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Mapping regional energy interests for S3P-Energy

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Abstract
This report presents results from a national and regional (NUTS2 level) energy technology interest mapping exercise as well as socio-economic similarities across regions with common interests and potential alignment amongst regions and countries they belong to.

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Executive summary

Mapping energy priorities under the framework of the smart specialisation concept may help policy makers to define actions plans as well as maximize the impact of available resources. This report identifies groups of regions and countries with common energy technology interests based on a set of technologies included in the Strategic Energy Technology Plan (SET-Plan) of the European Union.

In order to carry out the mapping, the tool EYE@RIS3 has been used and more precisely the description provided by each territorial unit and collected by this tool. The methodology proposed to develop the mapping analyses aims to avoid an individual analysis of every single regional or national smart specialisation strategy. However, the approach proposed could lead to overlapping in terms of semantic interferences, an issue that has also been analysed in this report.

Once the groups of regions/countries have been defined, potential similarities have been assessed based on socio-economic indicators. Finally, the level of alignment between regional and national levels has been studied. The findings of this report establish the basis to carry out a deeper analysis focused on a specific energy technology and with a reduced number of regions.

1. Introduction

The smart specialisation concept has established a new approach in order to help governments in their decision-making processes concerning long term innovation strategies and smart allocation of resources. Thus, both at national and regional levels, authorities have identified strengths that led to the definition of strategic areas.

Amongst different areas, energy plays a main role as a cross-cutting issue that affects many other sectors as well as their productivity. Therefore, a strengthening of innovation capacities in the area of energy could bring countries and regions a long term benefit.

Beyond individual strategies, Europe represents an ideal environment to foster cooperation. The smart specialisation concept contributes to this cooperation across territorial units that have shown common interests. Potential alliances will accelerate learning and knowledge sharing by creating trans-regional learning arenas and exchange of good practices as enabling tools to put strategies into practice. The cooperation could also contribute to the removal of barriers to internal market supported by the Energy Union.

In order to promote cooperation, this reports aims to identify regions with common energy technology interests. Based on a set of energy technologies included in the Strategic Energy Technology Plan (SET-Plan), the regional and national mapping exercise will allow identifying regions with the same interests.

This first mapping exercise will allow studying similarities, gaps, areas of cooperation and differences and finally connecting regions that may implement common energy solutions in terms of infrastructures, public-private partnerships or energy policies.

2. Objective

The main goal of this report is to carry out the first stage of a regional energy mapping based on regional innovation strategies set under the name of smart specialisation process (SSP). The report aims at identifying groups of regions with common interests in certain energy technologies. Therefore, the methodology and results presented in this document constitute valuable information in order to determine which regions already have clear objectives in terms of energy technologies leading to the identification of potential synergies in a future integrated energy technology analysis. As it will be explained later in this document, a more detailed analysis will be required to increase the accuracy of this regional energy mapping exercise in the future.

3. Methodology

3.1 Scope of the methodology

In order to carry out the regional energy mapping, the complete list of regional smart specialisation strategies is included because we assume a broad concept of energy. This complete list includes information from every single region and country that has introduced information about its strategy no matter the topic is about.

From this wide perspective, based on the fact that there are more than 1300 priorities, the proposed methodology aims to simplify the searching process as much as possible. So, based on the description field included in EYE@RIS3 database (see Table 2), we first classify energy regional strategies into energy technology groups defined previously.

3.2 Selection of energy technologies

The first step in the methodology proposed is the selection of energy technologies and then the identification of associated key-words to scan the description field (Figure 1).

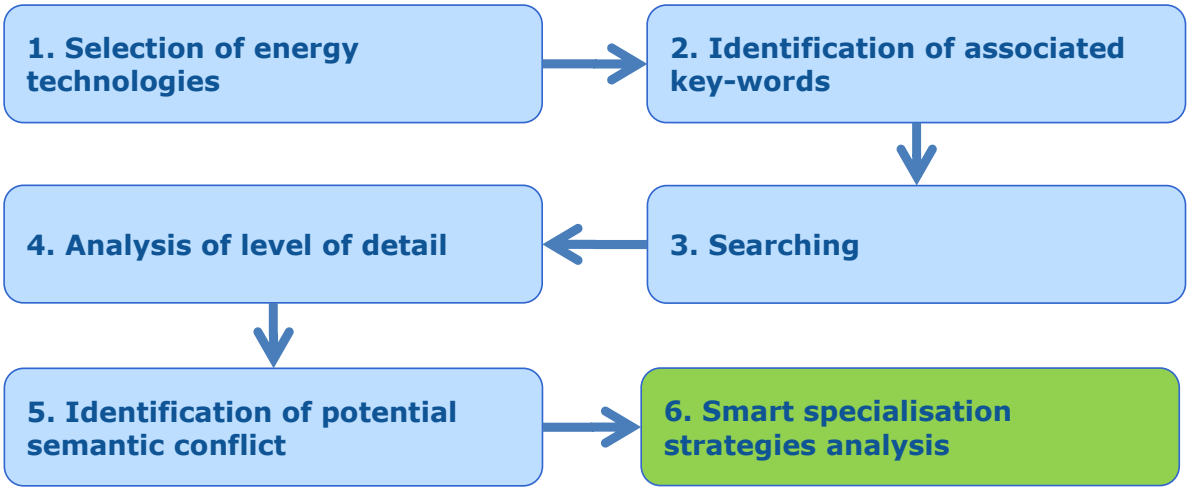

Figure 1: Methodology steps

This selection has been based on the smart specialisation platform interest as well as on SETIS [European Commission 2015] with a focus on sustainable technologies and techniques that could lead to the decarbonisation of the European energy sector:

- Smart grids
- Electric vehicles
- Solar
- Bioenergy
- Geothermal
- Wind
- Hydro
- Ocean
- Combined heat and power (CHP)/Heating & Cooling
- Carbon capture utilisation and storage (CCU/S)
- Hydrogen/Fuel cells
- Nuclear
- Storage
- Oil/Gas
- Energy efficiency
- Renewable & energy generic[1]

[1] Under this label regions with generic descriptive concepts such energy or renewable have been included.

3.3. Identification of associated key-words

Once the set of energy technologies has been established, searching is carried out based on a set of key-words linked to the technologies. Table 1 shows the keywords used to produce the mapping.

Table 1: Keywords used to identify energy technology interest based on the description field

Energy technology	Keyword #1	Keyword #2	Keyword #3	Keyword #4
Smart Grids	smart grids	grids	electricity	smart
Electric vehicle	mobility	sustainable transport	electric vehicle	urban mobility
Solar	solar	PV	concentrated	photovoltaic
Bioenergy	bioenergy	biogas	biofuel	biomass
Geothermal	geothermal	geo-energy	ground energy	geological
Wind	wind	shore	marine	ocean
Hydro	hydro	hydropower	water energy	hydro energy
Ocean	ocean	blue energy	tidal	marine
CHP	heating	CHP	cooling	combined
CCS/U	carbon	capture	carbon utilisation	—
Hydrogen	hydrogen	sustainable transport	vehicle	fuel cells
Nuclear	nuclear	—	—	—
Storage	storage	energy storage	store	
Oil/Gas	oil	gas	—	—
Energy efficiency	energy efficiency	building	construction	—
Just renewable or energy	renewable	energy	—	—

It should be noticed that the keyword list in Table 1 acts as a first filter. Keywords such as 'electricity' may represent concepts related to 'smart grids' or others related to 'solar' or 'wind'. The case of 'mobility' might also be related to logistics instead of energy themes. Then, a crosscheck is required to avoid potential semantic interaction between concepts. Accordingly, in the definition of the keyword list, it is essential to consider wide concept at a first stage and then check manually in a second stage.

3.4. Searching

To cover the regional searching, EYE@RIS3 tool implemented by JRC-IPTS has been used [Eye@RIS3 2015][2]. This searching tool provides information about regional smart specialisation strategies from a wide perspective including themes such as agriculture, human health, tourism or construction.

[2] Available at: http://s3platform.jrc.ec.europa.eu/map

Based on the information provided by RIS3 strategies, peer review workshops and expert assessment reports, the tool offers information organised in 12 fields (Table 2).

Table 2: Retrieved information from EYE@RIS3

Field	Description	Example
NUTS ID	Nomenclature of Territorial Units for Statistics	BE2
Region/Country Name	Name of the region	Flemish region
Description	Short description including key words from the complete strategy	Sustainable energy technologies with focus on hydrogen, wind energy and electrical vehicles. part of 'Sustainable living
EU Priority	Based on the list provided in Annex III	Sustainable innovation
EU Priority (Sub)		Sustainable energy & renewables
Capability		Energy production & distribution
Capability(Sub)		Power generation/renewable sources
Target Market		Transporting & storage
Target Market (Sub)		Road transport & related services
Source	Origin of the information	Final RIS3 Document
Date Of Source	Date of the information	Feb-13
Date Encoded	Date updated in the EYE@RIS3	Feb-13

In order to carry out specific queries, EYE@RIS3 allows users to apply different filters based on the following issues:

- Research & Innovation Capabilities
- Business Areas & Target Market
- EU priorities

as well as subcategories associated with them for more specificity (Figure 2).

The list with all the possible options in terms of categories and sub/categories aforementioned are shown in Annex III.

When we look at the categories that could be related to energy mapping, we see one specific category called 'Energy production and distribution' with two subcategories: 'Energy distribution' and 'Power generation/renewable sources' that may simplify identification of regions. However 'energy' as a smart specialisation area might be wider than that and it could include aspects beyond this category. As an example, the category 'Construction' and its associated sub-category 'Construction of buildings' might include regions focused on improving energy performance of buildings which is an important energy issue. In section 4, we will explain how the energy mapping has been developed in order to close such data gaps.

The geographical scope of the EYE@RIS3 tool, based on regions and countries that have already submitted information about smart specialisation strategies, includes countries and regions from the EU-28. In addition, it includes information about non-EU countries namely; Albania, Bosnia and Herzegovina, Moldova, Montenegro, Norway, Serbia, Ukraine and Turkey. From a regional perspective, the tool includes information about different regional levels; NUTS1, NUTS2 and NUTS3. In this report, emphasis has been put on NUTS2 level since it includes regions with the capacity to develop regional policies.

On the other hand, the quality of data included in the EYE@RIS3 tool depends on regions' availability of data. Information available depends on level of detail provided. This fact leads to potential lack of homogeneity[3]

Finally, it is important to note that the main goal of the EYE@RIS3 tool is not covering statistical analysis but to help strategic development at the regional level [JRC/IPTS 2015]. This aspect has been considered in the methodological approach of the regional energy mapping in terms of sampling and representativeness of data.

[3] Regions are welcomed to update data to improve the accuracy of the analysis.

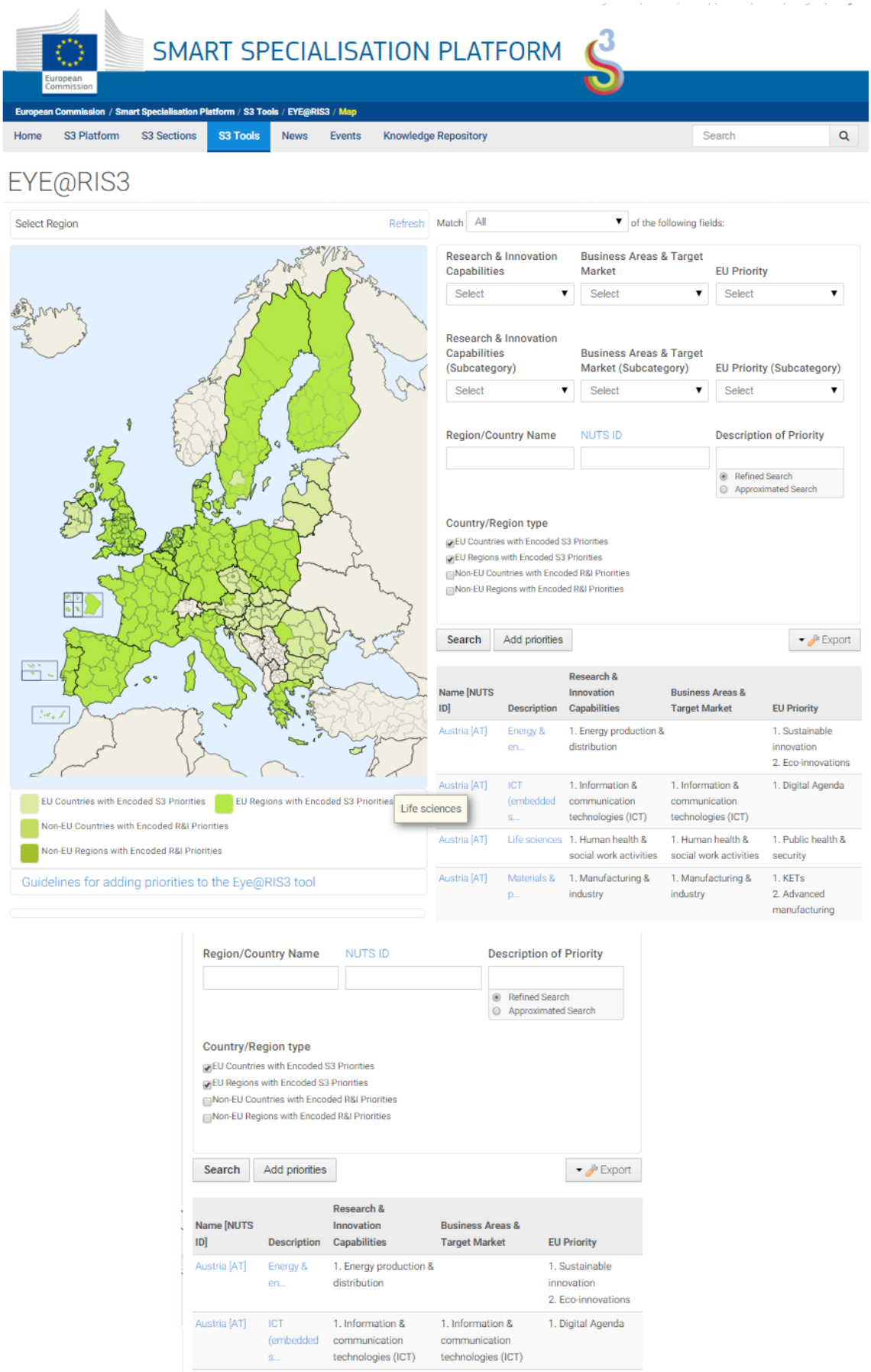

Figure 2: EYE@RIS3 Software tool interface

3.5. Analysis of level of detail

Once the search was completed, an analysis about the level of detail is required because there are descriptions that do not allow an adequate classification. For that reason, in the list of technologies, a generic class 'Just renewable or energy' was defined. Under this title, regions with general information as presented in example 1 in Table 3 have been included and also those that even have information on specific technology refers to energy theme in a wide sense (see example 3 in Table 3). This procedure constitutes the fourth step in the methodology and it will determine how much effort is required concerning the amount of unspecified regions or countries that require a broad study based on their complete strategies.

Table 3: Example of different level of detail in the description field

Field	Description	Example 1	Example 2	Example 3
NUTS ID	Nomenclature of Territorial Units for Statistics	BE2	SE313	FR83
Region/Country Name	Name of the region	Flemish region	Gävleborgs län	Corse
Description	Short description including key words from the complete strategy	Sustainable energy technologies with focus on hydrogen, wind energy and electrical vehicles. part of 'Sustainable living'	Energy & environment	… In terms of R&I, this will involve 1) the production of renewable energies 2) energy storage solutions (hydrogen & heat) and their connection to the electricity grid 3) energy efficiency of buildings (integrated buildings, new materials...)…
EU Priority	Based on the list provided in Annex III	Sustainable innovation	Sustainable innovation	Sustainable innovation
EU Priority (Sub)		Sustainable energy & renewables	Sustainable energy & renewables	Sustainable energy & renewables
Capability		Energy production & distribution	Energy production & distribution	Energy production & distribution
Capability(Sub)		Power generation/renewable sources	Power generation/renewable sources	Power generation/renewable sources
Target Market		Transporting & storage	Energy production & distribution	Energy production & distribution
Target Market (Sub)		Road transport & related services	Energy distribution	Power generation/renewable sources
Source	Origin of the information	Final RIS3 Document	Draft RIS3 Document	Final RIS3 Document
Date Of Source	Date of the information	Feb-13	Sep-13	Mar-14
Date Encoded	Date updated in the EYE@RIS3	Feb-13	Sep-13	Oct-14

As it can be seen from the examples included in Table 3, for SE313 (Gävleborgs län) it is not possible to go further in the classification of specific energy technologies, meanwhile in the case of BE2 (Flemish region) several energy technologies emerge from the description field. Therefore, this level of detail analysis will provide how reliable is the energy classification derived from the data content in the EYE@RIS3. Anyhow, the analysis carried out so far and presented in this report covers only the first searching stage in order to define further steps concerning a more detailed mapping.

3.6. Identification of potential semantic conflict

Despite energy technologies are clearly defined, in some cases there may be overlaps amongst them based on the description field. Two clear examples illustrate this situation.

- **'PV/Solar'** and **'Energy efficiency'** might be represented under a common definition since solar technology constitutes a mean to improve energy efficiency in buildings (Table 4).
- **'Wind'** and **'Ocean'** could also share common descriptions especially when strategies refer to off-shore wind that could be assumed as ocean energy.

These two issues are taken into consideration. Then, after retrieving information based on key-words procedure, a double check is covered to guarantee no duplicities or misunderstandings. In this section we quantify the number of regions that may be affected by the lack of clarity in terms of keywords for these two cases.

