	0.7	0.7	0.7	
Aluminium	Share secondary aluminium	33%	33%	100%	40%	47%	60%	
Aluminium	**GJ/tonne aluminium**	**10.5**	**8.6**	**<0.6**	**8.9**	**7.4**	**4.2**	**6.7**
Aluminium	***Index (GJ/tonne aluminium)***	***100***	***82***	***<6***	***85***	***70***	***40***	***64***
Ammonia production	GJ/tonne ammonia	15	8					
Ammonia production	Ammonia (index)	100	53					
Chlorine production	MWh/tonne chlorine	3.6	2.6					
Chlorine production	Chlorine (index)	100	72					
Ethylene production	Ethylene production by naphtha (GJ/tonne)	25-40	18					
Ethylene production	Ethylene production (index)	100	60					
Chemical and petrochemical	Index best practice implementation (GJ/tonne)	100	62		89	77	55	
Chemical and petrochemical	Index improved material efficiency and recycling (GJ/tonne)	100			95	90	80	
Chemical and petrochemical	*Index (GJ/tonne)*	*100*			*86*	*72*	*45*	*64*
Other industries	*Index (GJ/tonne)*	*100*			*84*	*68*	*35*	*64*
Total industry	Index (GJ/tonne)	100			84	69	38	64

Source: Umweltbundesamt, Germany, 2009 [UBA 2009]

[13] Innovation 2008: The Social Side of Energy Use
http://www.degw.com/press_article.aspx?id=14&name=Innovation+2008%3a+The+Social+Side+of+Energy+Use&a=1

6.6. Policies to Fight Energy Poverty

As indicated in the introduction to this report, concerns about energy poverty are growing in Europe. The Parliament warns "that special attention must be paid to consumer protection and that safeguards must be put in place in order to prevent grid disconnection" [EP 2008] of customers who cannot pay their energy bills. Some of the recommendations issued by the Parliament are further developed in this chapter:

- Improved transparency and information on energy consumption

The liberalization of the electricity and gas sectors has worked against transparency, as remarked in the Updated Interim Report. Companies purchase energy on the basis of private contracts, which are confidential, and prices have started to fluctuate considerably in the residential sector, with growing differences between regions and even cities. It is in this context that the Parliament and NGOs insist on the need for comparable bills and tools, such as smart meters and tariff simulators to help customers choose the lowest-cost supplier.

- Consumer Awareness and Education

According to the survey of regional decision-makers, the present spread of information on energy efficiency to the population is insufficient. 49% of the respondents consider current dissemination levels to be acceptable only in some sectors, and 22% consider it to be generally inadequate. When looking into details regarding which regions are satisfied with the dissemination level there seems to be a connection to the regions where this responsibility has been delegated to regional authorities. This should be taken into account when implementing the European strategy on "education and training needs for the carbon-free energy society" [EESC 2009b]. In this context, the EESC stresses the need for action not only on school level, but also in the field of (continued) vocational training.

- Social policies

Energy poverty in households must be addressed in the context of social policies, which are generally implemented on the local level. However, there is a need for setting a common definition of public service obligations, which are specific to the energy sector, as foreseen by the European Charter on the Rights of Energy Consumers. Work in the area is just beginning, since, according to the Parliament, the notion of energy poverty still needs to be defined and an "appraisal should be made of the extent to which the individual national social security or tax systems take account of the risks associated with energy poverty." However, it is clear that policy measures must prioritize investment in energy efficiency in low-income households, rather than on subsidizing energy consumption.

6.7. Relevance of Policy Measures for Regional Clusters and Scenarios - Conclusions

Although all policy measures proposed in this report are considered important to fight the different forms of energy poverty in the regions, some have a higher priority for certain clusters and under different scenario assumptions. This evaluation, which is meant to form the basis for debate with policymakers, is presented graphically in the last table and commented thereafter.

Table 7 Evaluation of policy measures for regional clusters

	Policy recommendations		Regional Clusters 1	2	3	4
Reduce	General policy recommendations (Good Governance)	Promote energy solidarity between regions and territories	👍	👍	👍	👍
		Strengthen regional and local networks	👍	👌	👌	👍
		Fund and stabilize transnational research agencies	👍	👍	👌	👍
		Promote awareness among regional policy makers on the impact of rising energy prices and the need for economic diversification	👍	👍	👌	👌
		Define a vision for a regional energy model 2050	👍	👍	👍	👍
		Push municipal leadership in public-private partnerships	👍	👍	👍	👍

Policy recommendations			Regional Clusters			
			1	2	3	4
Reduce	Spatial and urban planning	Develop integrated spatial planning instruments	👍	👍	👍	👍
		Establish urban planning principles for solar energy use	👌	👍	👌	👍
		Implement Urban Metabolism procedures	👍	👍	👍	👍
		Promote industrial symbiosis and/or industrial eco-parks	👍	👍	👌	👌
	Environmental protection and risk prevention	Sustainable use of biocrops	👍	👍	👍	👍
		Prepare for climate change impacts in the regional energy infrastructure	👌	👍	👌	👍
	Policies to Accelerate deployment of renewable energy sources	Evaluate the feasible potential of all renewable sources in the region	👌	👍	👌	👍
		Incorporate solar and wind facilities in urban areas	👌	?	👌	👍
		Accelerate the transition to non-fossil fuels in the aviation industry	👌	👍	👍	👌

Policy recommendations			Regional Clusters 1	2	3	4
Reduce	Policies to promote energy efficiency	Improve the data on energy use and efficiency in Europe	👌	👌	👌	👌
		Involve end users in energy efficiency programmes and policies	👍	👍	👍	👍
		Create a market for energy efficiency	👍	👍	👌	👍
		Improve efficiency of office design and work arrangements	👍	👌	👍	👍
		BAT (Best Available Technologies) for industrial energy efficiency	👍	👍	👌	👌
	Policies to Fight Energy Poverty	Improved transparency and information on energy consumption	👍	👍	👍	👍
		Consumer Awareness and Education	👍	👍	👍	👍
		Social policies	👌	👍	👌	👍

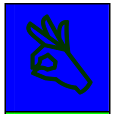
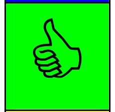
Table 8 Evaluation of policy measures for scenarios

	Policy recommendations		Scenarios: Green High-tech	Scenarios: Energy-efficient Europe	Scenarios: Nuclear energy for big regions	Scenarios: Business as usual?
Capacity to adapt	General policy recommendations (Good Governance)	Promote energy solidarity between regions and territories	👍	👍	?	👌
		Strengthen regional and local networks	👌	👌	👍	👍
		Fund and stabilize transnational research agencies	👍	👍	?	👌
		Promote awareness among regional policy makers on the impact of rising energy prices and the need for economic diversification	👍	👌	👍	👍
		Define a vision for a regional energy model 2050	👌	👍	👌	👍
		Push municipal leadership in public-private partnerships	👍	👍	?	👌

Policy recommendations			Scenarios			
			Green High-tech	Energy-efficient Europe	Nuclear energy for big regions	Business as usual?
Capacity to adapt	Spatial and urban planning	Develop integrated spatial planning instruments	👍	👍	👍	?
		Establish urban planning principles for solar energy use	👌	👍	?	👍
		Implement Urban Metabolism procedures	👍	👌	👍	👌
		Promote industrial symbiosis and/or industrial eco-parks	👍	👌	?	👍
	Environmental protection and risk prevention	Sustainable use of biocrops	👌	👍	👍	👍
		Prepare for climate change impacts in the regional energy infrastructure	👌	👌	👌	👌
	Policies to Accelerate deployment of renewable energy sources	Evaluate the feasible potential of all renewable sources in the region	👌	👍	👍	👌
		Incorporate solar and wind facilities in urban areas	👍	👍	👍	?
		Accelerate the transition to non-fossil fuels in the aviation industry	👌	👌	👌	👌

Policy recommendations			Scenarios: Green High-tech	Energy-efficient Europe	Nuclear energy for big regions	Business as usual?
Capacity to adapt	Policies to promote energy efficiency	Improve the data on energy use and efficiency in Europe	👌	👌	👍	👍
		Involve end users in energy efficiency programmes and policies	👍	👌	?	👍
		Create a market for energy efficiency	👍	👌	👎	👌
		Improve efficiency of office design and work arrangements	👍	👍	👍	👍
		BAT (Best Available Technologies) for industrial energy efficiency	👍	👌	👍	👌
	Policies to Fight Energy Poverty	Improved transparency and information on energy consumption	👍	👌	👎	👍
		Consumer Awareness and Education	👍	👍	👌	👍
		Social policies	👍	👍	👍	👌

The meaning of the symbols used is as follows:

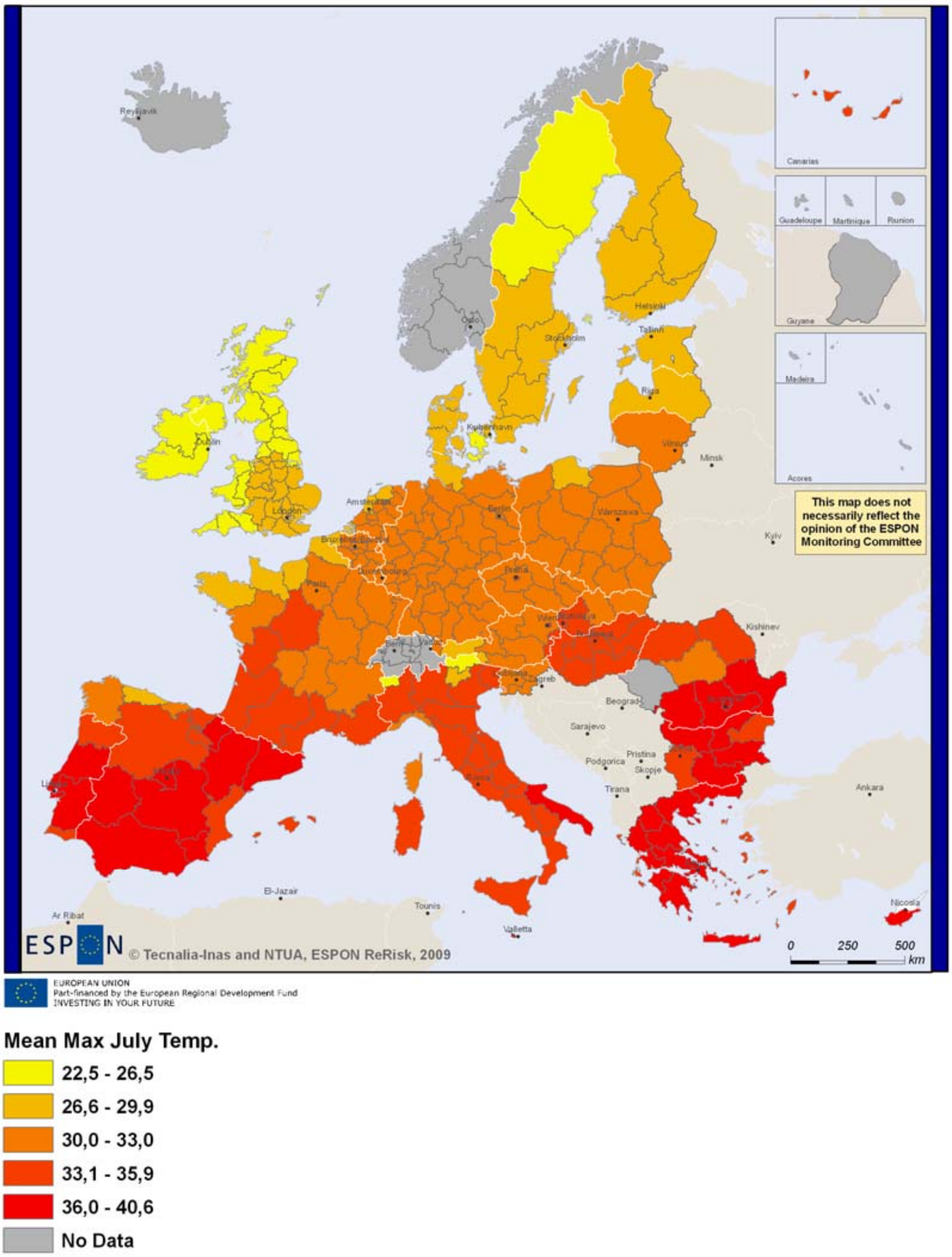
	Top priority
	Makes sense to include this measure with a high priority.
?	It is an ambiguous measure, depends on the region or the time lapse.
	This measure must be handled with care as it might result counteractive.

