ESPON

# GREECO
# Territorial Potentials for a Greener Economy

Applied Research 2013/1/20

(Draft) Final Report | Version 22/11/2013

Sector Report

Vol. 3.5. Green Research and Eco-innovation

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

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

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This basic report exists only in an electronic version.

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# 1 Introduction to and conceptual elements of green research and eco-innovation

This report is devoted to green research and eco-innovation as a key sector in delivering the transition towards a greener economy and a more sustainable development. The status of the economy and the environment are two aspects which condition and affect the lives of all Europeans. On the one hand, a good environmental quality is essential for ensuring prosperity and life quality. On the other hand economic growth is indispensable for maintaining the aforementioned life quality. Eco-innovation is in the intersection where reducing environmental impacts and increasing economic competitiveness meet. Historically, economic and environmental objectives have often been seen as being contradictory. However, the perception that a choice must be made is wrong. Eco-innovation in companies leads to reduced costs, improves capacity to capture new growth opportunities and enhances their reputation among customers.

That is why EU environment policy is contributing to a shift towards employment associated with cleaner, more efficient products and processes and the transition to an energy and resource-efficient economy. This is not only good for the environment but also for economic growth and the creation of new jobs

In such a context, eco-innovation is an essential tool in the pursuit of resource efficiency, competitiveness and job creation (European Commission (EC) 2011a). To date, there are a number of definitions of what eco-innovation is, the most relevant for this project being:

The one provided by the Eco-Innovation Action Plan (Eco-AP) (European Commission (EC) 2011b), which aims to put eco-innovation at the heart of all European policies[1]:

> **BOX 1: Eco-innovation definition, as in the Eco-AP (ibid):**
>
> Eco-Innovation is any form of innovation resulting in or aiming at significant and demonstrable progress towards the goal of sustainable development, through reducing impacts on the environment, enhancing resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources.

In addition, it should also be highlighted the definition used by the Eco-innovation Observatory:

> "... the introduction of any new or significantly improved product (good or service), process, organisational change or marketing solution that reduces the use of natural resources (including materials, energy, water, and land) and decreases the release of harmful substances across the life-cycle." (EIO 2010)

Even if the wording differs, both definitions stress the flexible nature of eco-innovation, since it encompasses products, processes, services, marketing strategies, institutional innovations (changes in values, beliefs, knowledge, norms, and administrative acts) etc. as long as they contribute to reducing environmental pressures. Moreover, eco-innovation is not limited to environmentally motivated innovations, but also includes "unintended environmental innovations", that is to say the environmental benefits (the eco side) of an innovation can be a side-effect of other goals (Arundel 2009), e.g. the recycling of heavy metals in order to reduce costs.

The relevance of eco-innovation lies on the environmental benefits to be achieved, but also and most importantly on the enhanced competitiveness of EU companies. In the context of rising costs for resources, for manufacturing / producing and for managing waste, competitiveness is ineludibly linked to becoming eco-innovative, i.e. resource efficient. The global economy will have no choice but to adjust to environmental and resource constraints

[1] The European Commission had already provided a definition of eco-innovation, prior to launching the Eco-AP: *Eco-innovation refers to all forms of innovation – technological and non-technological, new products and services and new business practices – that create business opportunities and benefit the environment by preventing or reducing their impact, or by optimizing the use of resources (including energy use) (European Commission (EC) 2009)*.

and this will need eco-innovation (European Commission (EC) 2011b). Moreover, this transition can also generate jobs and growth and is essential for competitiveness of the economy, particularly in Europe, which has historically based its economic growth on intensive resource use (ibid). In the words of Josef Ackermann (CEO of Deutsche Bank, in December 2010):

> "Make no mistake: a new world order is emerging. The race for leadership has already begun. For the winners, the rewards are clear: Innovation and investment in clean energy technology will stimulate green growth; it will create jobs; it will bring greater energy independence and national security".

In summary, the expectations on eco-innovation are high as a tool to (1) tackle the big challenges facing humanity (climate change and environment depletion) and (2) to create new jobs and foster sustainable economic growth.

Against this backdrop, The Oslo Manual (OECD 2005) differentiates between four types of innovation including product (good or services), process, marketing and organisational innovation, which may be defined as follows:

- **A process innovation** is "*the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software*"
- **A product innovation** is "*the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics*"
- **A marketing innovation** is "*the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing*".
- **An organisational innovation** is "*the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations)"*.