Table 4: List of regions from wind technology query potentially connected with ocean energy issues

NUTS2	Region	Wind	Ocean	Other key word
DE6	Hamburg			Marine technologies
DE94	Weser-Ems	X	X	
ES11	Galicia			Marine energies
ES12	Principado de Asturias			off-shore energy industries
ES13	Cantabria			off-shore energy
FR25	Basse-Normandie			Renewable marine energy generation
FR51	Pays de la Loire			Renewable marine energy
FR94	Réunion			Marine energy
IE	Ireland			Marine Renewable Energy
PT	Portugal			Valorization of marine ecosystems and links with renewable energy
PT11	Norte			Marine and Maritime Technologies
PT30	Região Autónoma da Madeira			Evaluation of ocean energy potential
SE33	Övre Norrland	X		
UKK3	Cornwall and Isles of Scilly			Marine energy
UKM	Scotland			Marine energy

Most of the regions include general concept that initially could allocate regions under both technologies. The criterion has been to include those regions with generic definitions in both groups 'Wind' and 'Ocean'.

In the case of solar, potential regions connected with energy efficiency and basically focused on buildings, are shown in Table **5**.

Table 5: List of regions from solar technology query potentially connected with energy efficiency issues

CY	Cyprus
DE	Germany
DE3	Berlin
DE94	Weser-Ems
ITI2	Umbria
RS1	Vojvodina

For the title 'Energy efficiency' category, all regions included could potentially incorporate solar as a solution to boost energy efficiency (Table 6).

Table 6: List of regions from energy efficiency technology query potentially connected with energy solar energy issues

AT31	Oberösterreich	**FR81**	Languedoc-Roussillon
BE2	Flemish Region	**FR82**	Provence-Alpes-Côte d'Azur
CY	Cyprus	**ITF1**	Abruzzo
DE	Germany	**ITF2**	Molise
DEE	Sachsen-Anhalt	**ITF6**	Calabria
DE2	Bayern	**ITH5**	Emilia-Romagna
DE3	Berlin	**LU**	Luxembourg
EE	Estonia	**MD**	Moldova
EL12	Kentriki Makedonia	**MT**	Malta
EL14	Thessalia	**NL3**	Western Netherlands
ES22	Comunidad Foral de Navarra	**NO031**	Østfold
ES24	Aragón	**PL**	Poland
ES41	Castilla y León	**PL11**	Lódzkie
ES51	Cataluña	**PL31**	Lubelskie
ES61	Andalucía	**PL33**	Swietokrzyskie
FI1C2	Kanta-Häme	**PL34**	Podlaskie
FI1C3	Päijät-Häme	**PL52**	Opolskie
FI1C4	Kymenlaakso	**PT**	Portugal
FI194	Etelä-Pohjanmaa	**PT30**	Região Autónoma da Madeira
FI196	Satakunta	**RO**	Romania
FR10	Île de France	**RO42**	Vest (RO)
FR22	Picardie	**RS**	Serbia
FR23	Haute-Normandie	**RS1**	Vojvodina
FR24	Centre	**SE**	Sweden
FR26	Bourgogne	**SE213**	Kalmar län
FR42	Alsace	**SE312**	Dalarnas län
FR53	Poitou-Charentes	**SI**	Slovenia
FR61	Aquitaine	**UKK3**	Cornwall and Isles of Scilly
FR71	Rhône-Alpes	**UKZ**	England
FR72	Auvergne		

So, as it could be verified, 13 territorial units in the field of marine energy and 59 territorial units in the field of energy efficiency are identified. These regions, depending on specific actions might take part in just one or two technology groups. In a further analysis these cases will require a particular assessment per region. To understand the precise meaning under general labels such as 'Marine energy' the individual smart specialisation strategies of every region has to be analyses in detail.

In any case, based on the scope of this first mapping stage this issue has just been identified. In further steps a deeper analysis is needed to determine which regions have interest in both technologies or just in one of them. So, it means energy classification is carried out according to the results obtained from the searching based on keywords Table 1.

4. General overview on Smart Specialisation

Starting from global information available on the EYE@RIS3 some information could be extracted to provide an idea about the interest of regions in the SSP. From a national level and according to the information available by the end of October 2015, there are 26 countries with at least one encoded priority, being 20 EU28 countries and 6 non-EU countries accounting for a total of 160 and 40 encoded priorities respectively. The distribution of number of priorities per country is presented in Figure 3.

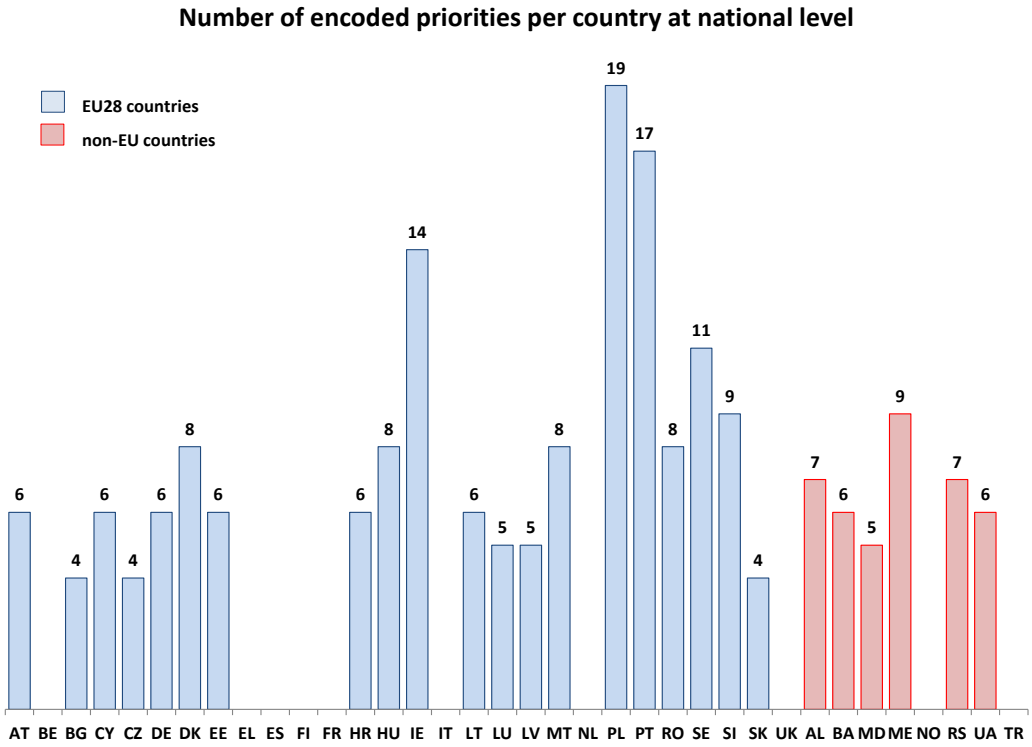

Figure 3: Number of encoded priorities at the national level

Poland, Portugal and Ireland lead in terms of number of encoded strategies ; meanwhile others such as Greece, Spain or United Kingdom do not present any strategy for the whole country which does not mean there are no strategies in regions belonging to them (Figure 4).

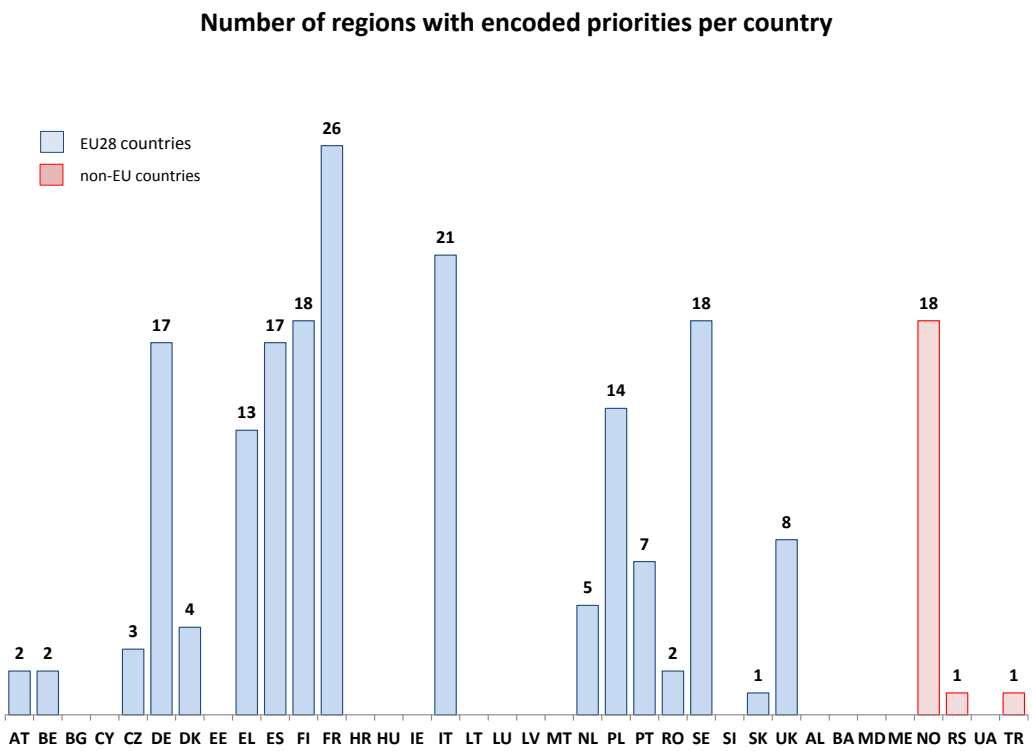

Figure 4: Number of regions with encoded priorities per country

From the regional perspective including NUTS1, NUTS2 and NUTS3 levels there are 1,167 strategies distributed amongst 198 regions. As it could be assessed in the case of Greece or Spain there are 13 and 17 regions respectively with endorsed strategies even though there are not national strategies. Combining the two above chart, all countries included in the study have at least one strategy.

In section 7.4, the alignment between national and regional strategies will be analysed to assess a potential correlation between national interests in energy issues and how regions contribute to them.

In terms of number of regions with encoded strategies per country France is the country with the largest number of regional strategies as well as the largest number of regions involved (169 strategies from 26 regions) followed by Spain (143 strategies from 17 regions) and Germany (129 strategies from 17 regions). For non-EU countries Norway presents the largest number of regional strategies (51 strategies from 18 regions).

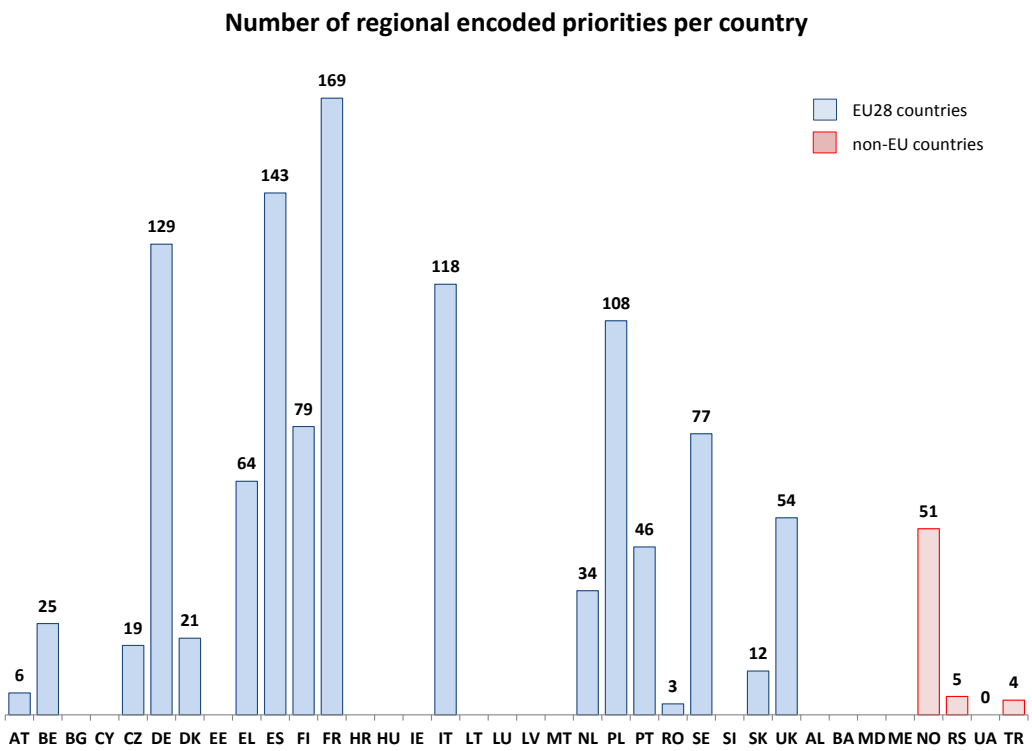

Figure 5: Number of regional encoded priorities per country

5. Energy mapping

As presented in section 4, it is not trivial to allocate every single energy priority under a certain energy technology based on the information provided in the description field by EYE@RIS3. The first analysis done to understand how far the EYE@RIS3 mapping could lead in the mapping of energy technologies interest is the identification of generic and not generic information.

Generic information does not allow a classification in terms of energy technology including description such as 'Energy & Environment' or 'Energy'.

Based on the analysis carried out, up to 22 % (36 out of 162) of strategies related to energy considering both national and regional levels include in the description key words as Energy or Renewable without any further description; meanwhile 32 % (52 out of 162) combine generic description with some specific information about technologies. For those, a further analysis is also required in order to pinpoint technologies behind the strategies. At every level, 46 % of the strategies are technology-specific.

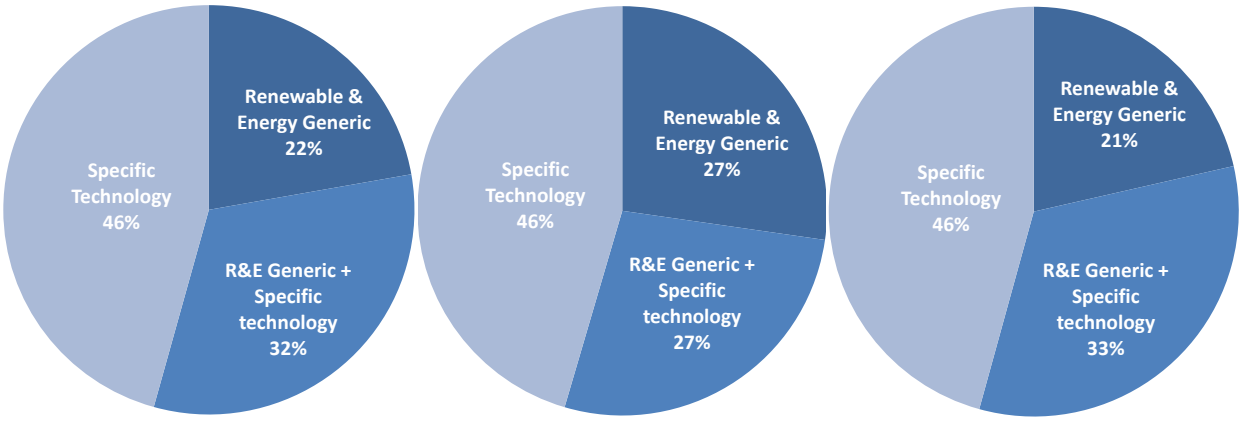

Figure 6: Level of definition of (a) national and regional levels, (b) national level and (c) regional level based on the information included in the description section in the EYE@RIS3.

Taking into account the representativeness of data, the distribution of energy technologies is presented in Figure 7, Figure 8 and Figure 9. In these figures, both information from 'Specific Technology' regions and countries as well as the specific information included in the group of "R&E Generic + Specific Technology" have been considered.