Cluster 3, for example, groups the regions with the most unfavourable economic structure, so that industrial diversification strategies are vital to conserve competitiveness. Since this cluster is also characterized by high demand for heating and cooling, the construction of efficient networks is also a priority. Likewise, regions with high level of commuting (cluster 2) or at the periphery (cluster 4), with an important dependence on air travel, have a greater need for action in the field of mobility and freight transport.
Social policies – so far rather underdeveloped with regard to energy poverty – play a crucial role for regions in cluster 1 and 3 and under the assumptions of the "Business as Usual?" scenario and could be combined with innovative financing measures on municipal level. For regions with low disposable income, but considerable PV potential, urban solar planning tools may provide the information necessary to achieve the greatest deployment of these technologies at the lowest cost possible. In Member States that opt primarily for building new nuclear plants and will therefore have a large baseload capacity (electricity that is being produced 24 hours a day), overall energy efficiency may not be the determining aspect in the corresponding policies, but rather the shift from fossil fuel use to the constant consumption of electricity. A critical question in this context is acceptance and consumer preferences, for example for "green tariffs".

European initiatives are especially important when benchmarks are needed, for example in industries with high energy spending, and for promoting regional cooperation through network extension, energy research and the development of a joint and more reliable renewable portfolio. The European framework will furthermore be decisive where major transition processes need to be implemented, mainly with regard to air and freight transport.

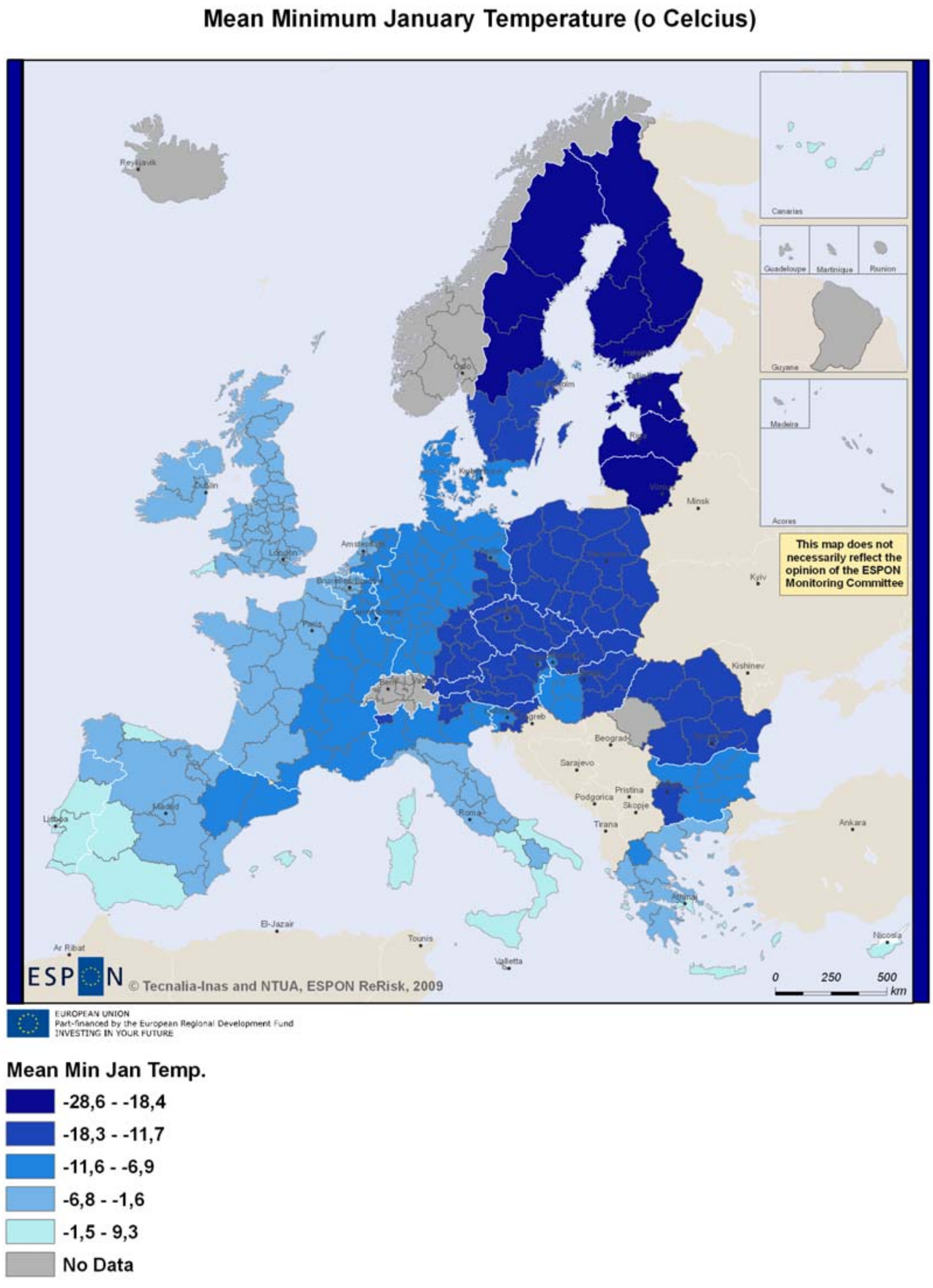
Annex 1: Maps of Individual Indicators

Mean Maximum July Temperature (o Celcius)



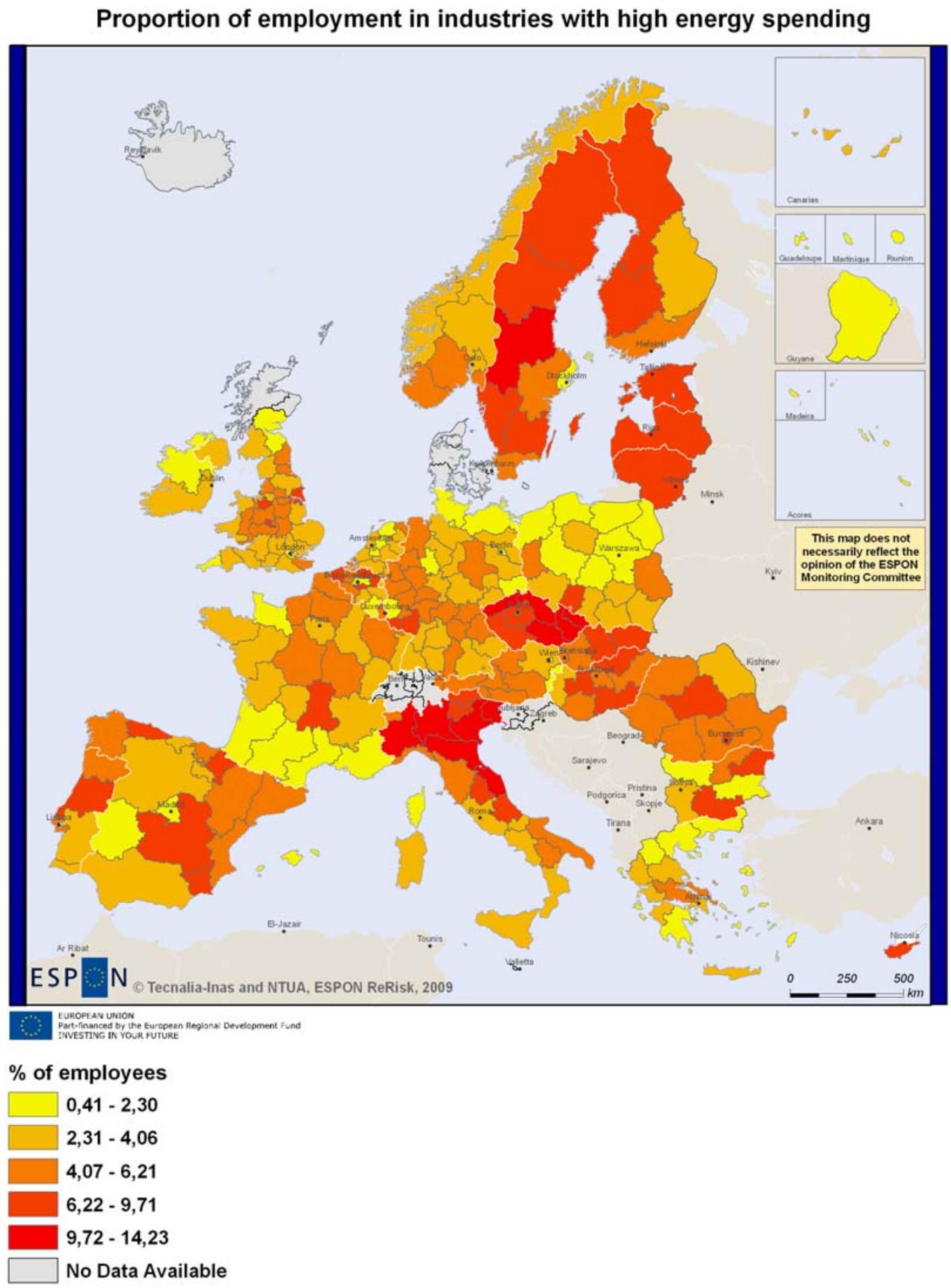
Source: Joint Research Centre, Ispra - IPSC -MARS Unit