Taking this as a starting point the EIO included two additional categories to the above classification (EIO 2012b):

- **A social innovation** is a novel solution to a social problem that is more effective, efficient, sustainable than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals. In addition, it aims to create social change and value, rather than commercial innovation and financial value and social innovation processes often involve not only business, but also the public sector and non-governmental organisations.
- **A system innovation** is a transition from one socio-technical system to another". Thus, system innovations lead to systemic changes in both social (values, regulations, attitudes etc.) and technical (infrastructure, technology, tools, production processes etc) dimensions and, most importantly, in the relations between them. System innovation may include elements or combinations of all types of innovations (product, process, marketing, organisational or social) and are, by definition, developed and implemented by many actors.

In addition to the above types of eco-innovation, one additional classification could be whether the degree of change fostered by an eco-innovation (from incremental to disruptive). According to the "Introducing Eco-Innovation" brief (EIO 2011):

> *Incremental eco-innovations concern improved components of products or services, improved processes or streamlined organisational set-ups. Incremental changes do not lead to a substantial change alone. They do, however, result in improved environmental performance. Over time, incremental innovations may accumulate and result in a significant change. The scale of application also makes a difference: incremental changes applied on a large scale may lead to substantial environmental and economic benefits.*
>
> *Innovations that lead to shifts in a paradigm or in the functioning of an entire system are often referred to as disruptive eco-innovations. They can lead to reconfiguring*

*entire markets, consumer behaviour and technological systems. Systemic changes resulting from such innovations can make some existing products or services redundant. In this case, there may be short-term costs for achieving long-term benefits, or "slow wins".*

Along these lines, recent analyses suggest that strategic eco-innovators developing emerging eco-innovations are different to other innovators as they have clear first mover strategies. This type of eco-innovators has a different innovation dynamics due the fact that they are in a stage of the innovation cycle that has high uncertainty and risks. This type of eco-innovators is not yet consolidated, but they are often high-growth, SMEs. They primarily develop product, service and "collaboration-al" innovations that are new to the world and markets.

All in all, no matter the degree of change fostered, all eco-innovative changes are beneficial, since they lead to a greater resource efficiency (i.e. reduced use of natural resources and decreased emissions) across the whole lifecycle. Nonetheless, EU Environment Commissioner Janez Potocnik stated in September 2012 that eco-innovation should aim at disruptive changes if it is to overcome the current challenges (resource constraints, sustainability, water scarcity, etc.).

**BOX 2: Janez Potocnik at an event on Eco-innovation: Harnessing R&D for a Green Economy, organised by the Science|Business Innovation Board (26 September):**

Eco-innovation should go beyond incremental environmental improvements and efficiency gains, and aim at "breaking out of locked-in systems and thinking". (…)

Policymakers could use regulation to promote change. The Commission is "seriously considering" a ban on landfilling of waste, to come into force in 2020, Potocnik noted. This would "create a very clear case financially" for investing in recycling, and for reducing waste. Speakers at the event discussed how cars or buildings, for example, could be better designed so that at the end of their life spans they could be dismantled and their parts re-used, rather than treated as waste. (…)

Eco-innovation could encompass a range of policies designed to encourage different patterns of production and consumption. These include "shifting taxes from labour to polluters," removing environmentally harmful subsidies, eco-design and eco-labelling, and appropriate resource pricing policies, such as water pricing, Potocnik said.

All of the above, has represented a shift in understanding of eco-innovation, from eco-innovation belonging solely to the environmental industry to being integrated in all industries (EIO 2013). The turning point for this shift in understanding was the 2008 Community Innovation Statistics (CIS), which included an ad-hoc eco-innovation module. CIS are survey based statistics and are produced in the 27 Member States, 3 countries of the European Free Trade Association (EFTA) and in EU candidate countries. The CIS 2008 is the most recent statistic in EU innovation by Eurostat and it is remarkable for GREECO because it included for the first time a module on innovation with environmental benefits (i.e. eco-innovation), so that surveyed companies could report whether they developed eco-innovative activities. This survey showed that companies from all sectors (NACE codes ranging from A-Agriculture, Forestry and Fishing to N-Administrative and support service activities) reported they developed innovations with environmental benefits. Therefore, to grasp a holistic view of green research and eco-innovation an approach beyond sectoral limits (NACE code restricted) is required.

Against this backdrop, it has been decided to widen the approach of the GREECO-Green Research & Eco-innovation sector (see table below for NACE Rev. 2 activities foreseen in the Interim Report), so as to cover all the eco-innovation spectrum. That is to say, to consider the eco-innovation activities carried out in economy-wide sectors, where the core activity is not research, e.g. energy, transport, etc., and thus do not belong to the M70-74 NACE Rev. 2 codes. In addition, not all products and services provided by businesses classified under M70-74 are eco-innovative (or green), nor necessarily innovative.