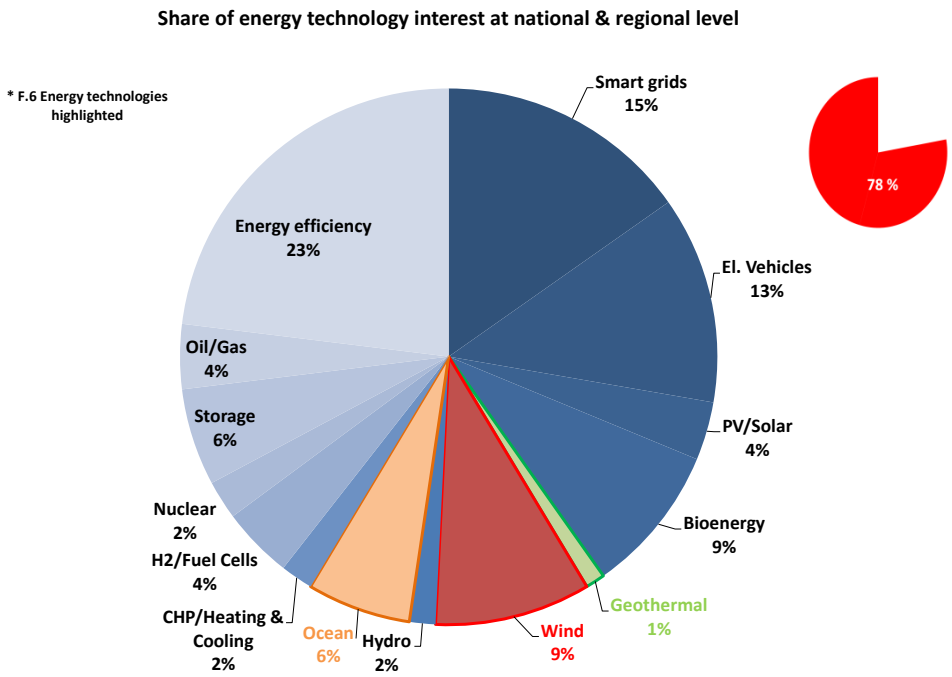

Figure 7: Share of energy technology interest at both national and regional levels[4]

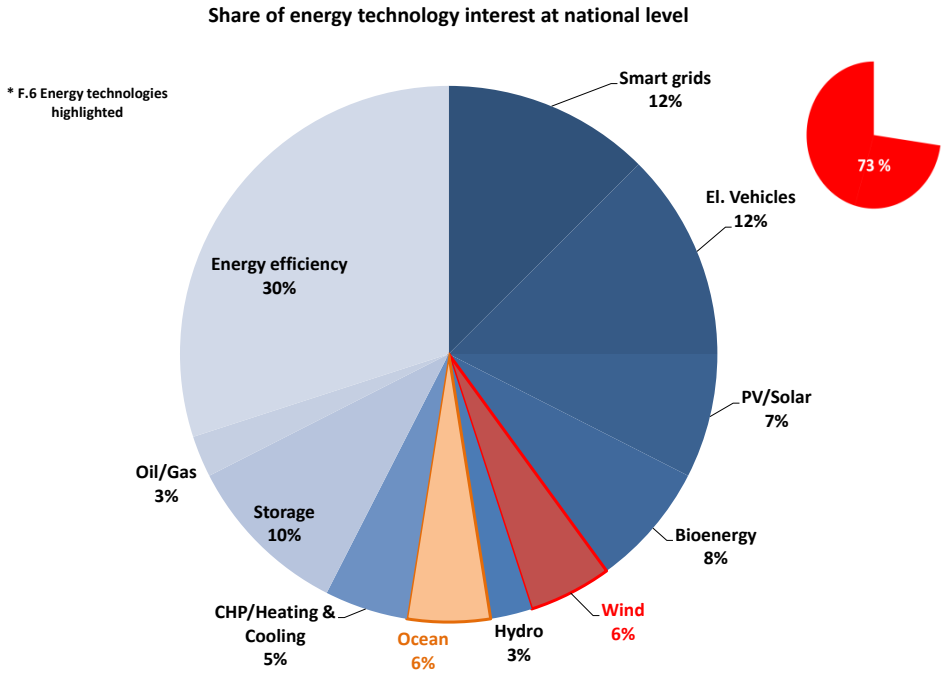

Figure 8: Share of energy technology interest at national level[4]

[4] Red pie charts represent the total share of territorial units: countries and regions (Figure 7); countries (Figure 8); regions (Figure 9) with specific technologies in the description of their priorities including both groups 'Specific Technology' and 'R&E Generic + Specific Technology'.

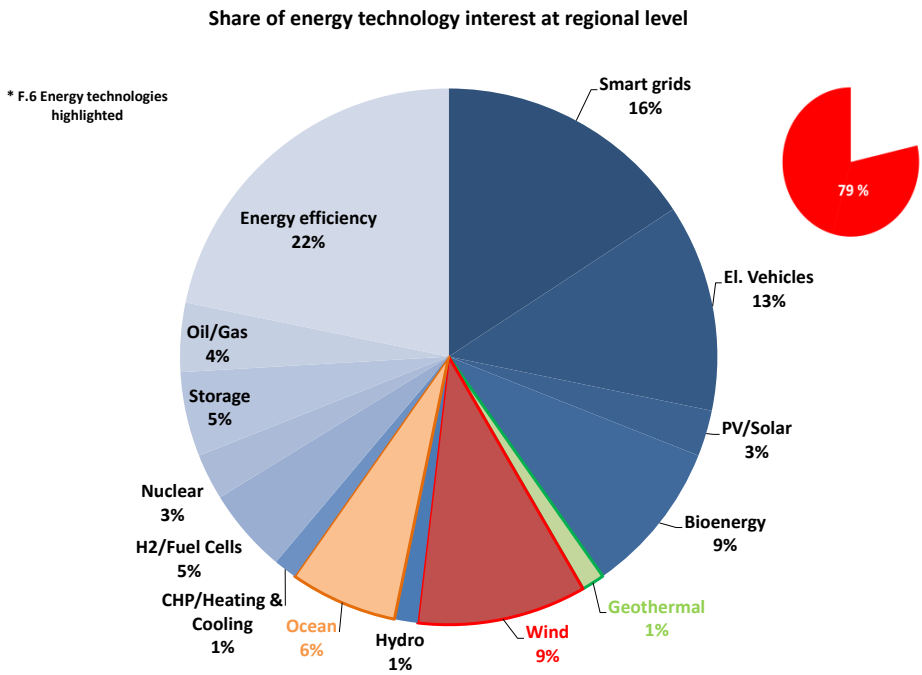

Figure 9: Share of energy technology interest at regional level[4]

In terms of total number of regions and countries with interest in certain technology, "energy efficiency" includes the greatest number of both regions and countries (Figure 10).

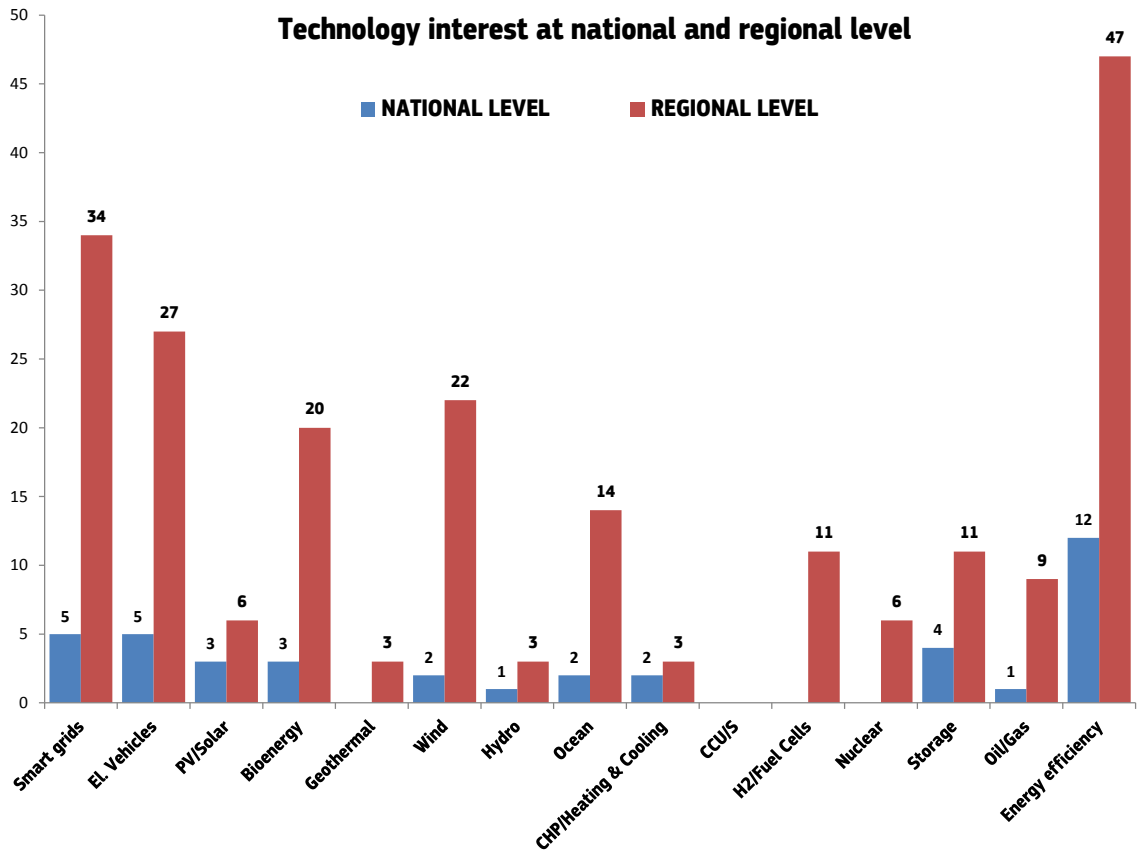

Figure 10: Distribution of technology interest per regions and countries

Apart from 'Energy efficiency' that could include a great number of methods, technologies and materials, smart grids appear as the most interesting concept to deploy under the concept of smart specialisation in the area of energy, followed by e-mobility and wind energy technologies. As it is presented in Figure 36, only wind energy presents a certain level of geographical aggregation including regions from the European Atlantic Arc associated with off-shore wind potential.

Interest in energy efficiency is also dispersed from a geographical perspective (Figure 44) as there are no limiting conditions (such as e.g. coastal areas for off-shore wind) for the deployment of energy efficiency. In addition, an increase in the energy efficiency of the building/construction sector is a strong need in many European countries.

The lack of interest in Carbon Capture Utilisation or Storage is also remarkable. This issue may rely on the low level of maturity associated with these technologies. Additionally, these technologies are mainly driven by the industry itself which means in one hand just regions with important industrial sectors may be interested and in the other the potential impact of other technology in terms not just of sustainability but social involvement may be higher.

6. Economic indicator analysis

In order to understand why regions are interested in certain energy technologies it is important to analyse common features presented in those regions. As mentioned in previous sections, there are evident aspects that make the difference for certain regions in order to prioritize certain technology or group of them as the case of wind or ocean technologies (Figure 36 and Figure 38). Nonetheless, beyond energy resource availability, economic reasons could determine regional prioritisation.

To assess the impact of economics in the SSP, the parameters evaluated have been;

- Gross Domestic Product per population (GDP/inhabitants) [Eurostat 2015a]
- Cost of Gas for domestic users ($€_{2013}$/kWh)[5] [Eurostat 2015b]
- Cost of Electricity for domestic users ($€_{2013}$/kWh)[6] [Eurostat 2015c]

This analysis has been done from two different perspectives; the number of energy technology interest (from 0 to a maximum of 7 in the case of DE94 – Weser-Ems) of regions and per technology. Just NUTS2 regions and countries have been taken into consideration. Certain regions with no parameters available have not been considered for the analysis. Additionally, only EU28 data has been considered taking into account the availability of the abovementioned parameters.

6.1 Countries

From the national perspective there is not a correlation amongst economic indicators and the number of energy technologies a region is interested in. As shown in Figure 11, the group of countries (2 in total) with the highest GDP is interested in two energy technologies meanwhile those countries with no energy technology interest are the group with the lowest GDP per capita. Since energy is an important economic driver this is surprising since the opposite trend was expected; the less developed regions the higher energy interest. On the other hand, it may be possible that less developed countries may not be aware of the Smart Specialisation Process in comparison with others that have an extensive experience in European innovation programmes or they are even still working on it.

In terms of energy costs, excluding Slovenia (6 energy technology interest) a positive trend linked to the number of energy technology interest is followed by the electricity cost. The series reach the maximum value for Portugal and Germany (5 energy technology interest) with an average price of 0.28 $€_{2013}$/kWh (0.24 & 0.32 $€_{2013}$/kWh respectively). For the gas case, prices are more similar for all countries ranging from 0.05 to 0.09 $€_{2013}$/kWh

Regarding specific technologies (Figure 13), MS with the highest combined energy price (average price of gas and electricity) are focused on Solar (0.183 $€_{2013}$/kWh), geothermal and hydropower (0.181 $€_{2013}$/kWh).

[5] The cost of the gas represents the average price of users classified by annual energy consumption. The price includes taxes.
[6] The cost of the electricity represents the average price of users classified by annual energy consumption. The price includes taxes.

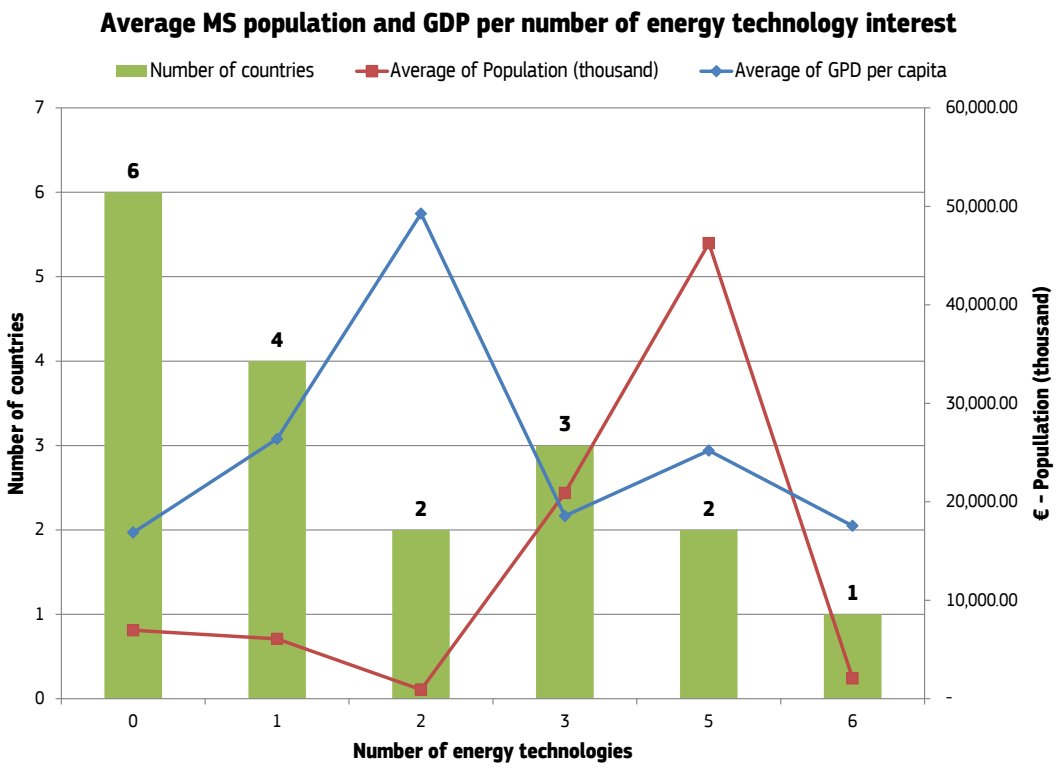

Figure 11: Average population and GDP per capita per Member State with the same number of energy technologies interest

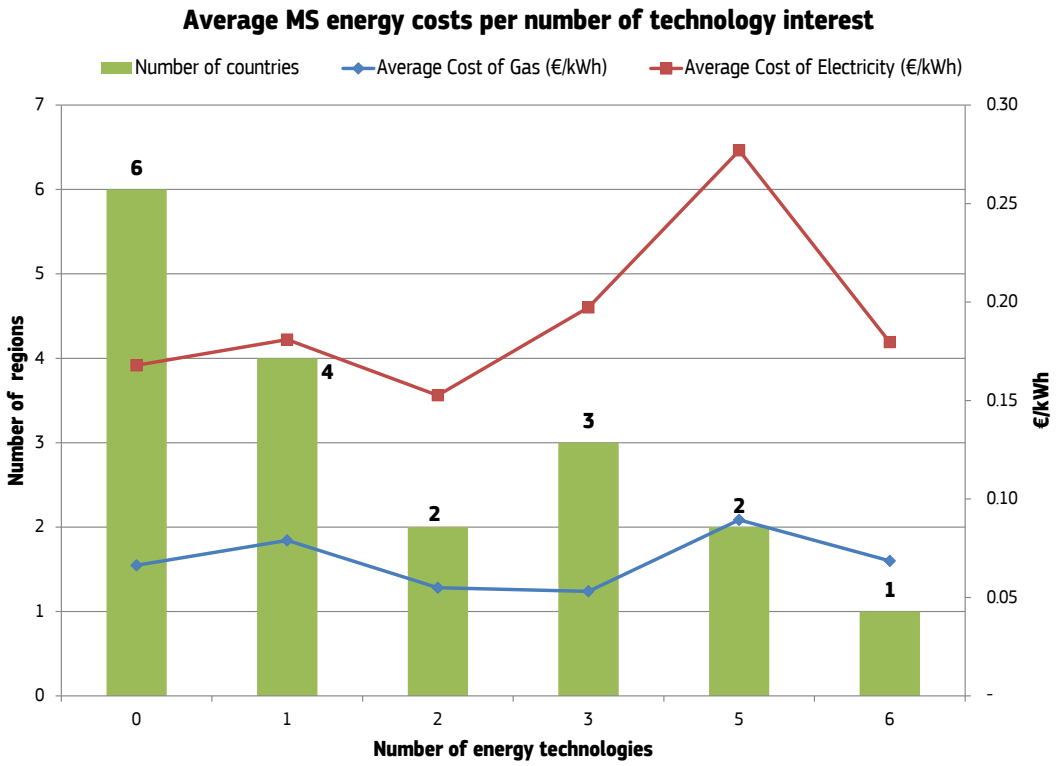

Figure 12: Average energy cost per group of MS with the same number of energy technologies interest

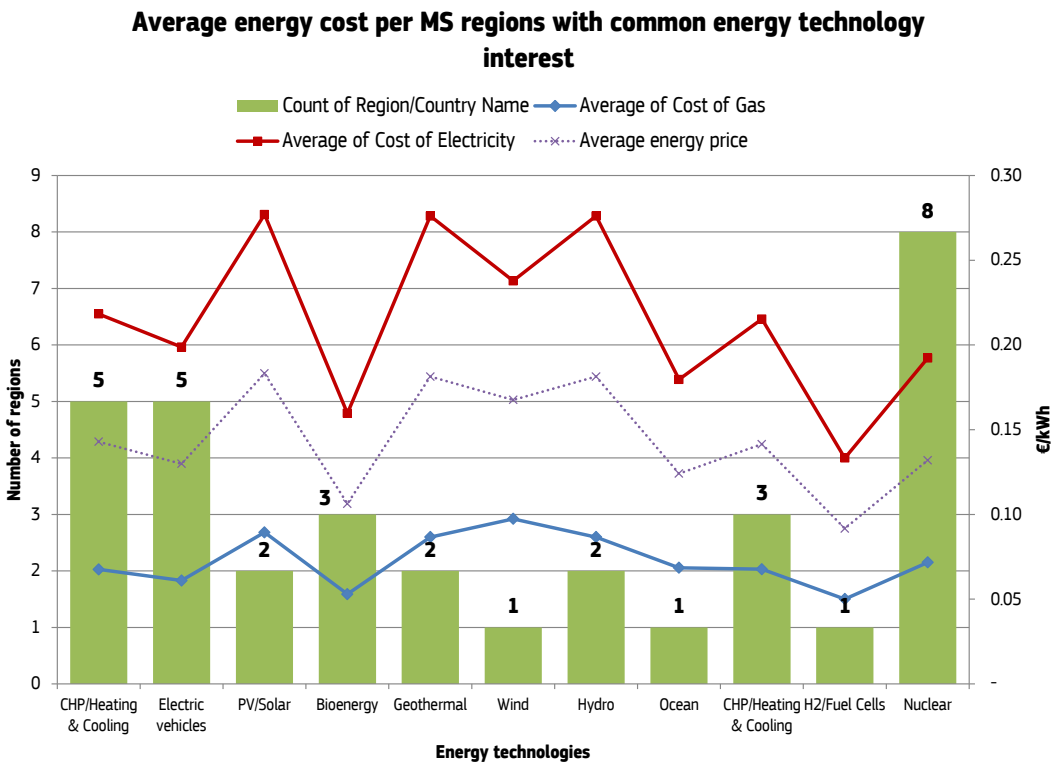

Figure 13: Average energy cost per group of MS with interest in one specific energy technology

6.2 Regions

At the regional level, conclusions are similar as at the country level. Therefore it is not possible to establish patterns comparing economic indicators to determine the level of interest of regions in the Smart Specialisation Strategy process.