Map 2 Mean maximum July temperature in the EU regions (NUTS II)



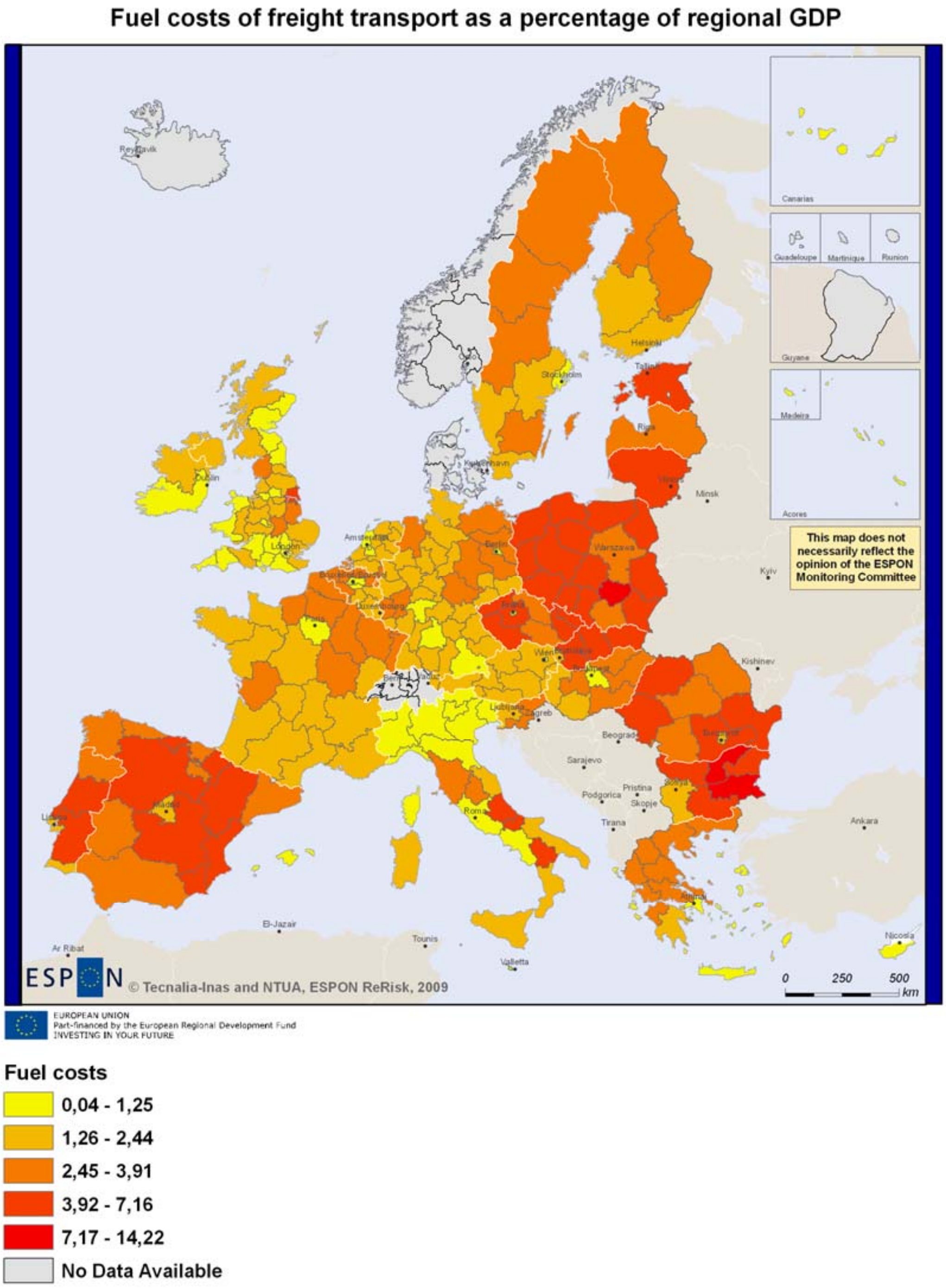
Source: Joint Research Centre, Ispra - IPSC -MARS Unit

Map 3 Mean minimum January temperature in the EU regions (NUTS II)



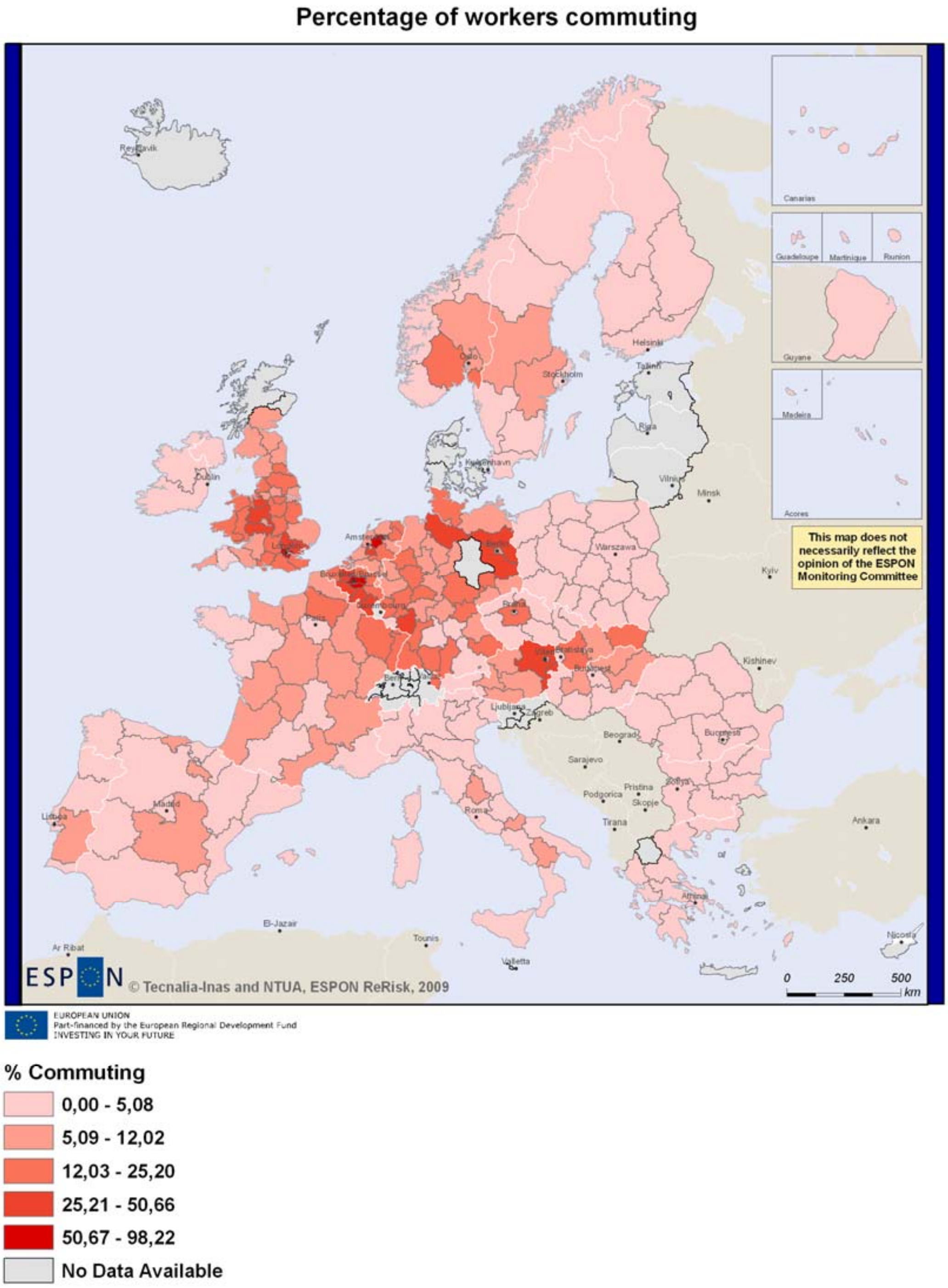
Source: Own elaboration based on Eurostat data

Map 4 % of employment in industries with high energy purchases in the EU regions (NUTS II)



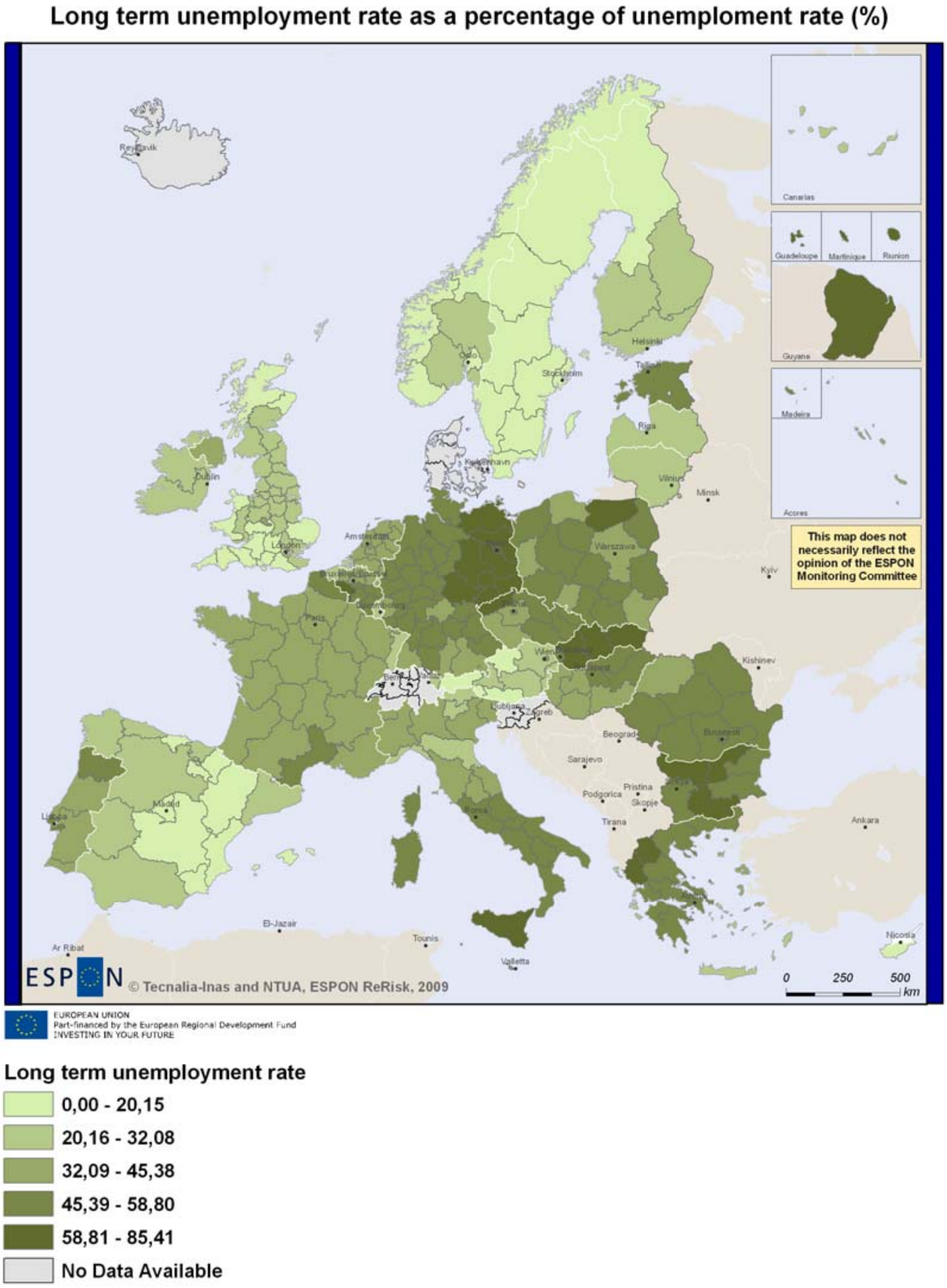
Source: DG Regio

Map 5 Fuel costs in the EU regions (NUTS II)



