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 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

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

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

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

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. 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.

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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

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

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

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>CY</td>
<td>Cyprus</td>
</tr>
<tr>
<td>DE</td>
<td>Germany</td>
</tr>
<tr>
<td>DE3</td>
<td>Berlin</td>
</tr>
<tr>
<td>DE94</td>
<td>Weser-Ems</td>
</tr>
<tr>
<td>ITI2</td>
<td>Umbria</td>
</tr>
<tr>
<td>RS1</td>
<td>Vojvodina</td>
</tr>
</tbody>
</table>

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

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

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).
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

Number of regional encoded priorities per country

EU28 countries
non-EU countries
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

Figure 8: Share of energy technology interest at national level

---

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'.
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 (€\textsuperscript{2013}/kWh)\textsuperscript{5} [Eurostat 2015b]
- Cost of Electricity for domestic users (€\textsuperscript{2013}/kWh)\textsuperscript{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 €\textsuperscript{2013}/kWh (0.24 & 0.32 €\textsuperscript{2013}/kWh respectively). For the gas case, prices are more similar for all countries ranging from 0.05 to 0.09 €\textsuperscript{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 €\textsuperscript{2013}/kWh), geothermal and hydropower (0.181 €\textsuperscript{2013}/kWh).

\textsuperscript{5} The cost of the gas represents the average price of users classified by annual energy consumption. The price includes taxes.

\textsuperscript{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
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.
Average NUTS2 regional population and GDP per number of energy technology interest

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

Average NUTS2 regional energy costs per number of technology 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 common energy technology interest

### 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

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

Average NUTS2 cohesion indicators per number of technology interest

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

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 establish 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.
**References**


[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 section 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 section 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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