What is notable is the fact that combined energy price in average (electricity and gas) does not differ between group of regions with the same number of energy technology selected (Figure 16). Thus, it could be assumed that the selection of certain energy technologies is more related to endogenous resources or the supply chain in the region than to the cost of the energy.

From the GDP perspective, despite less developed regions were expected to be more interesting there is no correlation.

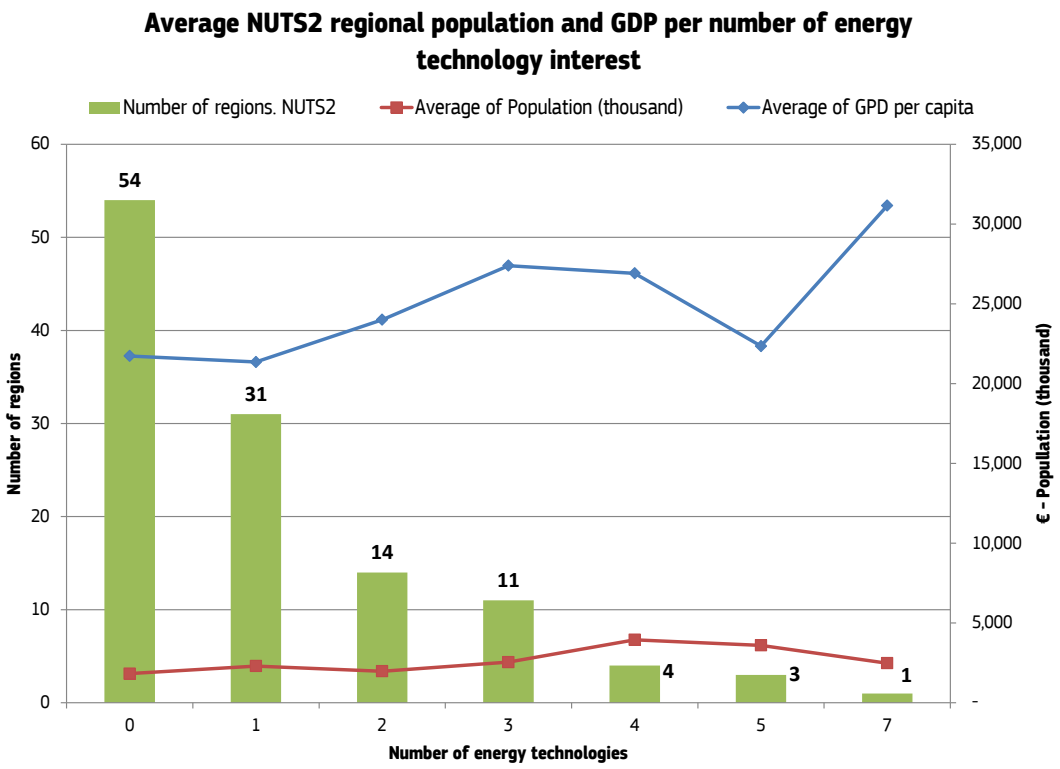

Figure 14: Average population and GDP per capita per regions with the same number of energy technologies interest

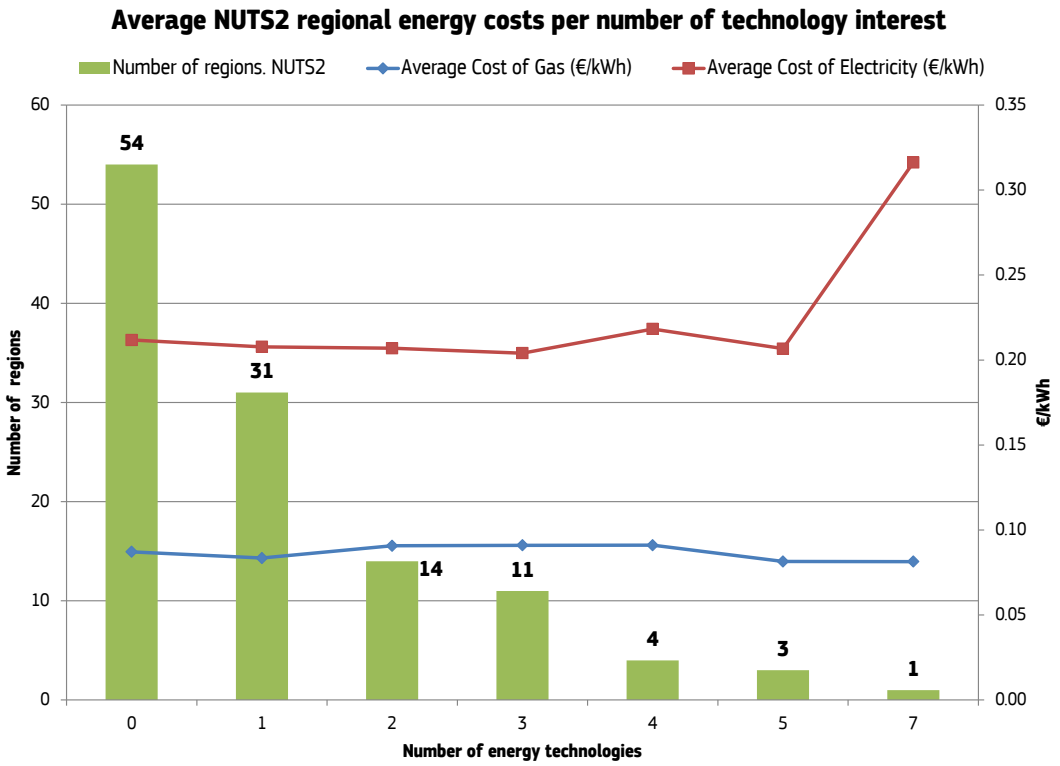

Figure 15: Average energy cost per group of regions with the same number of energy technologies interest

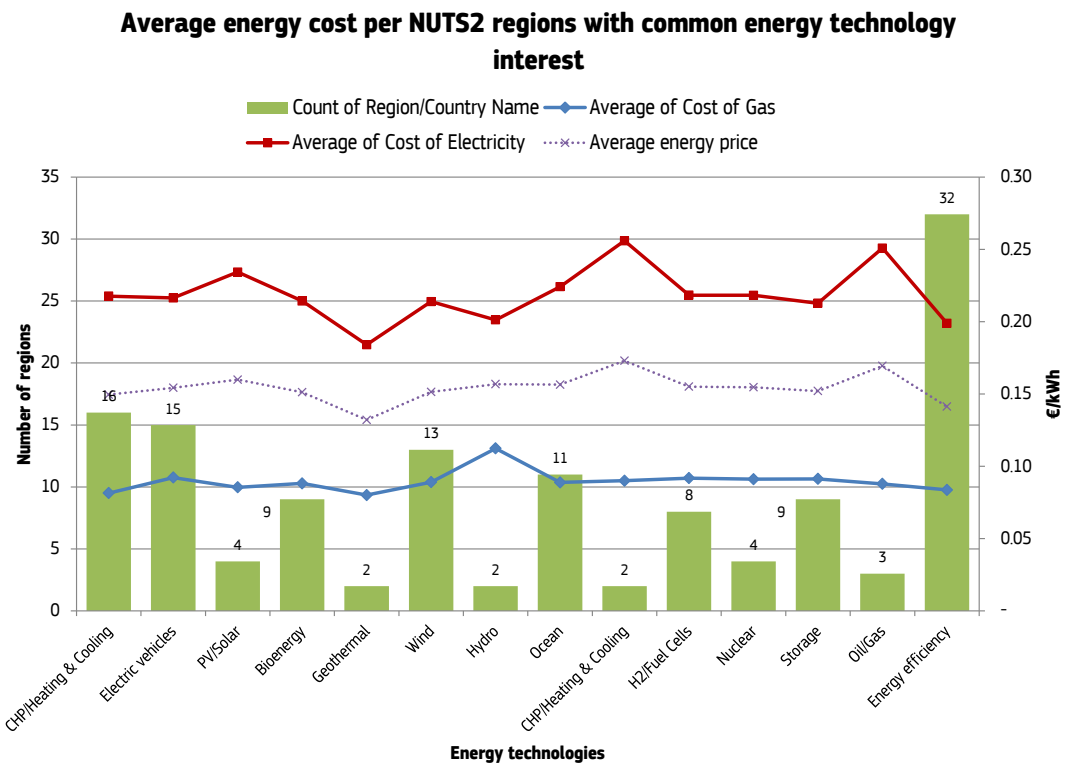

Figure 16: Average energy cost per group of regions with interest in one specific energy technology

6.3 Regional cohesion indicators

In addition to the indicators presented above, we performed also an assessment of indicators related to smart growth, namely;

- Number of Patent applications to the European Patent Office (EPO) by prior year 2011 [Eurostat 2015d]
- Total intramural R&D expenditures (€/inhabitant) 2013 [Eurostat 2015e]
- Unemployment rate from 20 to 64 years (%) 2014 [Eurostat 2015f]
- Tertiary educational attainment, age group 25-64 by sex and NUTS 2 regions in 2011 [Eurostat 2015g]

These indicators give an idea about the capacity of the regions to deploy energy technologies from an innovative perspective. The information presented in Figure 17 and Figure 18 is sorted by number of energy technologies per region and number of regions per energy technology. To produce this information just NUTS2 regions have been considered and from this group those regions with available information according to Eurostat database consulted.

It should be acknowledged that these indicators do not just represent the energy sector but the complete innovation force in regions. They have been considered based on the most updated available information taking into consideration the representativeness of date. According to the list of NUTS2 regions with interest in energy (120 regions) available information for these parameters are presented in Table 7.

Table 7: Level of parameter representativeness at NUTS2 level

Parameter	Not available data (%)	Number of regions assessed
Number of Patent applications to the European Patent Office (EPO) by prior year 2011	6.67	112
Total intramural R&D expenditures (€/inhabitant) 2013	22.50	93
Unemployment rate from 20 to 64 years (%) 2014	-	120
Tertiary educational attainment, age group 25-64 by sex and NUTS 2 regions in 2011	10.83	107

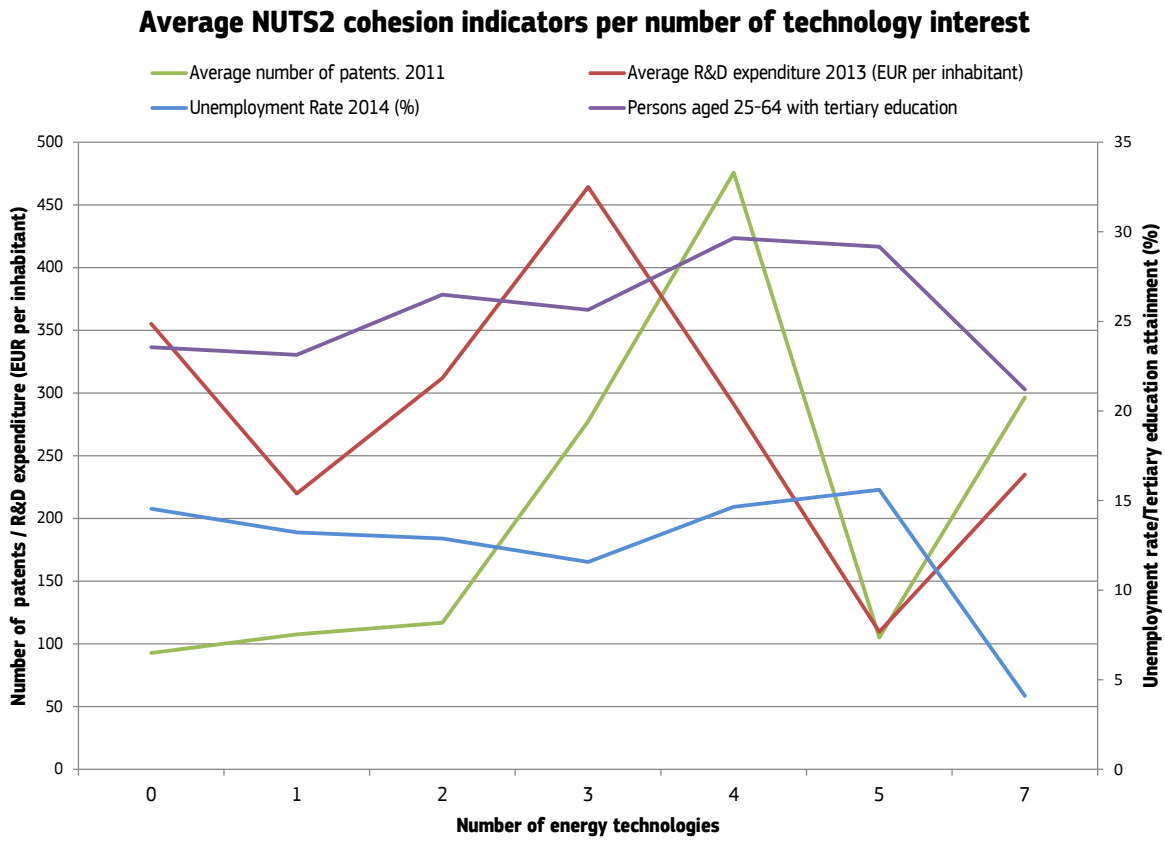

Figure 17: Average cohesion indicators per group of NUTS2 regions with the same number of energy technology interest

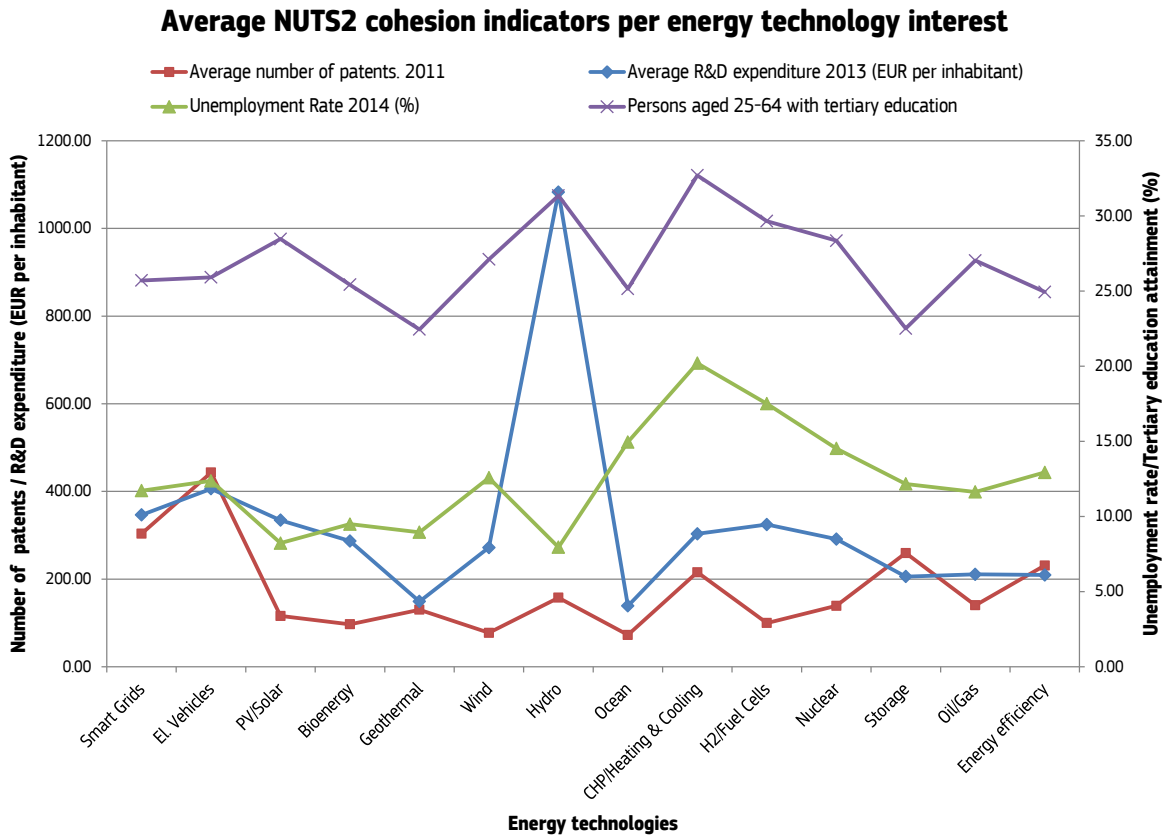

Figure 18: Average cohesion indicators group of NUTS2 regions with interest in one specific energy technology

Concerning the unemployment rate (blue line - Figure 17), results show a correlation between an increasing number of technology interests and an increasing unemployment rate except for the region DE94 (7 technology interest) less representative than other groups with a higher number of regions. The R&D expenditure, including all sectors, shows big differences across regions ranging from 110 to 465 EUR per inhabitant in average by 2013 without correlation with number of technology interests, being the group of regions with three energy technology interest the one with the highest R&D expenditure and the group of five technologies the one with the lowest.