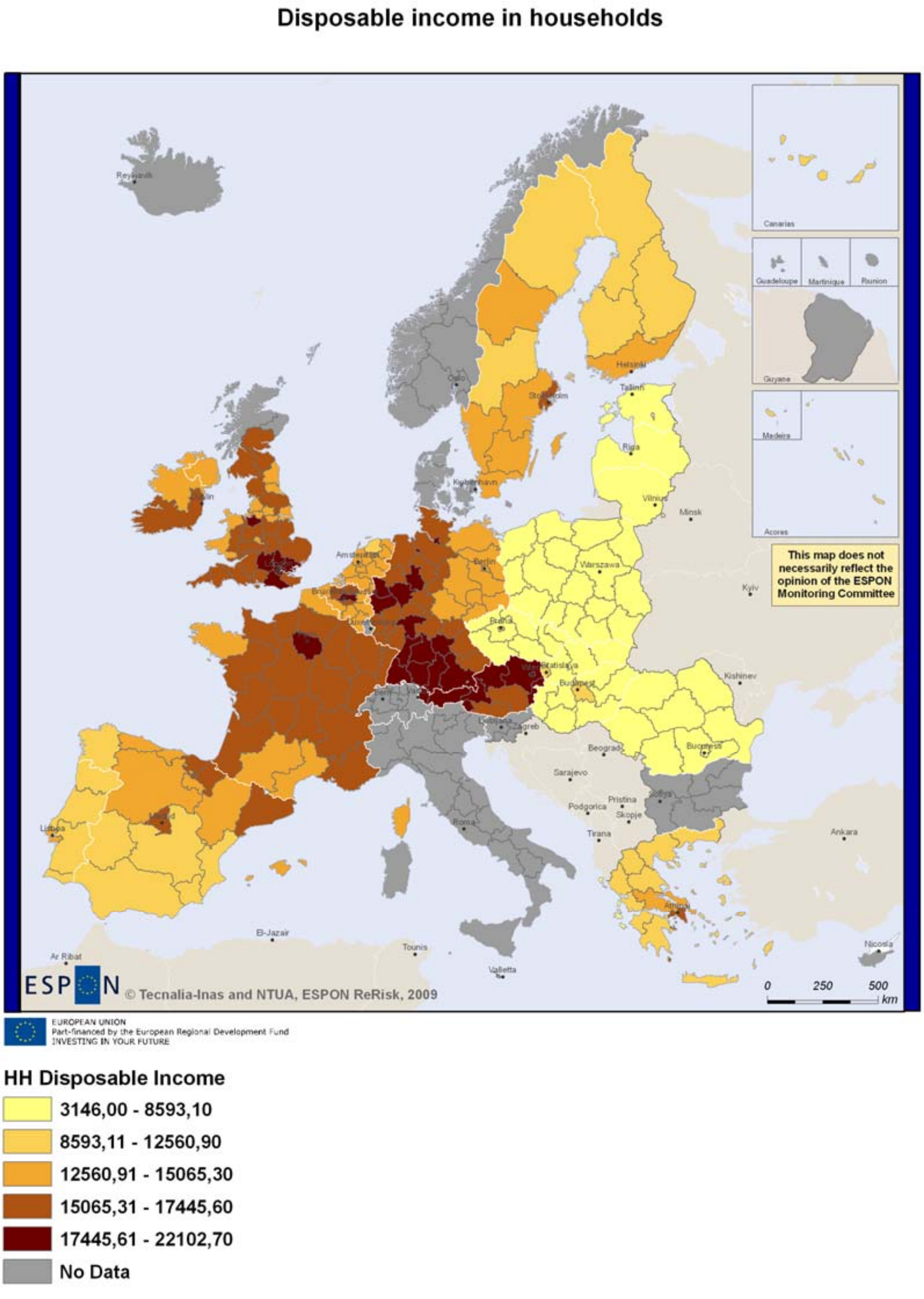
Source: Own elaboration based on Eurostat data

Map 6 Percentage of workers commuting to another region (NUTS II)



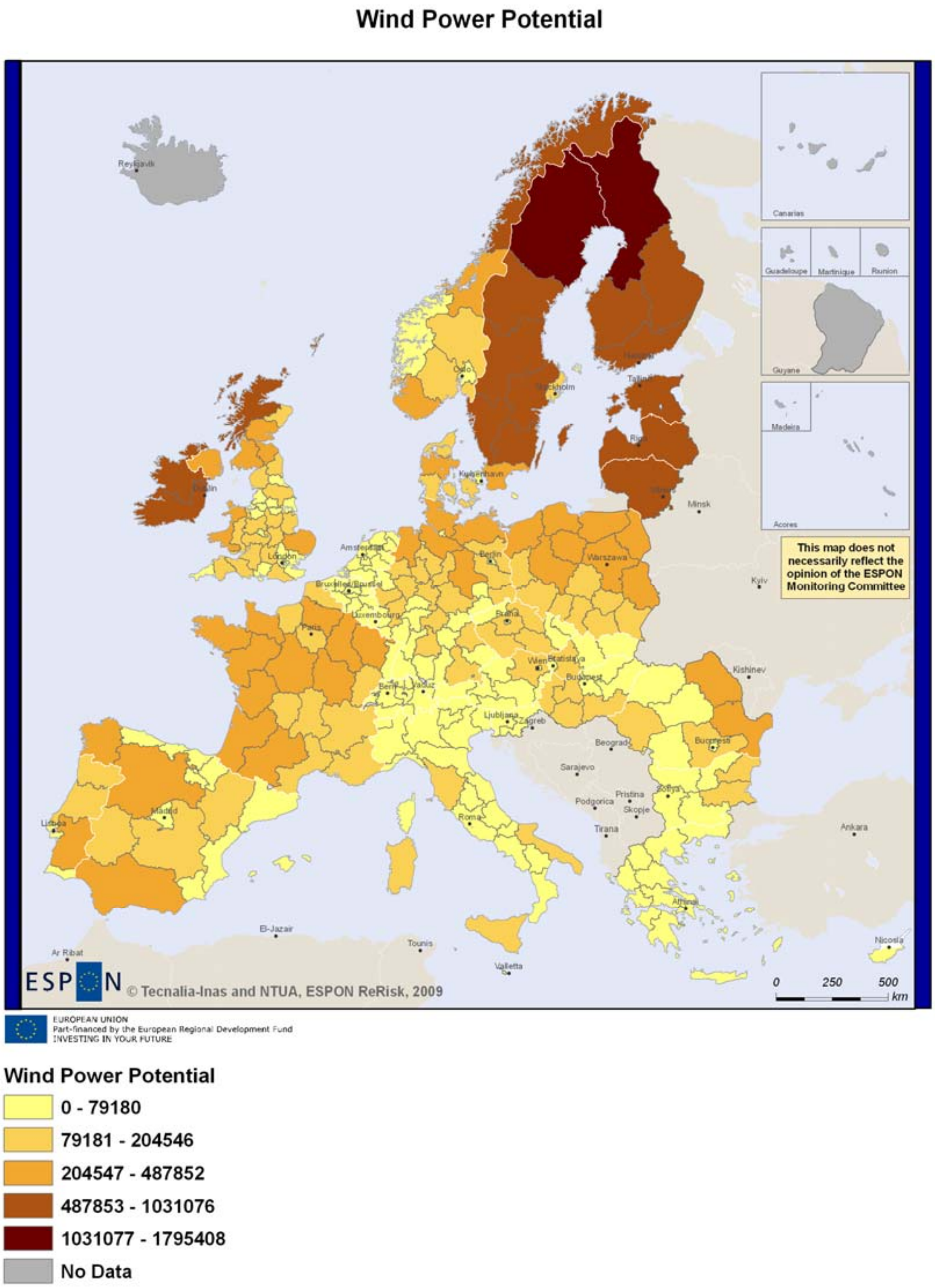
Source: Own elaboration based on Eurostat data

Map 7 Long term unemployment rate in the EU regions (NUTS II)