**Table 1** Green research and eco-innovation activities as in the Interim Report

| NACE codes | Activities |
|---|---|
| **Green research and eco-innovation** | |
| M70 | Activities of head offices; management consultancy activities |
| M71 | Architectural and engineering activities; technical testing and analysis |
| M72 | Scientific research and development |
| M73 | Advertising and market research |
| M74 | Other professional, scientific and technical activities |

Since eco-innovation and green research do not have a straight forward correlation with NACE Rev. 2 codes, the scope has been modified in order to provide a holistic picture on eco-innovation patterns, barriers and drivers and thus, potential. Therefore, the content of the current sectoral report will differ slightly from other GREECO sectoral reports. The structure will be comparable and it will analyse the same topics, but it will not emphasize in socio-economic data (i.e. GVA, productivity, etc.) for the above mentioned reasons.

A large part of the EU economy depends on the environment and by extension holds a great potential for benefiting from eco-innovation. In addition to an entire sector devoted to environmental technologies (eco-industry), many jobs in the EU are linked in some way to the environment – from forestry and agriculture to sustainable construction and large parts of the tourism industry. The eco-industry branch (i.e. environmental technology industries), has an estimated turnover of around €227 billion, corresponding to 2.2% of EU GDP, and employs 3.4 million people directly (Ecorys 2009). For this eco-industry branch, an increase in demand is foreseen in the coming years, for the carbon capture and storage (CCS) technologies in particular, a potential for growth through Europe's leadership has been identified (ibid). Nonetheless, a more in-depth consideration of any environmental technology in particular, is considered to be somehow out of the scope of the GREECO project.

Besides, not much is known yet on the growing global trade in environmentally beneficial goods and services, since environmental technologies have not been thoroughly considered in economic statistics. Moreover, little is known on the adoption of eco-innovations by companies, sectors and regions, and the subsequent environmental improvements achieved (Arundel 2009). Therefore, some challenges remain in the measurement and monitoring of eco-innovation, for instance (1) the on-going nature of an eco-innovation, (2) the novelty and importance of an eco-innovation, (3) the possibility to combine different innovation measures (input indicators and output indicators, direct and indirect measures). At the same time, reducing uncertainly about future market developments will help boost investment and accelerate innovation in environmental technologies, products and services. Besides, market replication is somehow a gray area in eco-innovation research although some sound empirical evidence has been produced, mainly using patent data (Johnstone and Hascic 2009) and innovation surveys (Montalvo, P. ten Brink et al. 2007). We do not know many specific factors enabling market replication and diffusion for a number of eco-innovation areas, although some work is being done under the notion of Technological Innovation Systems (Coenen and Díaz López 2010).

Along these lines, there is an eco-innovation gap in Europe, since only around 15% of companies in the EU eco-innovate, with wide disparities in both the scale and scope of changes in different EU Member States (EIO 2012c). Along these lines, while the low-hanging fruits are probably an easy win-win solution in the short-term, more systemic changes are needed to reach a major decrease in resource use, which, for businesses, could mean developing new markets and innovating their business models to face current and emerging global challenges (ibid). Furthermore, the Montalvo and P. ten Brink (2007) study

In addition, green research and eco-innovation has a remarkable difference. It is not a sector which should become greener in order to enable the transition. On the contrary, it is the sector which will enable the transition to a green economy for other sectors.

**Table 2** Eco-innovation's contribution to Green Economy (EIO 2012)

| | Current global economy | Green global economy |
|---|---|---|
| Environment | 1.5 planets are needed to regenerate renewable resources and absorb the CO2 waste at current levels of consumption. | Resource extraction and emissions are within the planetary boundaries. For the EU, this requires reducing total consumption levels of primary materials, land, water and energy. |
| Social | 870 million people were chronically undernourished in 2010-12 and 1.29 billion people lived in extreme poverty in 2008. People in industrialised countries consume up to 20 times more materials than people in least developed countries. | Available global resources are more equitably distributed across the globe. For the EU, this implies substantially reducing total per capita resource consumption. |
| Economic | Economic prosperity is coupled with resource use. Relative decoupling has been observed for the EU, but not absolute decoupling. | Economic prosperity is decoupled from primary resource consumption. For the EU. This means transforming the economy to find growth opportunities in resource efficiency, recycling, re-use and new business models. |
| Territorial* | Does not consider territorial cohesion and inclusion parameters explicitly. | Place-based, taking into account territorial assets and with the perspective of an inclusive and cohesive growth. |

** GREECO addition.*

For all the above reasons, eco-innovation needs to be accelerated in a way that boosts resource productivity, efficiency, competitiveness and helps to safeguard the environment (European Commission (EC) 2011b). So, accelerated market uptake and dissemination of eco-innovation will lead to improved environmental performance and resilience across the economy being at the same time cost-effective and good for business and society as a whole (ibid). In other words, eco-innovation is key for a sustainable growth, which de-couples economic growth from environmental degradation (European Commission (EC) – DG REGIO (2012)).