Related to patents, it should be highlighted the large value reached by 4-technology-interest group including Rhône-Alpes (FR71), Cataluña (ES51), Champagne-Ardenne (FR21), and Cantabria (ES13) with 1,405.12, 410.63, 75.66 and 11.35 EUR per inhabitant respectively. In addition, this group represents the highest tertiary education attainment (29.65 %) that may explain its patent level purple line - Figure 18).

As it could be checked, because of the relatively reduced regional sample the effect of one single region as FR71 makes the difference to set the 4-technology-interest group as the one with the higher number of patents.

Based on the results, a direct relation between R&D expenditures and unemployment rate (red and blue lines - Figure 18) could not be confirmed.

From the single energy technology perspective, it is notable the reduced number of patents for regions under **wind** and **ocean** with less than 80 applications by 2011. On the other hand, smart grids and electric vehicles present the highest values. Those two technologies bring together 34 and 27 regions considering NUTS1, NUTS2 and NUTS3 (Figure 10) meaning that there is interest as well innovative force in those regions. Therefore under the smart specialisation perspective these technologies are probably the

most promising. From a geographical approach both are represented across Europe (Figure 31 & Figure 32).

Considering tertiary education, CHP/Heating & Cooling, Hydro and H2/Fuel Cells regions present the highest value (30 % or more) with relatively high value for the number of patents just in the case of CHP/Heating & Cooling. In the case of H2/Fuel Cells despite the high tertiary education level the reduce number of patents is notable including NUTS2 regions from France (3 regions - 158 patents in average), Spain (4 regions – 80 patents in average) and Greece (1 region – 5 patents)

It is also interesting the case of Hydro group of regions that even having the highest rate for R&D expenditures (1083 EUR per inhabitant) it also has a relatively reduced number of patent applications, which beforehand should be the opposite. This group is formed why just two regions; Alsace (FR42) and Övre Norrland (SE33) with 251 and 64 patent applications. This issue might be explained because of the maturity of the hydropower energy.

In summary, from a general perspective no straightforward conclusions are obtained. As it has been shown the situation of every single region has to be considered to understand figures presented under the aggregation proposed in this section.

6.4 Alignment of strategies between national and regional level

An important aspect that could determine the selection of certain energy technology at the regional level is the potential alignment with the corresponding country.

However based on the information available there are only **7 countries** that have both national and regional strategies related to energy technologies.

In most cases, there are not national strategies that support regional implementation but it is expected that these regions have developed theirs based on the national goals, regulatory conditions and/or country needs.

It is important to note the SSP is mainly focused at the regional level, so it is likely countries have decided to support and monitor regions instead of starting their own SSPs.

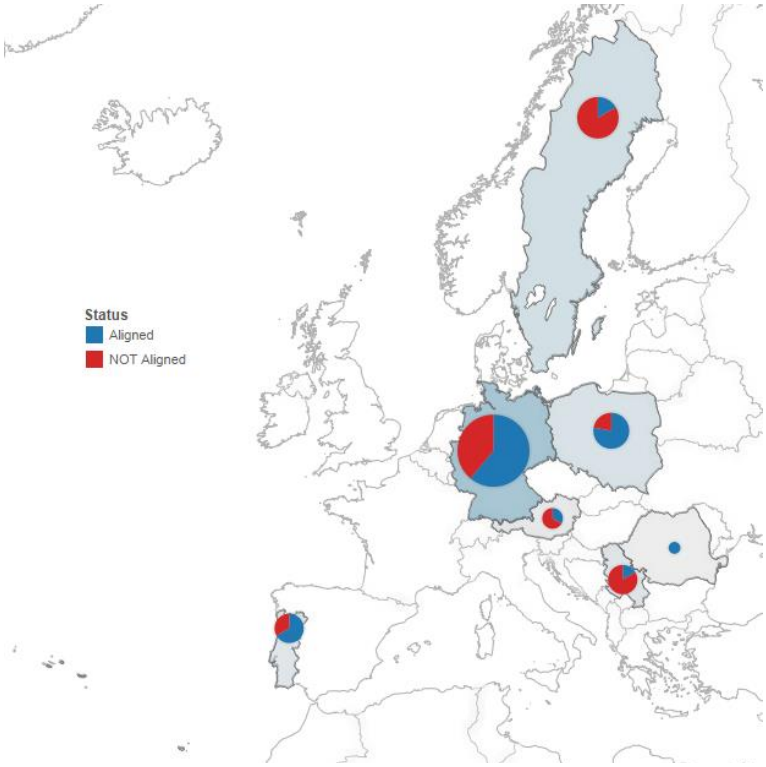

Figure 19: Share of regional strategies linked to corresponding national strategies

For the 7 countries identified, there are different levels of connection between these two geographical levels. Thus, in the case of Romania the share of alignment is 100 % but with just one region identified. For countries with a larger number of regions involved the alignment share ranges between (60 and 78 %) including Germany (61.1 %), Poland (77.7 %) and Portugal (66.67 %). In the case of Sweden the number of regions with common national interests represents the 16.67 % of regional strategies.

In summary, it could be extracted that there are not a tight connection between countries and regions even though it is expected both levels are contributing to the national energy goals.

7. Conclusions

This report aims to increase the level of understanding concerning national and regional energy technology interests under the framework of the smart specialisation platform. In order to simplify the mapping process, the results and conclusions presented throughout the document are based on a limited set of information included in [Eye@RIS3 2015] avoiding the analysis of every single national or regional strategy. As it has been explained in the methodology section, limitations exist because of weak descriptions and lack of homogeneity in the terminology used on the one hand and potential overlaps amongst technologies on the other hand. These two issues have been quantified in this report concerning about 55 % of regions involved in the study and consequently requiring a deeper analysis based on their strategies.

In addition to this finding, other indicators have been analysed to determine reasons why regions are selecting certain technologies. This analysis has not provided clear conclusions. Concerning economic development in regions, no greater interest from less developed regions in energy issues could be seen. Additionally, energy costs do not determine the selection of specific technologies either. The same holds true for cohesion indicators.

For specific technologies such as wind (off-shore installations) and ocean there exists a communality based on the geographic location of regions. These two technologies are predominant in the Atlantic Arc because of the availability of resources. In other cases, the promotion of certain technologies (e.g. 'energy efficiency') is not linked to specific conditions and the interest may appear in every geographical location. Finally, a connection between regions and countries did not increase either additional understanding about regional priorities.

The complexity of societies, affected by endogenous and exogenous factors, requires specific methodologies to determine energy priorities. To achieve a better understanding of the regional energy sector, indicators related to aspects such as: available resources, deployment of technologies or legislation has to be considered.

Therefore, to determine the reasons why a region has selected a certain energy technology, a more detailed assessment of the regional smart specialisation strategies would be needed.

Overall, cooperation is a key element to succeed in the implementation of the SSP. Accordingly, even if no clear similarities are demonstrated, the identification of regions with common energy technologies priorities is a valuable input for regions to identify potential cooperation. This information may lead to stablish knowledge-sharing information amongst those with common interests.

Future lines of the energy mapping work will take advantage of the ESIF tool that is under development by JRC/IPTS. This tool is expected to be available by mid-2016 and will be able to scan complete texts in order to find keywords leading to increase the understanding of regional energy priorities.

Meanwhile, further to this initial mapping, the next proposed activity is to carry out a deeper analysis for regions with interest in wind.

The selection of wind for the proposed first analysis is based mainly on the fact that it is mature enough to have a certain level of deployment and a real impact at regional level as well as wind interest presents a level of geographical aggregation, Atlantic coastal regions, which may simplify this first analysis in terms of common regional features.

The intention is to combine regions with different levels of wind energy deployment to identify good practices from the more advanced region and assess how to transfer knowledge to regions that are less advanced. This exercise will include the analysis of dimensions such as socio-economics, academia or private sector linked to the wind technology in this group of regions.

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[Eurostat 2015c] Eurostat: Electricity prices for domestic consumers - bi-annual data (from 2007 onwards). URL: http://appsso.eurostat.ec.europa.eu/nui/show.do

[Eurostat 2015d] Eurostat: Patent applications to the EPO by priority year by NUTS 3 regions. URL: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[Eurostat 2015e] Eurostat: Total intramural R&D expenditure (GERD) by sectors of performance and NUTS 2 regions. URL: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[Eurostat 2015f] Eurostat: Unemployment rates by sex, age and NUTS 2 regions (%). URL: http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

[Eurostat 2015g] Eurostat: Tertiary educational attainment, age group 25-64 by sex and NUTS 2 regions. URL: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tgs00109&plugin=1

[Eye@RIS3 2015] Eye@RIS3. URL: http://s3platform.jrc.ec.europa.eu/map

[JRC/IPTS 2015] JRC/IPTS: Guide to the Eye @ RIS3

Annex I. Country mapping

In this sections geographical distribution of countries with certain technology interest are presented.

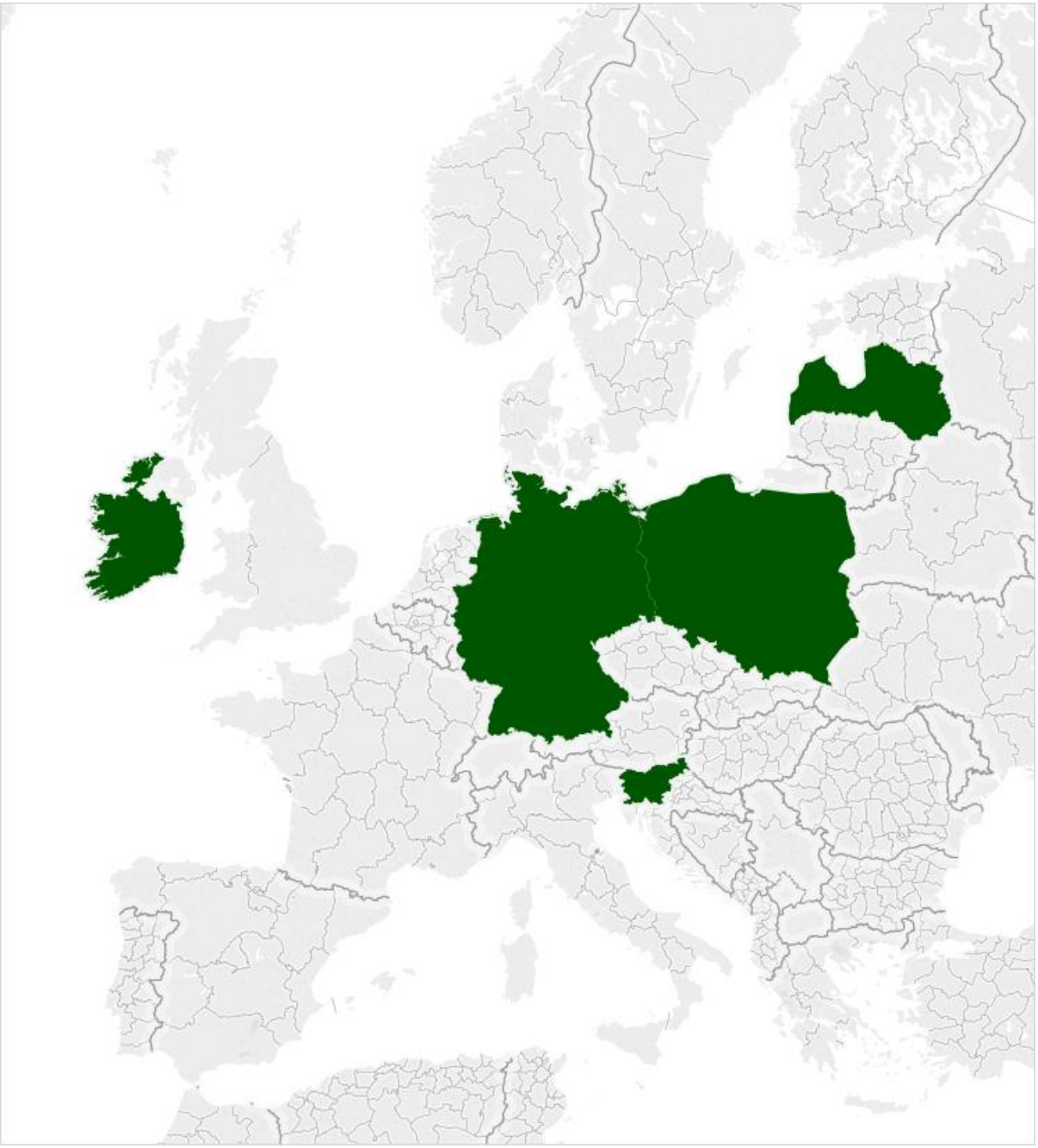

Figure 20: Countries with the smart grid concept included in their priorities

Figure 21: Countries with electric vehicle or e-mobility concept included in their priorities

Figure 22: Countries with solar technologies; solar thermal, PV or concentrated solar power included in their priorities

Figure 23: Countries with the promotion of Bioenergy included in their priorities