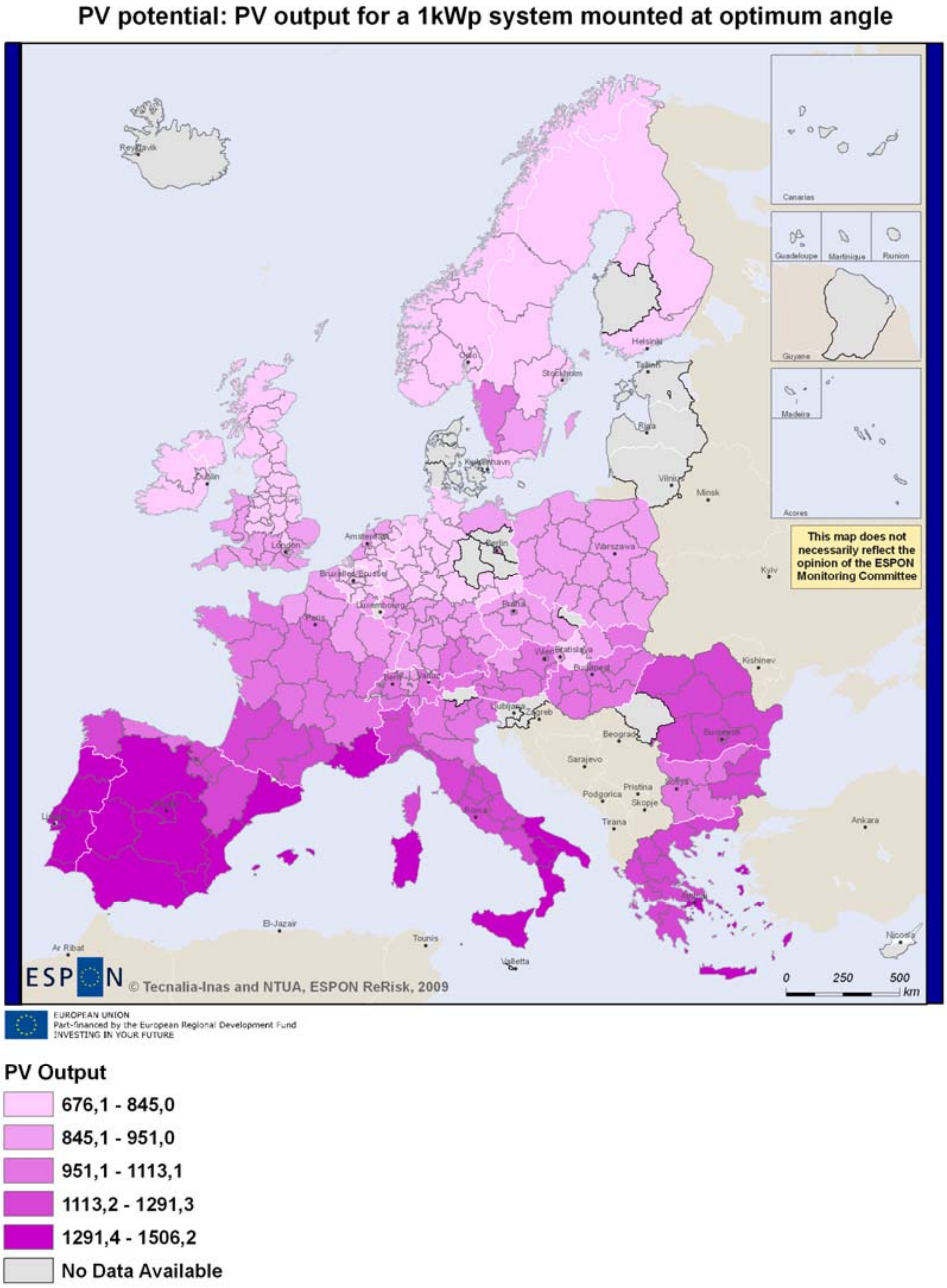
Source: Own elaboration based on Eurostat data

Map 8 Disposable income in households in the EU regions (NUTS II)



Source: Own elaboration based on European Topic Centre on Air and Climate change (ETC/ACC) data on wind intensity

Map 9 Wind power potential in the EU regions (NUTS II)



Source: Joint Research Centre, Renewable Energies Unit

Map 10 PV potential in the EU regions (NUTS II)

Annex 2: Regions by Cluster

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
AT11	Burgenland (A)	26,06	50,659	1,714	1,526	1.001,036	17.587,90	33,43	-10,67	32.383,72	2
AT12	Niederösterreich	29,46	36,293	2,238	3,504	971,181	18.256,40	32,89	-12,05	157.900,40	2
AT13	Wien	34,37	9,323	0,393	2,254	969,618	18.792,20	34,01	-10,54	5.397,04	1
AT21	Kärnten	16,93	7,180	1,868	4,752	995,716	17.064,70	31,59	-14,63	6.103,52	1
AT22	Steiermark	21,10	5,789	1,845	4,135	988,695	17.021,50	32,15	-13,67	44.274,00	1
AT31	Oberösterreich	18,47	6,423	2,312	4,889	931,984	17.687,00	32,59	-13,21	53.312,80	1
AT32	Salzburg	25,21	8,375	1,742	4,812	985,725	18.426,00	32,06	-15,25	8.236,32	1
AT33	Tirol	13,21	3,619	1,424	5,433	1.045,263	18.092,30	28,15	-13,92	13.791,68	1
AT34	Vorarlberg	23,80	12,444	1,569	5,279	1.001,500	18.628,60	31,37	-12,01	1.343,85	1
BE10	Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest	57,57	19,066	0,180	3,122	814,839	14.201,90	31,03	-6,12	2.932,48	1
BE21	Prov. Antwerpen	40,21	13,794	2,561	7,869	813,564	15.584,60	31,17	-6,72	40.870,80	3
BE22	Prov. Limburg (B)	32,73	23,333	3,005	7,267	809,911	14.419,40	32,35	-7,82	32.426,68	3
BE23	Prov. Oost-Vlaanderen	41,69	31,929	2,855	4,728	829,682	15.830,30	30,73	-5,13	43.892,40	2
BE24	Prov. Vlaams Brabant	35,03	72,922	1,238	2,104	813,195	18.069,10	31,25	-6,51	29.893,44	2
BE25	Prov. West-Vlaanderen	31,51	12,509	3,058	7,508	849,933	15.012,80	29,63	-4,65	50.602,40	3
BE31	Prov. Brabant Wallon	53,59	98,219	0,829	7,715	819,693	17.044,00	31,09	-6,71	15.145,56	2
BE32	Prov. Hainaut	60,78	29,065	2,543	4,591	838,364	12.888,90	30,58	-6,27	51.419,60	2
BE33	Prov. Liège	55,95	13,968	1,990	3,558	822,660	13.320,80	31,36	-8,13	54.728,80	1
BE34	Prov. Luxembourg (B)	47,65	45,143	1,838	0,414	853,459	12.987,40	30,43	-8,87	63.888,00	2
BE35	Prov. Namur	51,35	45,164	1,699	3,003	831,668	13.580,80	30,73	-8,09	49.963,20	2
BG31	Severozapaden	65,34	1,289	6,387	1,408	1.057,584	-9,00	36,81	-10,72	57.520,40	1

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
BG32	Severen tsentralen	65,22	1,027	14,221	4,458	1.089,911	-9,00	37,17	-11,41	77.092,80	3
BG33	Severoiztochen	54,35	0,648	7,162	7,799	1.155,245	-9,00	33,57	-11,05	145.277,60	3
BG34	Yugoiztochen	52,46	0,969	8,183	1,111	1.122,967	-9,00	36,95	-9,71	115.723,20	1
BG41	Yugozapaden	51,08	1,881	2,267	2,984	1.073,698	-9,00	34,57	-12,41	24.337,40	1
BG42	Yuzhen tsentralen	65,39	2,602	6,722	8,164	1.074,699	-9,00	37,82	-10,73	59.100,00	3
CH01	Région lémanique	-9,00	-9,000	-9,000	-9,000	1.028,687	-9,00	-9,00	-9,00	1.724,09	3
CH02	Espace Mittelland	-9,00	-9,000	-9,000	-9,000	971,546	-9,00	-9,00	-9,00	4.160,68	3
CH03	Nordwestschweiz	-9,00	-9,000	-9,000	-9,000	925,344	-9,00	-9,00	-9,00	2.210,30	3
CH04	Zürich	-9,00	-9,000	-9,000	-9,000	928,918	-9,00	-9,00	-9,00	2.703,40	3
CH05	Ostschweiz	-9,00	-9,000	-9,000	-9,000	999,125	-9,00	-9,00	-9,00	3.129,62	3
CH06	Zentralschweiz	-9,00	-9,000	-9,000	-9,000	950,981	-9,00	-9,00	-9,00	184,16	3
CH07	Ticino	-9,00	-9,000	-9,000	-9,000	1.002,877	-9,00	-9,00	-9,00	8,97	3
CY00	Cyprus	18,59	-9,000	1,081	6,659	-9,000	-9,00	38,04	2,11	39.050,24	2
CZ01	Praha	36,10	3,744	1,152	4,442	865,811	10.916,10	33,08	-12,47	4.327,88	1
CZ02	Strední Cechy	43,23	21,653	6,267	9,186	876,780	8.593,10	32,11	-13,19	84.332,00	3
CZ03	Jihozápad	42,24	3,389	4,793	9,706	851,415	7.955,80	31,54	-13,79	139.331,20	3
CZ04	Severozápad	61,06	3,504	5,547	11,488	868,100	7.190,30	32,13	-12,67	59.811,20	3
CZ05	Severovýchod	46,70	2,876	3,831	12,524	907,229	7.749,50	31,28	-14,96	88.970,00	3
CZ06	Jihovýchod	52,63	3,688	3,742	11,326	893,206	7.822,40	31,68	-13,83	128.057,20	3
CZ07	Strední Morava	54,79	3,965	5,307	12,754	868,146	7.461,40	31,69	-14,57	61.706,40	3
CZ08	Moravskoslezsko	57,49	2,743	4,805	14,225	-9,000	7.400,90	31,21	-15,70	43.606,80	3
DE11	Stuttgart	48,52	2,617	1,209	2,891	908,080	19.233,90	32,27	-11,33	90.122,80	1
DE12	Karlsruhe	51,56	14,401	1,490	2,988	892,656	18.363,10	32,79	-10,41	50.195,60	1
DE13	Freiburg	38,48	14,953	1,602	3,330	910,769	17.793,90	31,58	-9,45	23.948,00	1
DE14	Tübingen	47,16	14,678	1,597	3,478	925,365	18.435,90	30,67	-11,21	41.359,60	1
DE21	Oberbayern	44,02	2,558	1,060	3,617	977,526	19.913,70	31,84	-12,70	91.639,60	1
DE22	Niederbayern	47,51	12,545	2,269	3,552	912,478	15.973,30	31,85	-13,47	66.640,00	1
DE23	Oberpfalz	51,74	9,903	2,271	4,763	892,531	16.419,90	31,75	-13,41	89.144,00	1
DE24	Oberfranken	56,49	12,373	1,790	4,972	868,123	17.139,90	31,25	-12,54	69.864,80	1