## 2 Current performance and trends of eco-innovation

European environmental policies and increasing global environmental challenges have led to the emergence of a significant and competitive eco-innovation sector in Europe. As aforementioned, the eco-innovation comprises both the European eco-industry sector (mainly environmental technology related) and wider cross-sectoral eco-innovative companies.

**BOX 3: European eco-industry sector (Ecorys 2009):**

European eco-industries have an estimated annual turnover of € 319 billion or about 2.5 % of the EU's gross domestic product (GDP). This means that they are larger than the steel, pharmaceuticals or automobile industries. Recently, eco-industries have been growing by around 8 % a year. The main sub-sectors deal with waste management (30 %), water supply (21%), wastewater management (13 %) and recycled materials (13 %). The sector directly employs 3.4 million people, around 1.5 % of all Europeans in employment. Around 600 000 additional jobs were created between 2004 and 2008. The annual growth rate in employment in all subsectors between 2000 and 2008 was roughly 7%.

In fact, in 2008 the eco-industry sector was estimated to employ 3.4 million people in Europe, by using methods which rely on environmental protection expenditure data (Ecorys 2009).

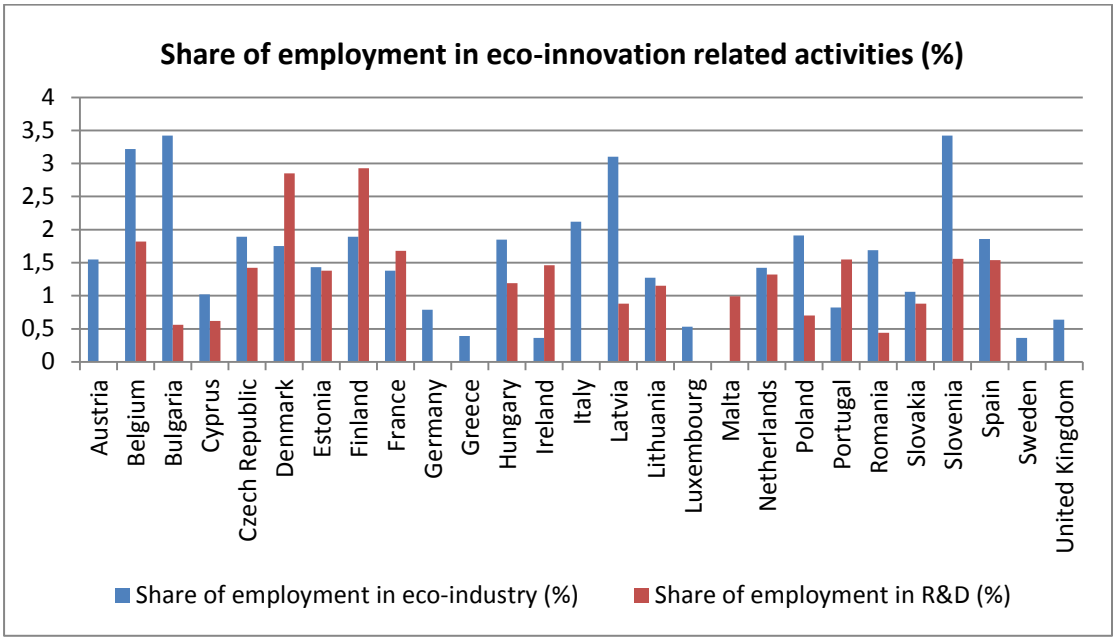



**Figure 1** Share of Employment in eco-innovation related activities (% of total workforce) in 2008. *Data source for eco-industry employment: Eco-innovation Observatory; Data origin for eco-industry employment: N.A. – Data source for R&D employment: Eco-innovation Observatory; Data origin for R&D employment: Eurostat (rd_p_perslf)*