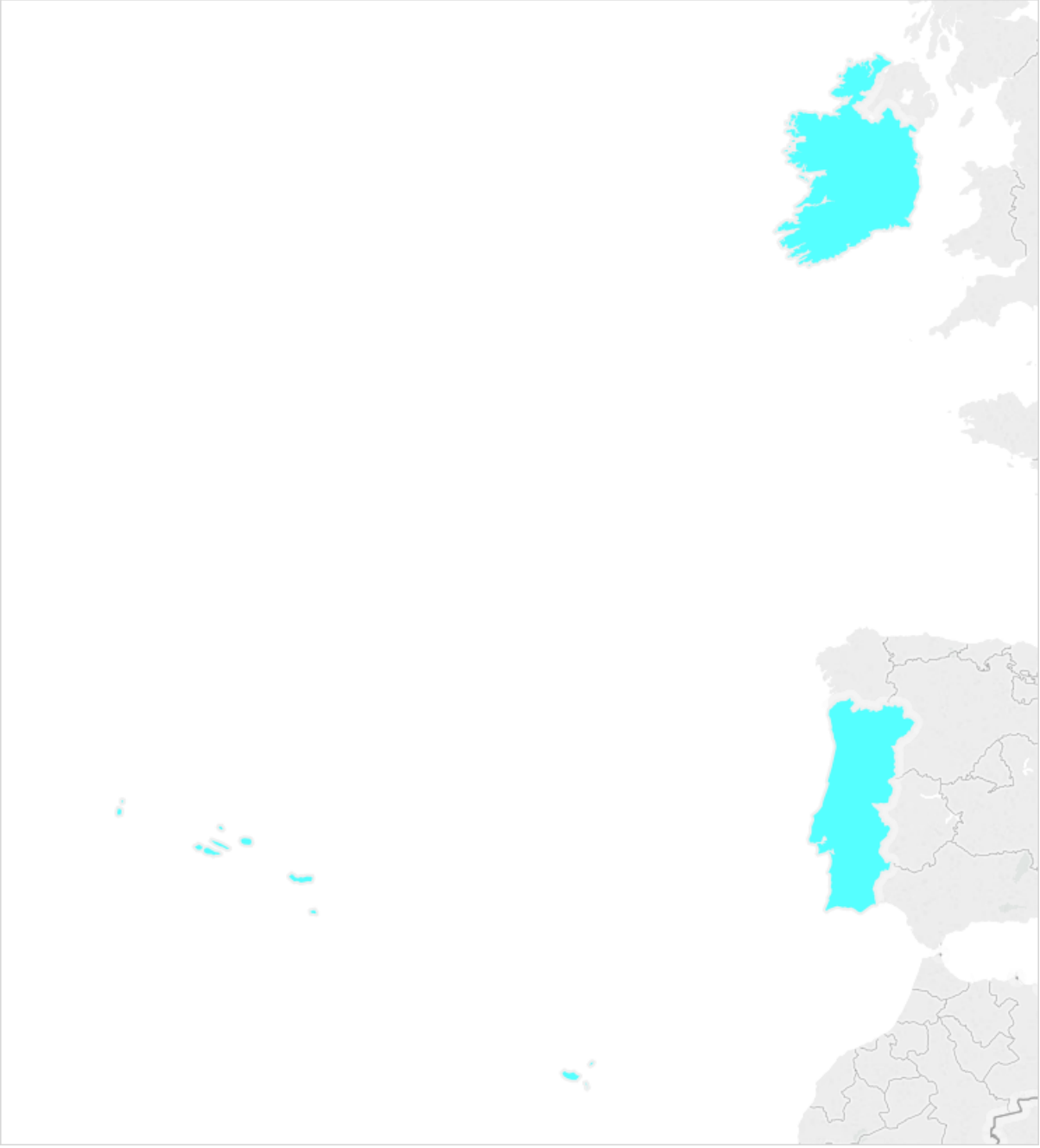

Figure 24: Countries with wind energy included in their priorities

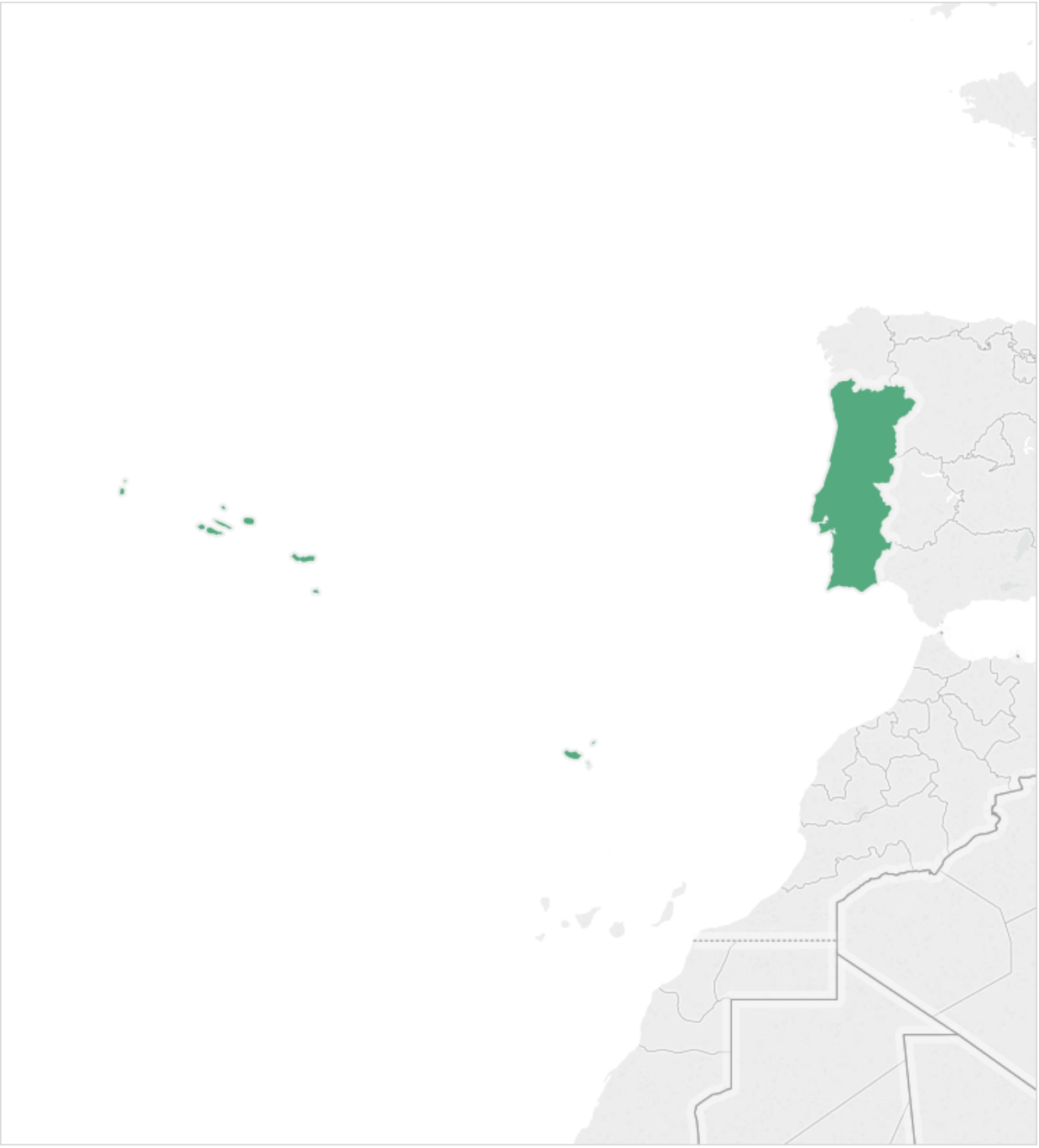

Figure 25: Countries with hydro energy included in their priorities

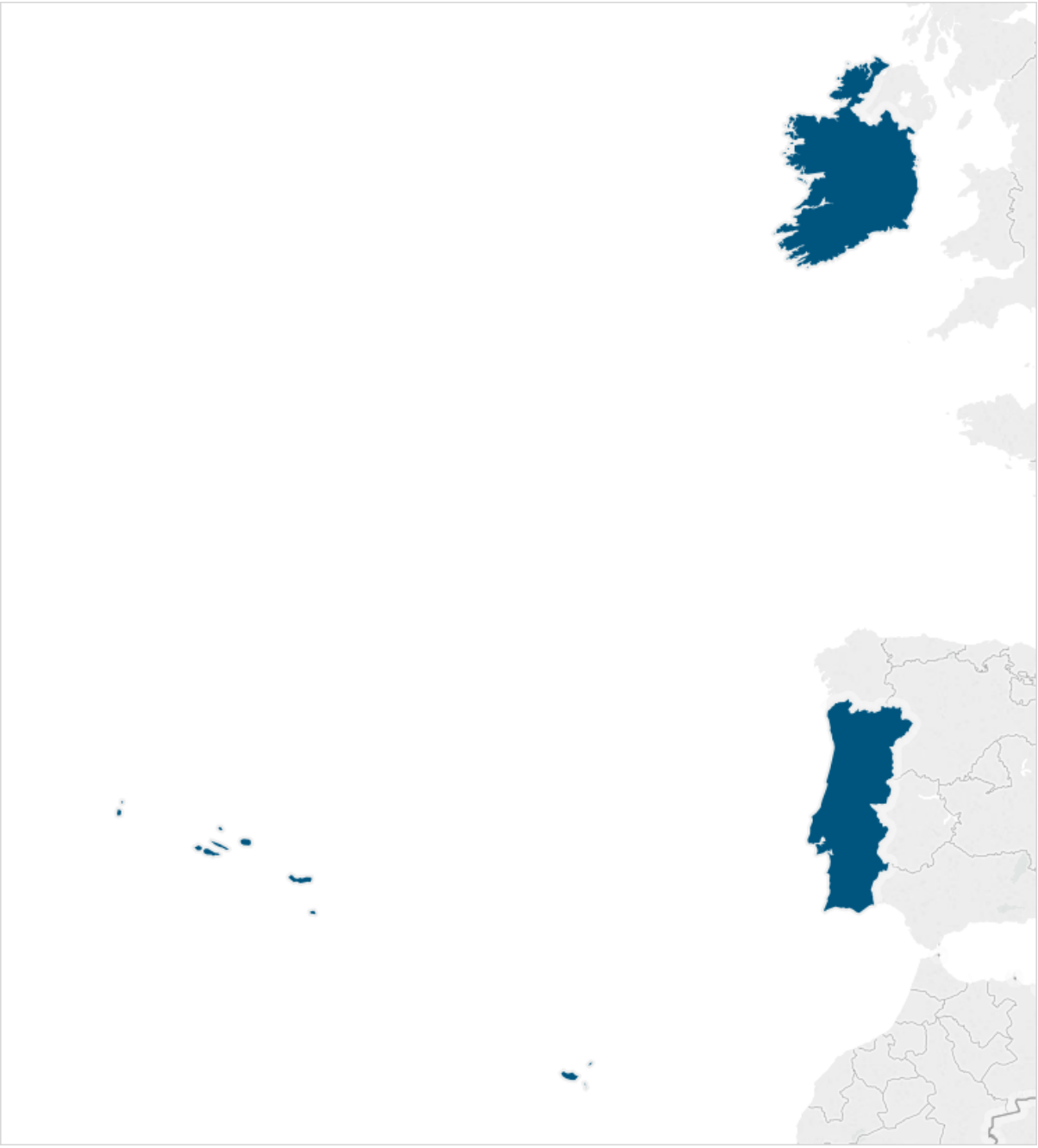

Figure 26: Countries with ocean energy included in their priorities

Figure 27: Countries with combined heat and power, heating and cooling included in their priorities

Figure 28: Countries with storage technologies included in their priorities

Figure 29: Countries with Oil & Gas included in their priorities

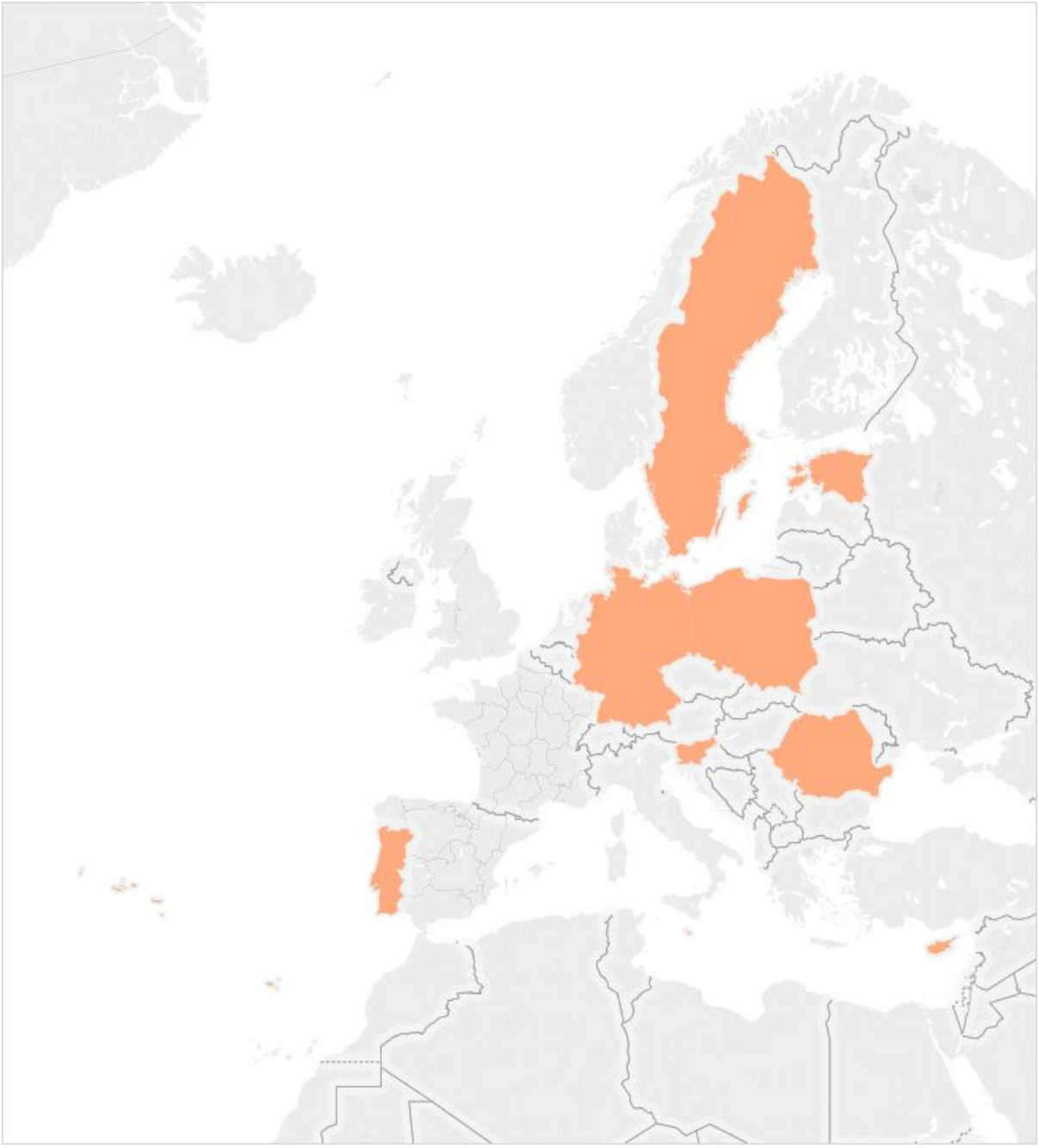

Figure 30: Countries with Energy efficiency included in their priorities

Annex II. Regional mapping

In this sections geographical distribution of regions with certain technology interest are presented.

Figure 31: Regions with the smart grid concept included in their priorities

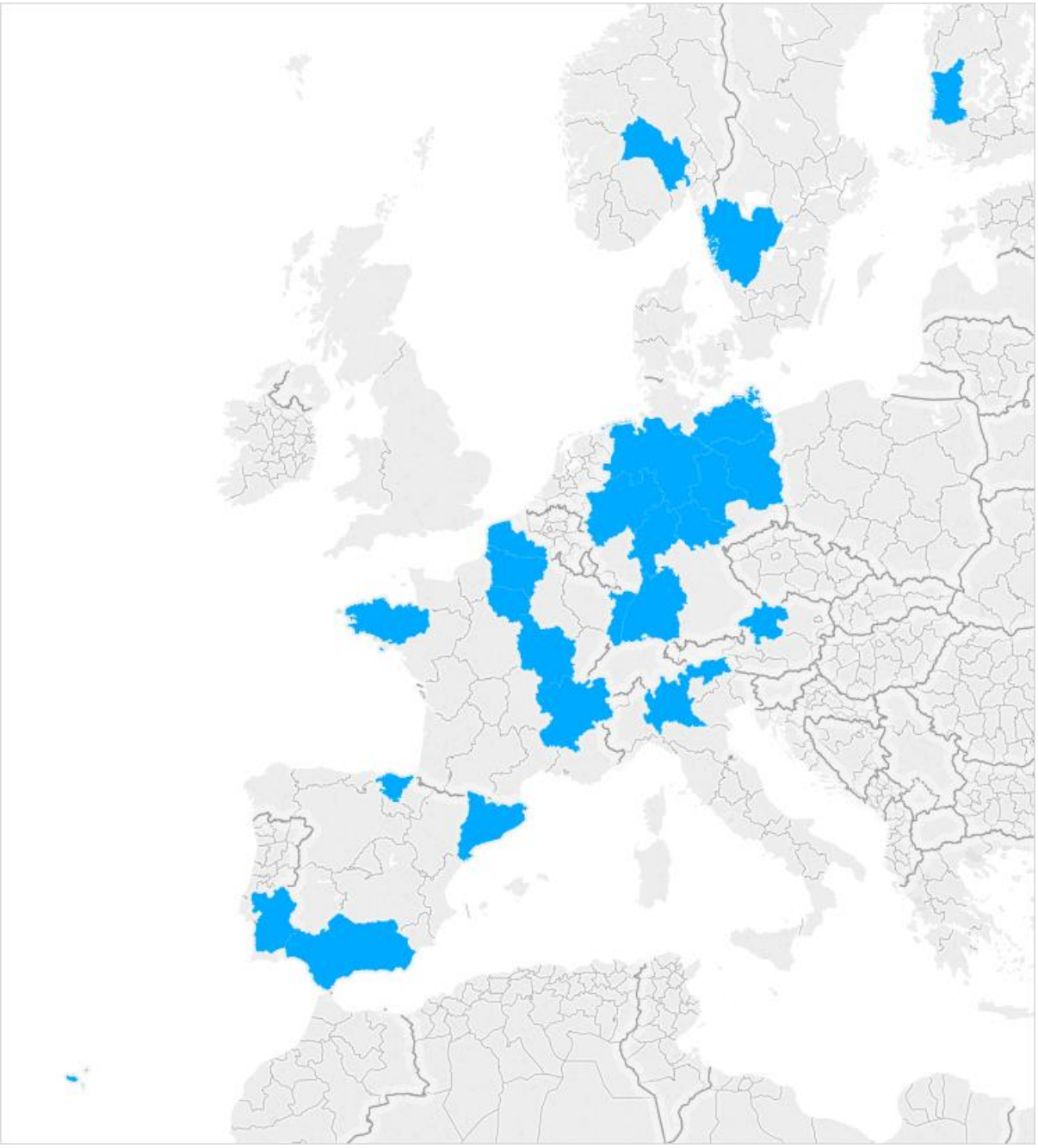

Figure 32: Regions with electric vehicle or e-mobility concept included in their priorities