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
DE25	Mittelfranken	51,36	4,223	1,448	4,418	900,935	18.290,10	32,54	-12,95	69.640,80	1
DE26	Unterfranken	43,81	12,015	1,964	4,137	873,171	16.976,90	32,33	-11,17	83.939,60	1
DE27	Schwaben	45,38	13,095	2,036	5,030	957,554	17.597,00	31,81	-13,60	58.764,80	1
DE30	Berlin	63,17	5,682	0,544	1,811	863,700	14.275,90	32,58	-11,18	13.646,36	1
DE41		59,63	34,583	3,711	2,572	-9,000	13.948,10	31,77	-11,56	197.381,20	2
DE42		59,78	31,596	3,430	2,525	-9,000	14.245,80	32,67	-12,27	171.486,00	2
DE50	Bremen	61,99	8,683	2,458	0,674	822,475	19.224,70	30,89	-8,67	5.928,64	1
DE60	Hamburg	54,88	6,633	1,435	1,026	826,056	22.102,70	31,29	-10,11	12.116,96	1
DE71	Darmstadt	53,63	9,858	0,817	4,591	862,771	18.752,30	32,74	-10,61	66.801,60	1
DE72	Gießen	50,44	16,675	1,708	5,264	834,762	16.912,70	31,64	-10,66	52.801,60	1
DE73	Kassel	57,23	7,493	2,184	3,292	827,828	16.647,40	30,96	-10,80	98.900,40	1
DE80	Mecklenburg-Vorpommern	60,75	8,898	2,747	0,635	868,246	13.455,60	30,32	-9,64	334.284,80	1
DE91	Braunschweig	52,58	8,944	1,831	2,490	818,461	16.292,50	31,27	-10,43	106.761,20	1
DE92	Hannover	56,77	7,636	1,870	2,624	812,804	17.106,80	31,39	-9,67	120.940,00	1
DE93	Lüneburg	56,94	48,338	2,093	2,862	823,394	17.167,20	31,33	-9,79	226.282,80	2
DE94	Weser-Ems	53,98	10,345	2,676	5,096	823,380	15.669,80	30,79	-8,39	215.954,00	1
DEA1	Düsseldorf	55,99	5,386	1,497	5,777	815,414	18.495,10	32,35	-7,88	66.887,20	1
DEA2	Köln	57,21	9,070	1,429	4,611	818,303	18.000,00	32,31	-9,09	89.118,80	1
DEA3	Münster	55,12	21,423	2,182	4,567	814,721	16.976,50	31,74	-8,77	85.136,40	1
DEA4	Detmold	56,14	6,829	1,905	2,269	812,931	18.802,10	31,07	-9,43	86.715,60	1
DEA5	Arnsberg	57,82	16,033	2,156	4,112	813,761	17.871,00	31,17	-9,49	108.004,40	1
DEB1	Koblenz	52,93	19,089	2,527	4,705	845,643	16.473,10	31,70	-10,57	86.606,80	1
DEB2	Trier	41,72	16,233	2,967	1,529	860,941	15.939,10	30,97	-9,59	54.603,20	1
DEB3	Rheinhessen-Pfalz	50,28	29,753	1,996	6,815	884,129	16.651,20	32,61	-10,32	60.763,60	2
DEC0	Saarland	51,90	4,940	1,638	6,567	890,082	16.527,30	31,20	-9,59	26.584,88	1
DED1	Chemnitz	64,55	10,373	2,028	3,132	845,027	14.253,00	30,89	-12,69	57.226,00	1
DED2	Dresden	59,33	6,348	2,022	2,055	842,515	14.092,80	31,91	-12,73	82.100,40	1
DED3	Leipzig	65,37	12,749	2,405	3,290	836,751	13.812,10	32,65	-11,75	45.674,40	1

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DEE0	Sachsen-Anhalt	64,07	-9,000	3,672	4,833	-9,000	13.512,90	32,08	-10,94	232.786,80	1
DEF0	Schleswig-Holstein	52,04	16,204	1,975	1,867	839,030	16.318,80	29,66	-8,14	252.764,80	1
DEG0	Thüringen	63,92	12,676	2,718	3,931	839,907	13.653,60	31,08	-11,67	171.329,20	1
DK01	Hovedstaden	-9,00	-9,000	-9,000	-9,000	-9,000	-9,00	27,65	-10,30	49.772,80	3
DK02	Sjælland	-9,00	-9,000	-9,000	-9,000	-9,000	-9,00	26,36	-7,83	126.669,60	1
DK03	Syddanmark	-9,00	-9,000	-9,000	-9,000	-9,000	-9,00	27,75	-7,95	204.545,60	1
DK04	Midtjylland	-9,00	-9,000	-9,000	-9,000	-9,000	-9,00	27,89	-9,98	229.267,60	2
DK05	Nordjylland	-9,00	-9,000	-9,000	-9,000	-9,000	-9,00	27,58	-9,63	154.593,60	2
EE00	Estonia	49,47	-9,000	4,256	9,238	-9,000	6.096,60	28,44	-18,47	616.728,00	4
ES11	Galicia	25,50	2,522	3,910	4,529	1.189,056	12.122,10	32,21	-2,15	342.181,20	1
ES12	Principado de Asturias	30,54	2,973	3,535	6,323	1.046,250	13.664,80	28,10	-0,83	73.938,80	3
ES13	Cantabria	20,15	5,423	4,146	3,426	1.093,632	14.183,60	31,68	-3,26	22.542,40	1
ES21	Pais Vasco	24,85	2,197	3,136	6,007	1.137,402	17.445,60	34,80	-4,69	53.032,80	1
ES22	Comunidad Foral de Navarra	14,44	4,851	4,451	9,051	1.224,147	17.237,90	37,29	-3,71	67.104,80	3
ES23	La Rioja	15,52	6,991	3,625	2,576	1.235,710	14.593,70	35,49	-5,45	14.260,76	1
ES24	Aragón	17,12	1,845	4,928	4,892	1.277,569	14.783,20	36,84	-7,65	177.241,20	1
ES30	Comunidad de Madrid	17,36	1,679	1,372	1,978	1.404,979	16.271,10	37,91	-3,97	11.105,48	1
ES41	Castilla y León	22,43	2,846	4,554	3,545	1.319,172	13.591,30	35,45	-5,37	274.301,60	1
ES42	Castilla-la Mancha	19,25	9,475	5,693	7,303	1.429,281	11.207,60	38,98	-4,57	199.338,80	3
ES43	Extremadura	25,10	2,825	3,513	2,285	1.450,185	10.429,60	40,16	-0,91	131.070,00	1
ES51	Cataluña	20,54	0,467	2,878	4,096	1.317,340	15.466,70	36,71	-7,38	56.236,40	1
ES52	Comunidad Valenciana	16,04	1,528	4,363	4,722	1.377,895	12.416,90	35,87	-4,43	31.758,56	1
ES53	Illes Balears	9,26	0,623	0,481	1,394	1.357,847	14.770,90	34,85	0,33	61.733,60	1
ES61	Andalucia	21,61	1,426	3,494	2,456	1.453,352	10.827,10	40,56	-1,01	218.206,40	1
ES62	Región de Murcia	14,42	2,760	6,129	6,765	1.464,838	11.033,30	37,09	-2,96	15.278,92	3
ES63	Ciudad Autónoma de Ceuta (ES)	46,32	4,400	0,188	0,843	-9,000	13.875,80	34,60	3,98	0,00	1

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
ES64	Ciudad Autónoma de Melilla (ES)	40,14	2,804	0,041	0,432	-9,000	13.788,60	34,69	4,49	0,00	1
ES70	Canarias (ES)	21,82	0,505	0,522	2,703	-9,000	11.957,60	33,36	9,29	-9,00	1
FI13	Itä-Suomi	22,77	3,007	3,480	2,925	786,749	10.884,00	27,44	-25,77	1.031.076,00	4
FI18	Etelä-Suomi	24,95	1,311	1,587	5,114	836,313	12.800,10	27,63	-19,16	617.064,00	4
FI19	Länsi-Suomi	23,35	3,582	2,326	6,415	-9,000	11.347,10	28,37	-21,75	890.264,00	4
FI1A	Pohjois-Suomi	16,40	3,271	3,029	6,443	793,711	10.754,70	26,91	-28,65	1.795.408,00	4
FI20	Åland	0,00	3,846	1,600	1,743	879,359	14.140,80	25,55	-10,83	16.307,16	1
FR10	Île de France	42,83	2,396	0,505	2,570	957,854	19.986,60	32,55	-6,03	151.173,20	1
FR21	Champagne-Ardenne	35,40	5,965	3,177	3,943	921,707	15.428,70	32,10	-8,52	269.868,00	1
FR22	Picardie	38,47	24,541	3,145	5,789	893,775	15.474,80	31,09	-6,41	238.716,80	1
FR23	Haute-Normandie	42,99	10,730	3,019	5,415	930,486	15.806,00	29,86	-5,27	181.766,40	1
FR24	Centre	37,94	9,805	2,432	4,507	1.006,197	16.237,20	33,23	-6,30	462.108,00	1
FR25	Basse-Normandie	34,58	6,407	2,168	1,967	978,022	15.102,30	29,45	-4,35	279.004,40	1
FR26	Bourgogne	37,83	9,218	2,610	4,542	995,295	16.047,60	33,02	-7,98	283.933,60	1
FR30	Nord - Pas-de-Calais	49,74	5,283	2,783	4,397	858,013	13.513,40	29,89	-5,44	183.049,60	1
FR41	Lorraine	40,19	15,349	2,693	4,289	903,514	15.437,30	31,51	-8,87	227.816,80	1
FR42	Alsace	31,61	12,817	2,569	3,682	907,954	16.406,10	32,85	-9,31	33.208,80	1
FR43	Franche-Comté	34,01	7,138	2,124	3,729	969,108	15.814,00	32,21	-8,45	97.856,80	1
FR51	Pays de la Loire	38,32	4,446	2,347	2,901	1.060,953	15.087,30	31,93	-4,62	424.388,00	1
FR52	Bretagne	35,32	3,786	2,062	2,413	1.006,694	14.910,80	28,93	-3,31	487.852,00	1
FR53	Poitou-Charentes	39,02	6,892	2,458	2,479	1.110,678	15.133,30	33,31	-4,87	283.670,80	1
FR61	Aquitaine	35,22	5,563	2,347	2,295	1.122,423	15.513,00	34,34	-4,54	348.758,40	1
FR62	Midi-Pyrénées	36,31	4,151	1,602	1,741	1.165,059	15.065,30	33,83	-5,78	235.079,60	1
FR63	Limousin	41,02	6,263	1,776	2,485	1.093,600	15.829,30	32,71	-6,13	168.034,80	1
FR71	Rhône-Alpes	34,94	5,487	1,807	4,057	1.104,103	16.320,20	32,77	-7,91	115.610,80	1
FR72	Auvergne	36,50	4,780	2,089	6,280	1.094,756	15.743,40	32,89	-9,07	122.008,80	1
FR81	Languedoc-Roussillon	46,18	8,379	2,095	1,965	1.265,843	14.274,70	34,67	-7,11	194.478,80	1

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
FR82	Provence-Alpes-Côte d'Azur	41,06	3,596	1,379	1,932	1.344,786	15.932,40	34,37	-8,35	132.322,00	1
FR83	Corse	46,42	2,849	0,325	1,253	1.291,322	14.313,80	32,07	0,83	24.319,48	1
FR91	Guadeloupe (FR)	80,75	0,131	-9,000	0,810	-9,000	-9,00	-9,00	-9,00	-9,00	1
FR92	Martinique (FR)	85,41	0,094	-9,000	0,745	-9,000	-9,00	-9,00	-9,00	-9,00	1
FR93	Guyane (FR)	67,02	0,796	-9,000	0,700	-9,000	-9,00	-9,00	-9,00	-9,00	1
FR94	Reunion (FR)	75,18	0,000	-9,000	0,916	-9,000	-9,00	-9,00	-9,00	-9,00	1
GR11	Anatoliki Makedonia, Thraki	55,88	0,176	3,558	1,134	1.126,759	11.393,40	36,39	-6,72	56.124,40	1
GR12	Kentriki Makedonia	54,51	0,164	3,552	1,356	1.182,286	12.403,70	37,77	-6,07	15.148,28	1
GR13	Dytiki Makedonia	62,97	-9,000	3,387	1,588	1.259,387	12.137,10	36,35	-10,65	5.704,96	1
GR14	Thessalia	48,13	0,482	2,881	3,675	1.205,066	11.280,70	38,80	-6,41	2.753,22	1
GR21	Ipeiros	59,78	0,410	2,731	3,804	1.193,026	10.985,70	36,15	-4,49	1.779,41	1
GR22	Ionia Nisia	27,91	0,221	1,020	1,596	1.180,945	7.210,90	35,37	-0,59	10.411,00	1
GR23	Dytiki Ellada	51,64	0,262	3,270	2,731	1.197,450	10.180,80	36,13	-5,36	2.711,04	1
GR24	Sterea Ellada	49,78	0,556	3,445	4,131	1.284,083	12.923,70	37,75	-5,30	27.276,92	1
GR25	Peloponnisos	54,05	0,164	2,417	1,069	1.271,129	10.263,90	37,11	-4,61	18.975,68	1
GR30	Attiki	49,95	0,074	1,102	2,926	1.338,304	16.241,60	37,77	-0,51	28.988,88	1
GR41	Voreio Aigaio	40,88	-9,000	0,526	2,267	1.339,197	11.156,30	35,35	-1,61	42.065,60	2
GR42	Notio Aigaio	21,86	0,000	0,433	1,861	1.388,884	12.560,90	35,33	4,53	47.282,40	1
GR43	Kriti	28,74	-9,000	1,004	2,418	1.346,387	11.613,30	36,53	3,50	61.745,60	2
HU10	Közép-Magyarország	51,39	1,616	1,168	5,606	1.050,079	11.282,80	35,03	-11,97	43.536,40	1
HU21	Közép-Dunántúl	41,19	10,404	2,959	6,933	1.040,598	7.163,00	33,89	-11,27	86.311,20	3
HU22	Nyugat-Dunántúl	44,38	4,009	1,959	3,148	1.016,166	7.214,00	33,47	-10,95	93.140,80	1
HU23	Dél-Dunántúl	43,76	4,001	2,445	5,966	1.019,657	6.218,90	34,08	-11,05	95.618,80	3
HU31	Észak-Magyarország	47,76	10,679	2,995	8,761	1.022,116	5.813,80	34,25	-12,19	58.764,80	3
HU32	Észak-Alföld	47,69	5,398	2,621	6,208	1.043,314	5.457,60	35,33	-13,14	73.933,20	3
HU33	Dél-Alföld	44,77	2,955	2,543	8,070	1.081,104	5.898,70	35,59	-13,53	92.440,80	3

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IE01	Border, Midlands and Western	30,21	1,348	1,788	1,581	796,647	13.080,70	22,51	-2,85	704.832,00	4
IE02	Southern and Eastern	29,94	0,272	1,126	2,602	833,354	15.181,10	23,21	-2,08	698.516,00	4
IS00	Iceland	-9,00	-9,000	-9,000	-9,000	-9,000	-9,00	-9,00	-9,00	-9,00	2
ITC1	Piemonte	43,44	3,133	0,445	10,946	1.165,327	-9,00	33,39	-7,30	1.306,95	3
ITC2	Valle d'Aosta/Vallée d'Aoste	34,20	2,621	0,287	5,272	1.123,822	-9,00	23,91	-13,06	18,50	1
ITC3	Liguria	31,64	3,350	0,748	4,708	1.209,446	-9,00	30,88	-3,77	15.185,36	1
ITC4	Lombardia	34,40	2,302	0,380	12,366	1.085,533	-9,00	34,42	-8,31	1.756,52	3
ITD1	Provincia Autonoma Bolzano-Bozen	23,00	2,104	0,271	6,368	-9,000	-9,00	26,25	-15,05	5.673,60	1
ITD2	Provincia Autonoma Trento	23,49	2,587	0,225	7,306	1.038,720	-9,00	29,46	-12,16	5.323,40	3
ITD3	Veneto	34,57	2,461	0,257	12,088	1.083,906	-9,00	34,36	-9,26	35.414,20	3
ITD4	Friuli-Venezia Giulia	33,91	3,015	0,374	12,504	1.066,320	-9,00	33,99	-10,75	10.489,24	3
ITD5	Emilia-Romagna	28,48	1,914	0,400	13,907	1.113,112	-9,00	34,35	-5,57	32.481,68	3
ITE1	Toscana	38,62	2,053	2,887	5,806	1.171,457	-9,00	35,09	-4,48	88.449,20	1
ITE2	Umbria	40,47	6,071	2,616	8,717	1.230,451	-9,00	35,23	-5,61	27.775,80	3
ITE3	Marche	35,61	3,944	2,307	10,406	1.241,164	-9,00	34,16	-4,56	17.963,04	3
ITE4	Lazio	51,07	1,450	0,612	2,779	1.256,899	-9,00	33,70	-1,92	49.698,80	1
ITF1	Abruzzo	46,66	3,933	5,623	7,412	1.247,805	-9,00	33,47	-4,29	10.030,08	3
ITF2	Molise	49,29	7,278	4,316	3,938	1.279,107	-9,00	34,57	-3,13	10.454,44	1
ITF3	Campania	54,16	4,275	0,969	3,814	1.282,123	-9,00	33,81	-0,39	25.596,72	1
ITF4	Puglia	52,98	4,109	2,084	5,371	1.368,917	-9,00	36,45	-1,21	156.014,80	1
ITF5	Basilicata	54,54	7,742	4,740	4,423	1.333,175	-9,00	34,99	-1,57	28.170,24	1
ITF6	Calabria	55,50	3,544	1,627	2,515	1.356,257	-9,00	33,91	0,61	43.950,80	1
ITG1	Sicilia	60,87	2,243	1,754	3,027	1.448,346	-9,00	35,30	2,81	109.274,80	1
ITG2	Sardegna	46,41	1,277	1,345	3,385	1.374,903	-9,00	35,72	0,60	93.829,60	1
LI00	Liechtenstein	-9,00	-9,000	-9,000	-9,000	-9,000	-9,00	-9,00	-9,00	2,92	3
LT00	Lithuania	32,04	-9,000	4,432	7,404	-9,000	6.917,30	30,14	-18,35	756.792,00	4

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
LU00	Luxembourg (Grand-Duché)	28,66	-9,000	1,352	6,138	-9,000	-9,00	31,15	-8,80	30.017,52	2
LV00	Latvia	26,43	-9,000	2,671	8,946	-9,000	5.794,80	29,11	-18,89	855.688,00	4
MT00	Malta	41,05	-9,000	1,000	-9,000	-9,000	-9,00	37,10	5,88	3.305,96	2
NL11	Groningen	39,27	13,083	1,326	4,252	842,594	12.600,30	29,97	-7,59	39.192,60	1
NL12	Friesland (NL)	39,36	8,766	1,533	1,745	857,250	12.371,30	29,14	-7,23	59.227,20	1
NL13	Drenthe	38,89	25,196	2,094	3,684	835,786	13.160,10	30,35	-8,03	39.843,80	1
NL21	Overijssel	44,17	11,485	1,829	3,568	822,760	12.647,90	30,77	-8,33	46.793,20	1
NL22	Gelderland	37,85	19,028	1,998	2,574	825,093	13.538,00	31,39	-7,55	69.812,40	1
NL23	Flevoland	43,11	60,618	1,911	2,061	839,686	13.209,90	30,21	-6,38	19.864,04	2
NL31	Utrecht	35,97	26,382	0,737	2,081	834,275	14.878,80	30,73	-6,95	21.593,08	1
NL32	Noord-Holland	41,18	8,395	0,792	3,881	850,501	14.840,00	28,79	-5,39	56.062,80	1
NL33	Zuid-Holland	39,42	9,187	1,848	3,000	845,826	13.932,70	30,08	-5,57	53.229,60	1
NL34	Zeeland	32,08	12,594	3,272	5,346	837,022	13.257,40	29,67	-3,89	22.788,96	1
NL41	Noord-Brabant	40,33	8,822	2,009	3,155	820,275	13.723,30	31,24	-7,19	69.479,60	1
NL42	Limburg (NL)	35,28	10,152	2,601	3,956	811,875	13.638,90	32,32	-7,40	29.045,28	1
NO01	Oslo og Akershus	15,37	5,467	-9,000	3,269	750,461	-9,00	-9,00	-9,00	41.981,60	1
NO02	Hedmark og Oppland	29,80	8,191	-9,000	4,050	734,945	-9,00	-9,00	-9,00	135.394,00	1
NO03	Sør-Østlandet	26,01	12,964	-9,000	5,287	744,325	-9,00	-9,00	-9,00	162.239,60	1
NO04	Agder og Rogaland	17,01	3,772	-9,000	4,137	741,688	-9,00	-9,00	-9,00	299.493,60	1
NO05	Vestlandet	14,34	3,488	-9,000	3,033	676,146	-9,00	-9,00	-9,00	61.240,40	1
NO06	Trøndelag	16,12	3,167	-9,000	3,130	743,359	-9,00	-9,00	-9,00	273.966,40	1
NO07	Nord-Norge	14,09	1,860	-9,000	2,420	683,162	-9,00	-9,00	-9,00	648.096,00	4
PL11	Lódzkie	54,46	2,126	4,477	2,025	875,828	6.828,40	32,05	-15,25	201.259,60	1
PL12	Mazowieckie	43,73	0,666	2,788	2,194	865,768	8.519,60	31,59	-15,75	395.949,20	1
PL21	Malopolskie	56,81	2,656	3,645	2,728	865,031	6.045,30	31,35	-16,37	116.584,80	1
PL22	Slaskie	58,80	1,573	4,406	2,957	856,208	7.579,20	31,48	-15,01	124.596,00	1
PL31	Lubelskie	49,89	2,534	5,079	4,437	874,706	5.462,80	31,71	-16,41	266.131,60	1
PL32	Podkarpackie	37,63	1,068	4,997	2,992	861,128	5.148,20	31,59	-15,72	181.968,40	1