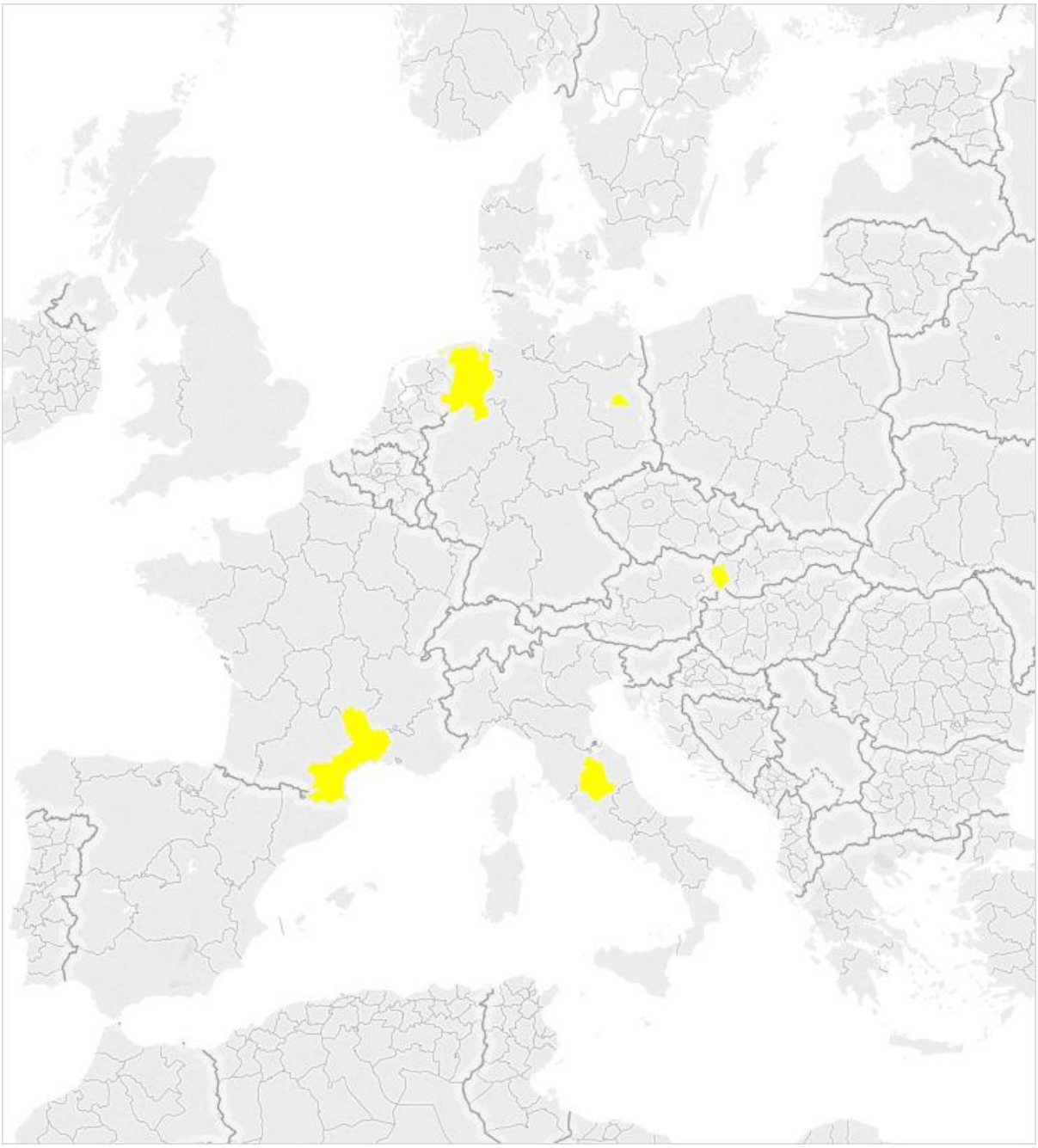

Figure 33: Regions with solar technologies; solar, PV or concentrated solar power included in their priorities

Figure 34: Regions with the promotion of Bioenergy included in their priorities

Figure 35: Regions with Geothermal included in their priorities

Figure 36: Regions with wind energy included in their priorities

Figure 37: Regions with hydro energy included in their priorities

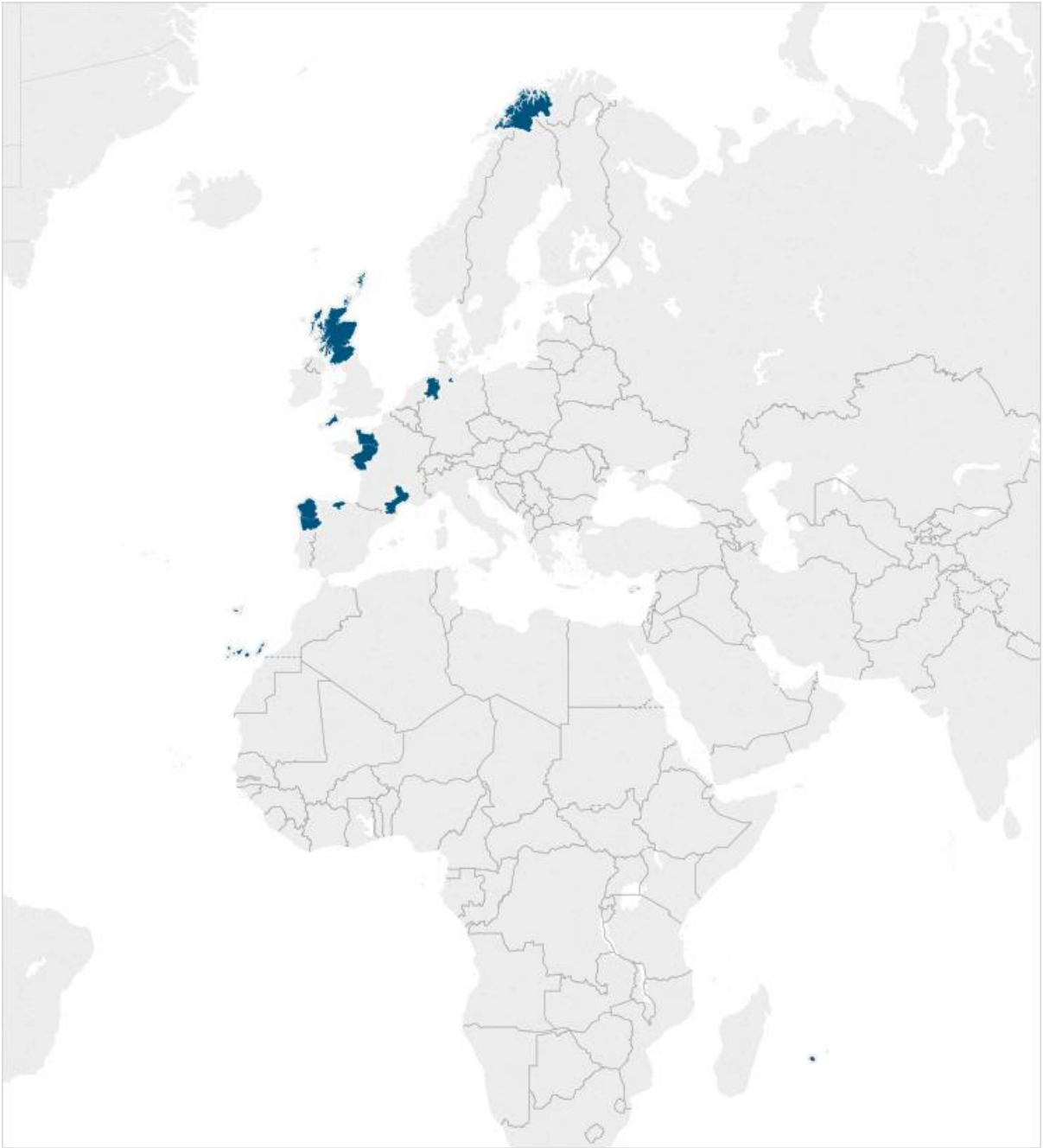

Figure 38: Regions with ocean energy included in their priorities

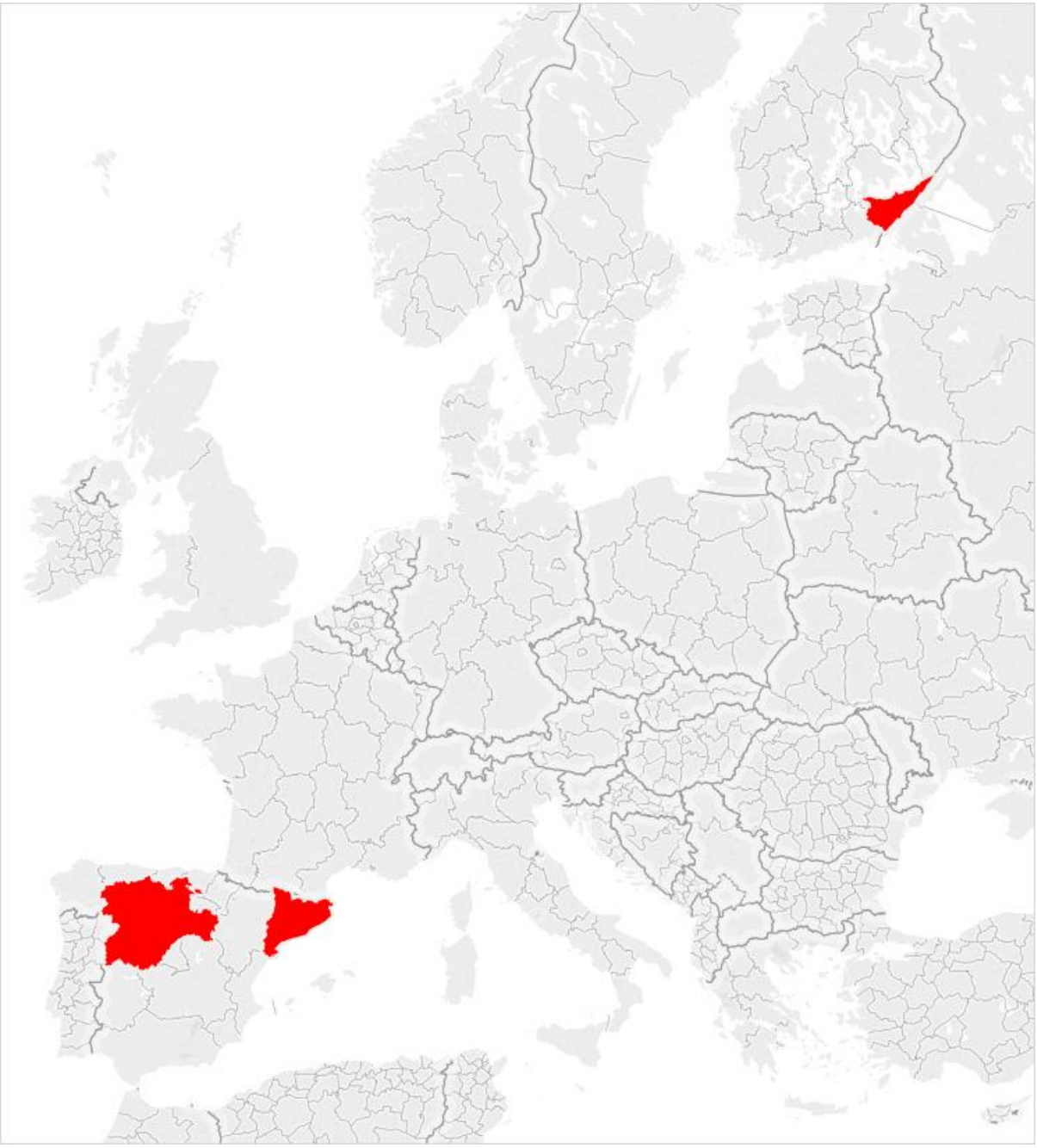

Figure 39: Regions with combined heat and power, heating and cooling included in their priorities