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
PL33	Swietokrzyskie	58,53	1,742	7,992	3,153	866,576	5.842,20	31,64	-16,09	123.425,20	1
PL34	Podlaskie	58,07	0,397	6,587	0,838	853,990	5.720,90	31,25	-17,21	230.127,20	1
PL41	Wielkopolskie	55,21	1,135	5,013	2,138	876,487	7.075,00	32,08	-13,87	343.226,40	1
PL42	Zachodniopomorskie	55,58	1,454	4,964	1,792	883,897	6.862,90	30,64	-12,59	323.118,80	1
PL43	Lubuskie	34,10	2,210	6,670	4,878	875,128	6.221,30	32,30	-12,99	181.275,60	1
PL51	Dolnoslaskie	51,98	2,733	4,589	3,322	861,783	6.912,20	31,69	-15,05	186.056,80	1
PL52	Opolskie	41,38	5,084	5,626	6,251	854,130	5.681,20	32,23	-14,83	84.745,60	3
PL61	Kujawsko-Pomorskie	56,75	1,368	5,331	2,877	869,594	6.363,10	31,71	-15,19	210.023,20	1
PL62	Warminsko-Mazurskie	59,32	2,547	5,911	1,188	859,430	5.775,90	30,53	-16,62	298.685,20	1
PL63	Pomorskie	42,35	1,895	4,956	1,886	877,532	6.385,30	29,57	-13,71	286.288,40	1
PT11	Norte	52,61	1,595	2,519	5,698	1.322,745	8.916,30	35,02	-3,56	95.854,00	1
PT15	Algarve	38,44	0,940	1,402	3,124	1.506,236	11.497,10	35,01	2,81	46.532,00	1
PT16	Centro (PT)	42,80	3,513	5,105	7,323	1.354,397	9.774,40	37,79	-0,03	172.934,00	3
PT17	Lisboa	45,93	1,834	1,543	4,487	1.394,874	13.792,70	36,94	3,69	34.146,80	1
PT18	Alentejo	35,78	7,210	4,806	2,779	1.484,336	9.964,80	38,43	1,81	253.304,80	1
PT20	Região Autónoma dos Açores (PT)	38,41	0,095	0,500	1,938	-9,000	10.290,60	-9,00	-9,00	-9,00	1
PT30	Região Autónoma da Madeira (PT)	46,36	0,086	0,500	1,769	-9,000	11.336,90	-9,00	-9,00	-9,00	1
RO11	Nord-Vest	42,72	0,613	5,252	5,644	1.129,820	3.904,70	35,17	-14,49	76.352,00	3
RO12	Centru	46,36	0,225	3,380	8,139	1.183,215	3.874,50	33,01	-17,37	35.292,44	3
RO21	Nord-Est	51,51	0,651	3,397	3,794	1.158,200	3.146,00	33,72	-15,44	224.228,80	1
RO22	Sud-Est	51,75	0,715	4,275	5,373	1.237,719	3.733,80	36,07	-12,73	282.158,00	1
RO31	Sud - Muntenia	50,98	3,388	4,588	5,391	1.156,470	3.549,60	37,83	-12,53	134.724,00	3
RO32	Bucuresti - Ilfov	49,30	0,293	1,985	6,784	1.163,713	7.164,30	36,67	-12,75	9.298,24	3
RO41	Sud-Vest Oltenia	51,89	0,571	2,914	4,249	1.138,342	3.612,70	35,99	-11,74	75.199,20	1
RO42	Vest	53,30	0,243	4,652	5,757		4.543,70	-9,00	-9,00	95.270,00	3
SE11	Stockholm	15,56	2,374	0,568	2,182	839,828	15.662,40	27,71	-14,22	91.826,00	1

NUTS2_2006	Regions name	Long Term Unemployment	Commuting	Fuel Costs in Freight Transport	Employment in high industries purchases	PV Output	Household disposible income	Mean Maximum July Temperature	Mean Minimum January Temperature	Wind Energy potential	Cluster
SE12	Östra Mellansverige	18,77	10,572	1,329	6,072	800,003	13.186,60	27,66	-16,02	557.860,00	4
SE21	Småland med öarna	13,00	3,560	3,157	8,442	853,439	12.704,10	27,37	-13,97	631.400,00	4
SE22	Sydsverige	9,07	4,711	2,100	5,934	799,896	13.288,10	27,10	-11,17	251.961,60	1
SE23	Västsverige	13,45	3,544	1,727	8,882	994,423	13.323,90	27,31	-13,83	533.628,00	4
SE31	Norra Mellansverige	11,60	6,109	2,978	12,135	838,614	12.473,00	26,79	-19,64	792.620,00	4
SE32	Mellersta Norrland	10,92	4,243	3,094	6,253	823,835	13.094,60	25,61	-23,24	667.076,00	4
SE33	Övre Norrland	14,26	3,152	2,786	7,130	815,031	12.180,80	25,37	-28,34	1.245.316,00	4
SI01	Vzhodna Slovenija	-9,00	-9,000	3,171	-9,000	-9,000	-9,00	32,56	-12,53	55.265,60	3
SI02	Zahodna Slovenija	-9,00	-9,000	2,419	-9,000	-9,000	-9,00	32,39	-11,51	20.832,56	3
SK01	Bratislavský kraj	53,62	2,927	1,878	5,643	939,031	11.845,70	33,89	-11,33	20.227,12	1
SK02	Západné Slovensko	69,75	13,066	4,951	4,248	839,508	6.980,20	33,86	-14,23	94.630,80	1
SK03	Stredné Slovensko	74,84	11,565	4,971	7,242	932,263	6.769,20	32,60	-16,19	64.782,00	3
SK04	Východné Slovensko	79,47	12,596	4,640	6,941	983,285	6.183,70	32,67	-15,58	76.645,60	3
UKC1	Tees Valley and Durham	22,64	16,755	1,813	4,853	811,555	14.254,00	24,95	-3,99	58.956,80	1
UKC2	Northumberland, Tyne and Wear	26,04	6,805	0,971	4,332	809,076	14.470,90	23,73	-3,30	115.654,80	1
UKD1	Cumbria	28,06	6,217	3,054	3,199	795,511	16.205,00	24,33	-3,50	127.378,40	1
UKD2	Cheshire	21,28	31,798	2,272	6,470	820,794	17.511,80	27,37	-3,78	41.204,40	2
UKD3	Greater Manchester	23,81	10,353	1,047	3,882	816,327	14.886,70	27,27	-3,34	25.927,88	1
UKD4	Lancashire	23,61	13,470	1,445	5,022	812,140	14.715,90	26,06	-2,75	56.951,60	1
UKD5	Merseyside	26,68	18,641	1,790	3,368	819,108	14.946,00	26,81	-3,03	13.152,80	1
UKE1	East Yorkshire and Northern Lincolnshire	25,55	9,432	4,428	7,249	828,571	14.924,30	26,19	-2,28	68.910,80	3
UKE2	North Yorkshire	20,63	19,673	1,862	3,522	815,269	17.130,60	26,27	-3,53	159.568,00	1
UKE3	South Yorkshire	24,31	13,742	1,536	6,020	813,525	14.676,10	27,56	-2,92	28.955,20	1
UKE4	West Yorkshire	23,99	7,953	1,211	5,420	810,069	14.999,60	27,43	-3,08	38.997,44	1
UKF1	Derbyshire and Nottinghamshire	21,71	14,661	1,527	5,258	818,891	15.300,90	27,91	-3,25	86.316,80	1

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UKF2	Leicestershire, Rutland and Northants	20,79	17,013	2,504	5,010	824,563	16.164,60	29,25	-3,95	86.881,60	1
UKF3	Lincolnshire	22,89	18,785	2,911	2,886	831,089	15.640,90	27,68	-3,11	103.046,40	1
UKG1	Herefordshire, Worcestershire and Warks	14,80	33,792	2,073	4,289	834,588	17.343,70	28,27	-3,99	103.329,20	2
UKG2	Shropshire and Staffordshire	22,23	26,644	2,199	5,452	827,020	15.526,10	27,55	-4,83	109.478,80	1
UKG3	West Midlands	32,32	10,881	1,067	6,597	829,857	14.161,90	28,45	-4,65	21.079,88	1
UKH1	East Anglia	19,51	7,566	2,299	3,760	851,021	16.526,60	28,07	-3,29	221.187,20	1
UKH2	Bedfordshire, Hertfordshire	22,94	37,175	0,832	3,437	839,508	18.920,10	29,11	-3,64	50.133,60	2
UKH3	Essex	26,47	31,338	1,935	3,147	846,786	18.175,70	28,11	-3,13	62.347,20	2
UKI1	Inner London	33,04	17,934	0,104	5,784	848,520	21.921,10	29,99	-2,61	6.016,40	1
UKI2	Outer London	26,95	77,293	0,437	1,926	849,122	18.861,20	29,41	-3,07	26.540,76	2
UKJ1	Berkshire, Bucks and Oxfordshire	20,01	20,062	0,638	3,545	848,855	19.428,60	29,31	-4,43	99.063,60	1
UKJ2	Surrey, East and West Sussex	17,30	23,608	0,322	2,717	867,312	19.880,70	27,92	-3,65	101.469,20	1
UKJ3	Hampshire and Isle of Wight	19,08	15,709	1,120	2,971	887,156	17.143,90	27,91	-3,72	78.774,80	1
UKJ4	Kent	25,03	17,951	1,717	4,134	851,815	17.436,30	27,52	-2,88	69.722,00	1
UKK1	Gloucestershire, Wiltshire and Bristol/Bath area	13,71	7,125	1,197	3,484	868,341	17.093,50	27,83	-3,71	128.569,60	1
UKK2	Dorset and Somerset	15,52	11,751	1,298	3,290	907,600	17.072,00	26,45	-3,87	102.325,20	1
UKK3	Cornwall and Isles of Scilly	12,09	7,739	1,192	2,093	929,970	15.135,60	24,11	-0,99	79.180,40	1
UKK4	Devon	14,93	4,337	1,015	2,381	928,819	15.772,30	25,15	-2,38	133.178,40	1
UKL1	West Wales and The Valleys	19,40	15,099	1,251	3,846	868,826	14.637,10	24,58	-1,83	245.417,60	1

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UKL2	East Wales	21,32	20,499	1,697	5,384	859,826	15.502,00	26,38	-3,33	128.016,00	1
UKM2	Eastern Scotland	22,38	5,666	1,224	0,841	769,709	16.399,10	23,59	-4,87	333.804,80	1
UKM3	South Western Scotland	21,90	6,946	1,350	2,834	764,846	15.232,30	23,49	-4,27	265.640,80	1
UKM5	North Eastern Scotland	15,17	-9,000	1,149	-9,000	771,666	-9,00	23,58	-5,05	152.903,20	2
UKM6	Highlands and Islands	15,17	-9,000	1,396	-9,000	741,592	-9,00	23,79	-4,69	712.224,00	4
UKN0	Northern Ireland	36,60	1,705	1,377	3,472	791,567	14.758,00	24,01	-2,89	305.517,60	1

**The value -9 means no data available for that region

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