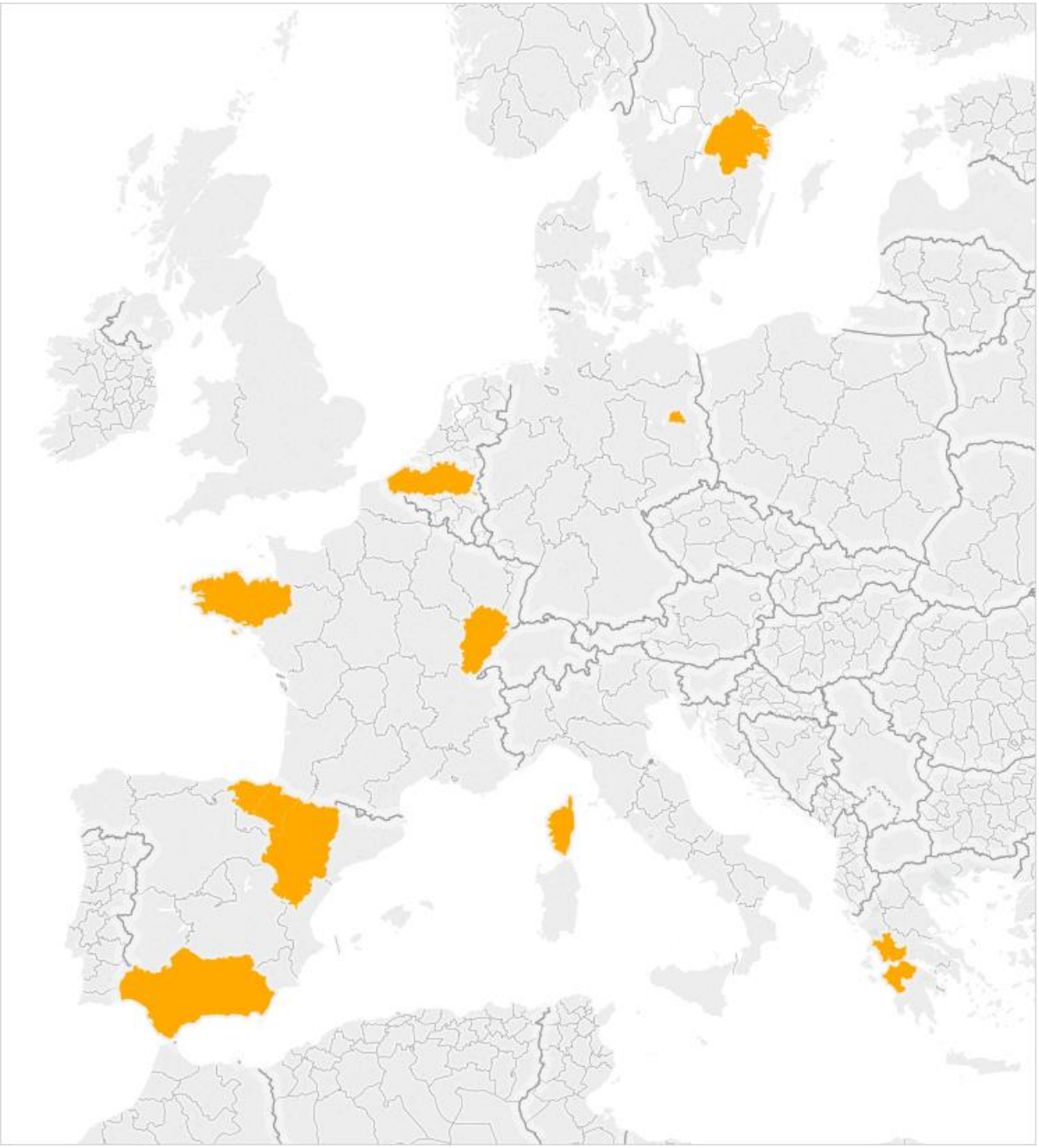

Figure 40: Regions with hydrogen and fuel cells included in their priorities

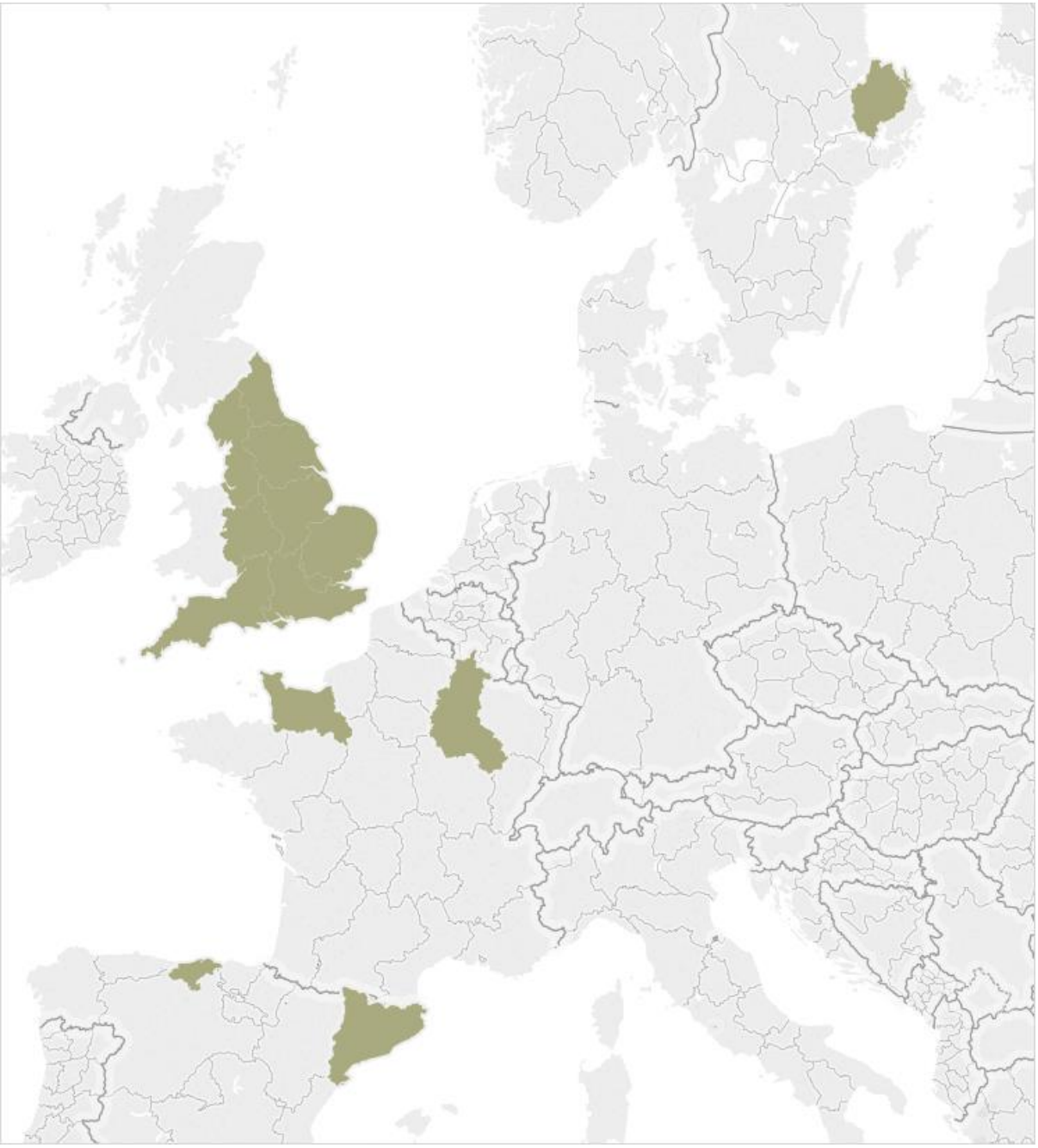

Figure 41: Regions with nuclear energy included in their priorities

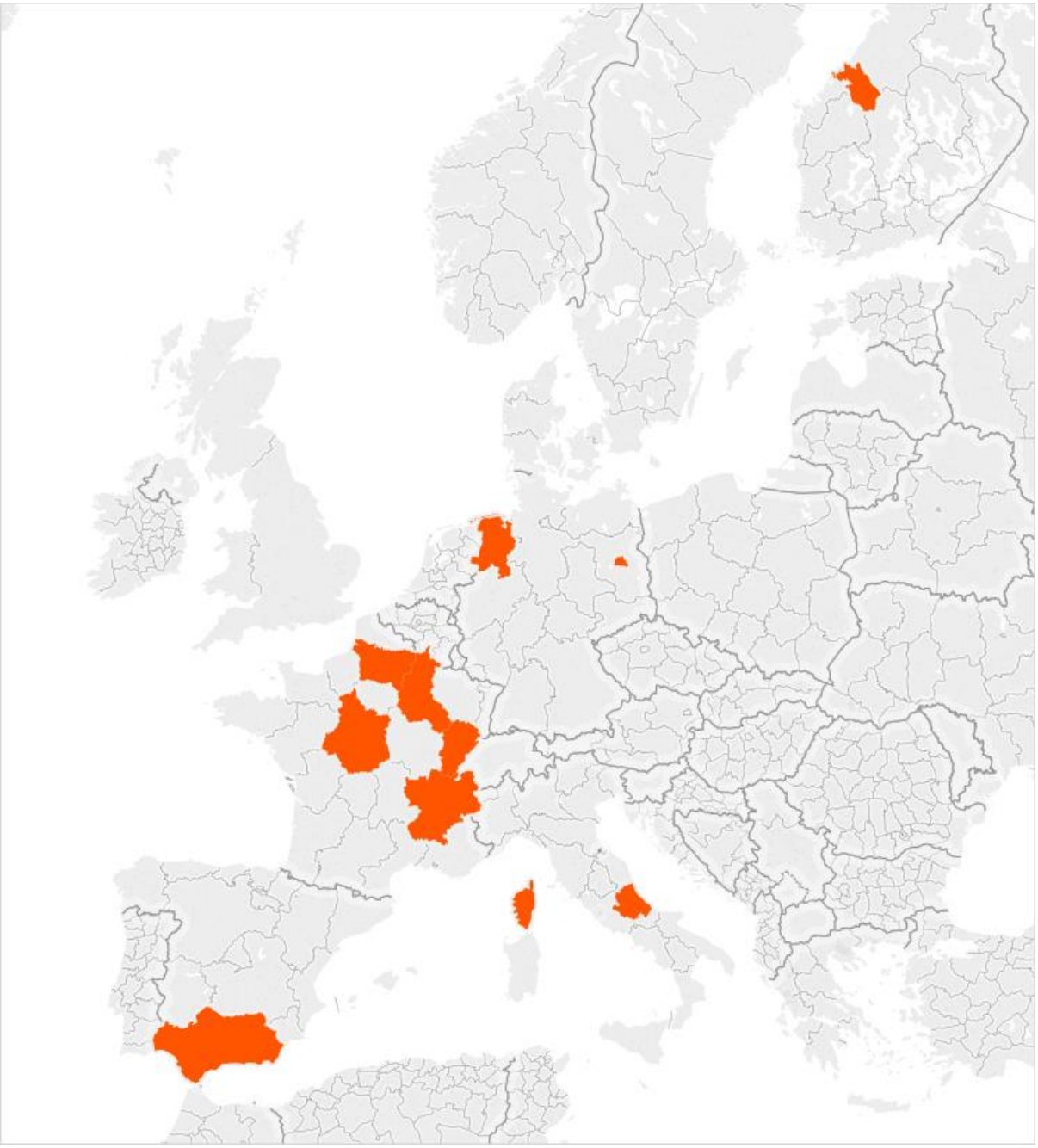

Figure 42: Regions with storage technologies included in their priorities

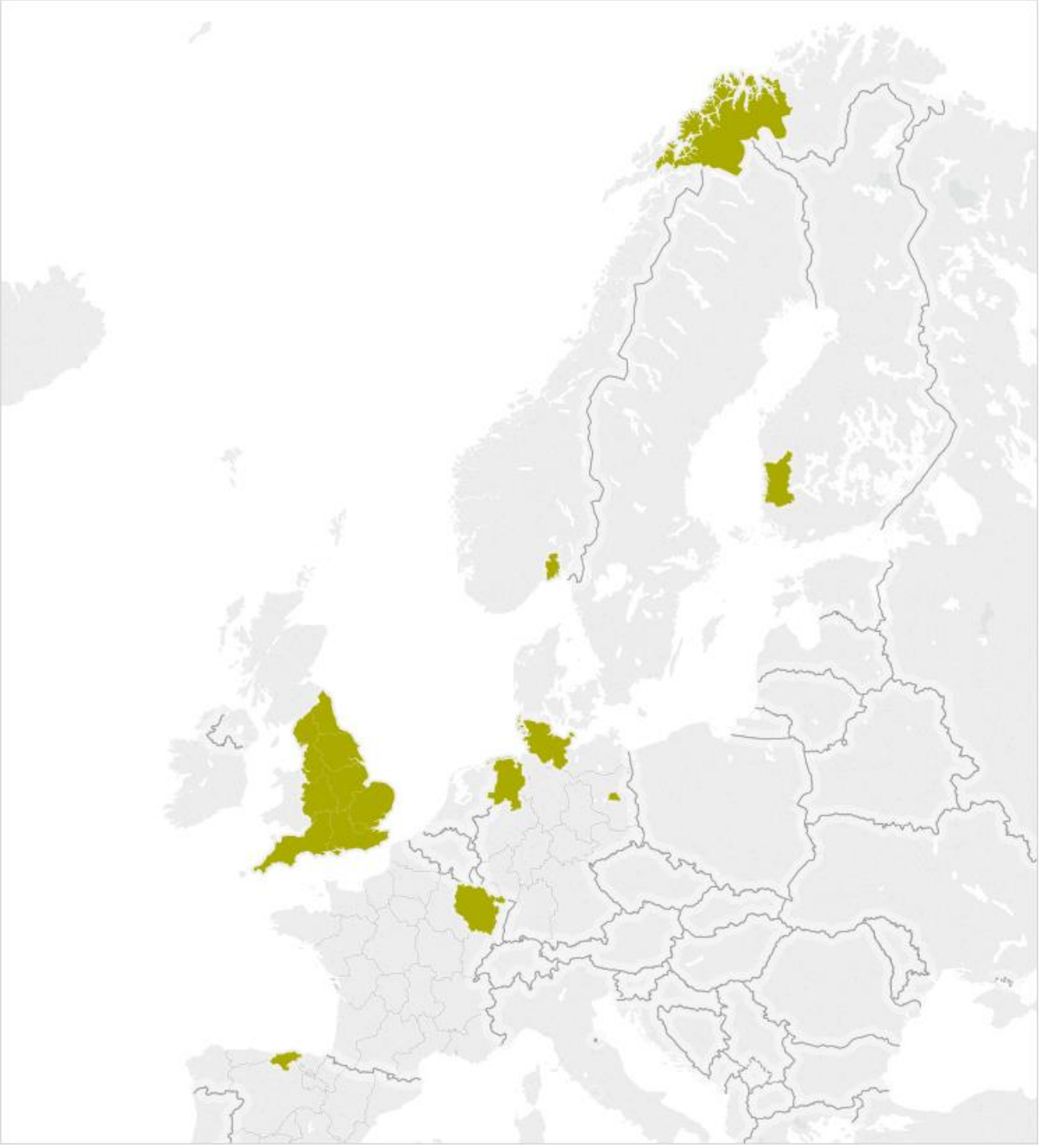

Figure 43: Regions with Oil & Gas included in their priorities

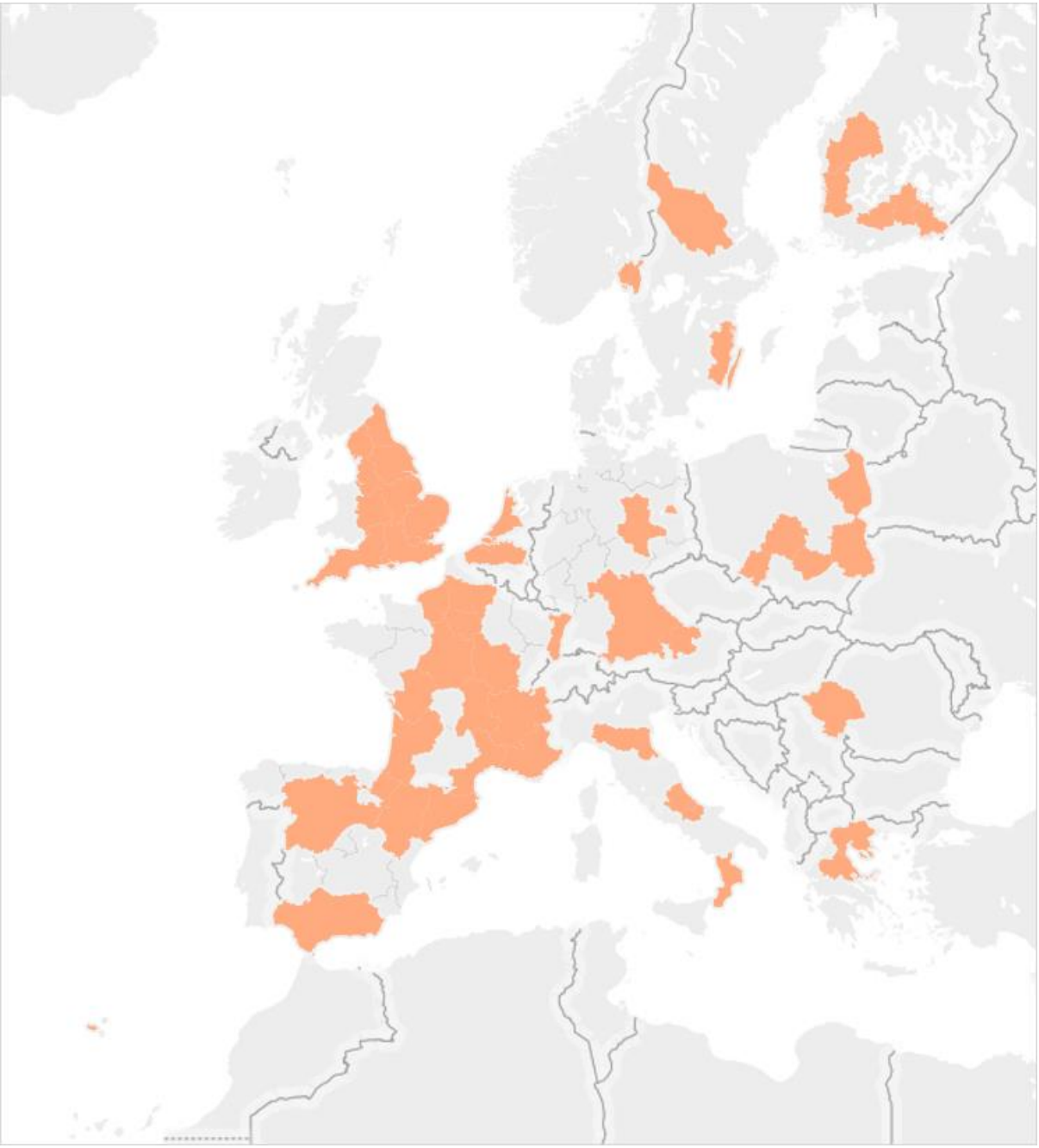

Figure 44: Regions with Energy efficiency included in their priorities

Annex III. Categories & EU priorities included in the EYE@RIS3 browser

Table 8: Categories and sub-categories for 'research and innovation capabilities' and 'business areas and target markets'

Agriculture, forestry and fishing

Agricultural services

Crop and animal production, hunting and related service activities

Fishing and aquaculture

Forestry and logging

Construction

Construction of buildings

Civil engineering

Specialised construction activities

Creative and cultural arts and entertainment

Amusement and recreation activities

Creative, arts and entertainment activities

Gambling and betting activities

Libraries, archives, museums and other cultural activities

Sports activities

Energy production and distribution

Energy distribution

Power generation/renewable sources

Human health and social work activities

Human health activities (medical services)

Residential care activities

Social work activities without accommodation

Information and communication technologies (ICT)

Computer programming, consultancy and related activities

Information service activities

Motion picture, video and television programme production, sound recording and music publishing activities

Programming and broadcasting activities

Publishing activities

Telecommunications

Manufacturing and industry

Basic metals and of fabricated metal products

Basic pharmaceutical products and pharmaceutical preparations

Biotechnology

Chemicals and chemical products

Coke and refined petroleum products

Computer, electronic and optical products

Electrical equipment

Food, beverage and tobacco products

Furniture

Handicrafts

Machinery and equipment n.e.c.

Motor vehicles and other transport equipment

Nanotechnology and engineering

Printing and reproduction of recorded media

Repair and installation of machinery and equipment

Rubber and plastic products

Textiles, wearing apparel and leather and related products

Wood and paper (except for furniture)

Other manufacturing

Other non-metallic mineral products

Mining and quarrying

Extraction of crude petroleum and natural gas

Mining of coal and lignite

Mining of metal ores

Mining support service activities

Other mining and quarrying

Public administration, security and defence

Defence

Public administration, justice, judicial, public order, fire service and safety activities

Services

Activities auxiliary to financial services and insurance activities

Activities of head offices and management consultancy activities

Advertising and market research

Architectural and engineering activities, technical testing and analysis

Education

Employment activities

Financial service activities, except insurance and pension funding

Insurance, re-insurance and pension funding, except compulsory social security

Legal and accounting activities

Office administrative, office support and other business support activities

Rental and leasing activities

Scientific research and development

Security and investigation activities

Services to buildings and landscape activities

Travel agency, tour operator and other reservation service and related activities

Other professional, scientific and technical activities

Tourism, restaurants and recreation

Accommodation (hotels, camping)

Rental and leasing activities

Restaurants and catering industry

Travel agency, tour operator and other reservation service and related activities

Transporting and storage

Air transport and related services

Postal and courier activities

Rail transport and related services

Road transport and related services

Warehousing and support activities for transportation (logistics storage)

Water transport and related services

Water supply, sewerage, waste management and remediation activities

Sewerage

Waste collection, treatment and disposal activities, materials recovery and remediation activities

Water collection, treatment and supply

Wholesale and retail trade

Retail trade

Wholesale trade

Table 9: Categories and sub-categories for EU priorities

Aeronautics and space

Aeronautics

Aeronautics and environment

Bio-fuels and energy efficiency

Remotely piloted aircrafts

Safety and security

Space

Transport and logistics

Blue growth

Aquaculture

Blue renewable energy

Coastal and maritime tourism

Fisheries

Marine biotechnology

Offshore mining, oil and gas

Shipbuilding and ship repair

Transport and logistics (including highways of the seas)

Cultural and creative industries

Development of regional cultural and creative industries

Support to link cultural and creative industries with traditional industries

Digital Agenda

Automated driverless vehicles

Basic broadband: coverage in rural areas

Cleaner environment and efficient energy networks (e.g. smart grids)

E-Commerce and SMEs online

e-Government (e.g. e-Procurement, e-Participation)

e-Health (e.g. healthy ageing)

e-Inclusion (e.g. e-Skills, e-Learning)

High speed broadband: last mile networks (>30Mbps)

High speed broadband: middle mile and backhaul

ICT trust, cyber security and network security

Intelligent inter-modal and sustainable urban areas (e.g. smart cities)

New media and easier access to cultural contents (e.g. heritage)

Open data and sharing of public sector information

KETs

Advanced manufacturing systems

Advanced materials

Industrial biotechnology

Micro-/nano-electronics

Nanotechnology

Photonics

Nature and biodiversity

Biodiversity

Ecotourism

Nature preservation

Public health and security

Ageing societies

Food security and safety

Public health and well-being

Public safety and pandemics

Service innovation

New or improved organisational models

New or improved service processes

New or improved service products (commodities or public services)

Social innovation

New organisational models and social relations that meet social needs

New products or services that meet social needs

Social innovation with regard to child care

Social innovation with regard to education, skills and training

Social innovation with regard to environmental issues

Social innovation with regard to health, well-being and elder care

Social innovation with regard to social inclusion

Sustainable innovation

Eco-innovations

High-speed rail-road transportation systems

Resource efficiency

Smart green and integrated transport systems

Sustainable agriculture

Sustainable energy and renewables

Sustainable land and water use

Sustainable production and consumption

Waste management

Specific local policy priority

List of abbreviations and definitions

CCS	Carbon Capture and Storage
CCU	Carbon Capture and Utilisation
CHP	Combined Heat and Power
ESIF	European Structural and Investments Funds
GDP	Gross Domestic Product
kWh	Kilowatt-hour
MS	Member State
NUTS	Nomenclature of Territorial Units for Statistics
PV	Photovoltaics
R&D	Research and Development
RIS3	Research and Innovation Strategies for Smart Specialisations
SETIS	Strategic Energy Technology Information System
SPP	Smart Specialisation Process

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As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation

Publications Office

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