Along these lines, government investments in eco-innovation related research, that is to say, environment and energy research and development funds[2] increased by 50% over the 2004 and 2008 period for the EU, raising from 0.02% of GDP up to 0.03%. However, this increase was not homogeneously distributed among European countries. In fact, in some countries such as France, Norway, Sweden, The Netherland, Hungary and Lithuania, these

[2] Government Budget Appropriations or Outlays on R&D (GBAORD) data are measuring government support to R&D activities in specific R&D areas. GBAORD data are built up using the guidelines laid out in the standard practice for surveys of research and experimental development by the OECD (Frascati Manual, 2002).

investments decreased. The case of Hungary is outstanding because it has evolved from being the country investing most in environment and energy R&D in 2004 (0.09%, when the EU27 average was 0.02%) to being one of the countries investing less in 2011 (0.01%, below the EU27 average). Apart from Hungary, over the 2007-2011 period, other countries, which had previously increased energy and environment R&D investments, such as Spain and Ireland, cut their funding to pre-crisis levels. In fact, the EU27 investment remained stable between 2007 and 2011.

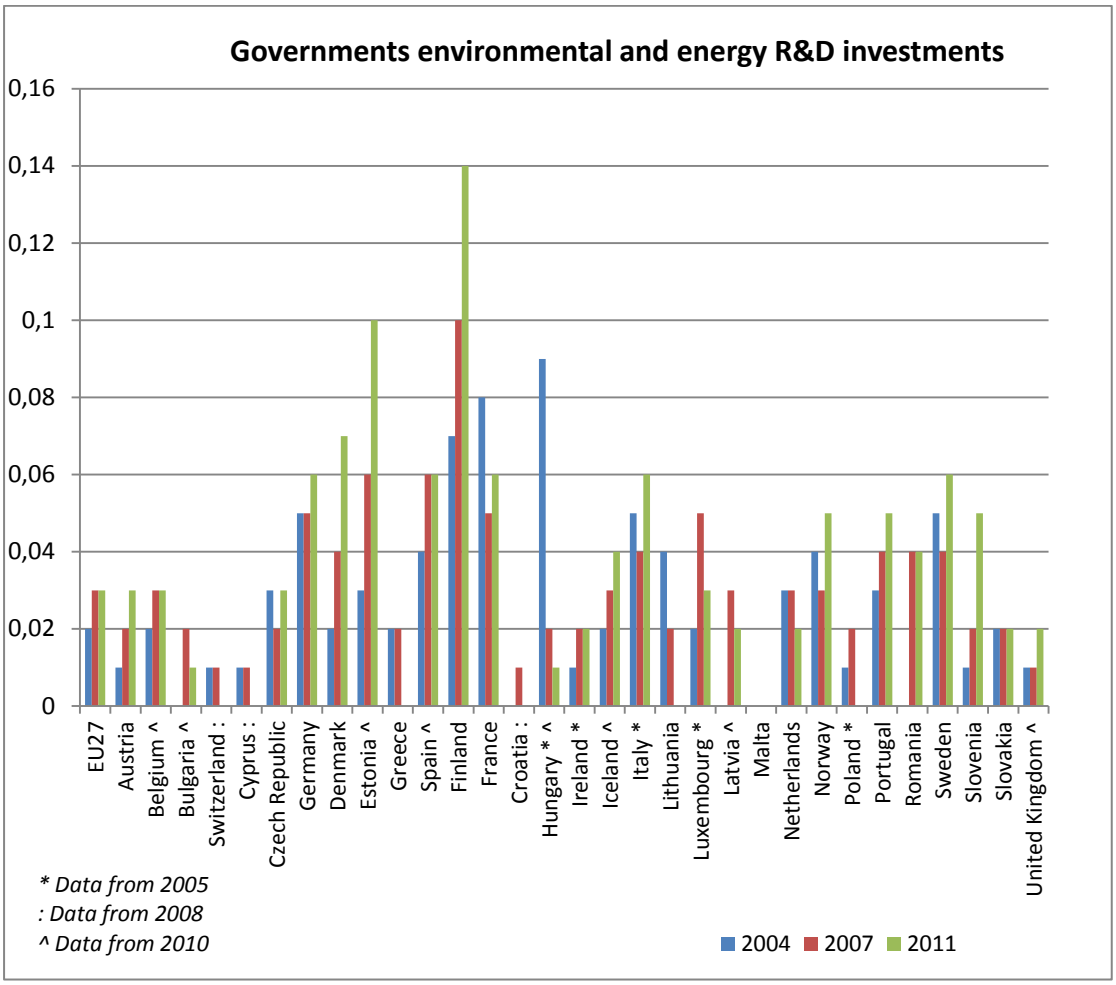
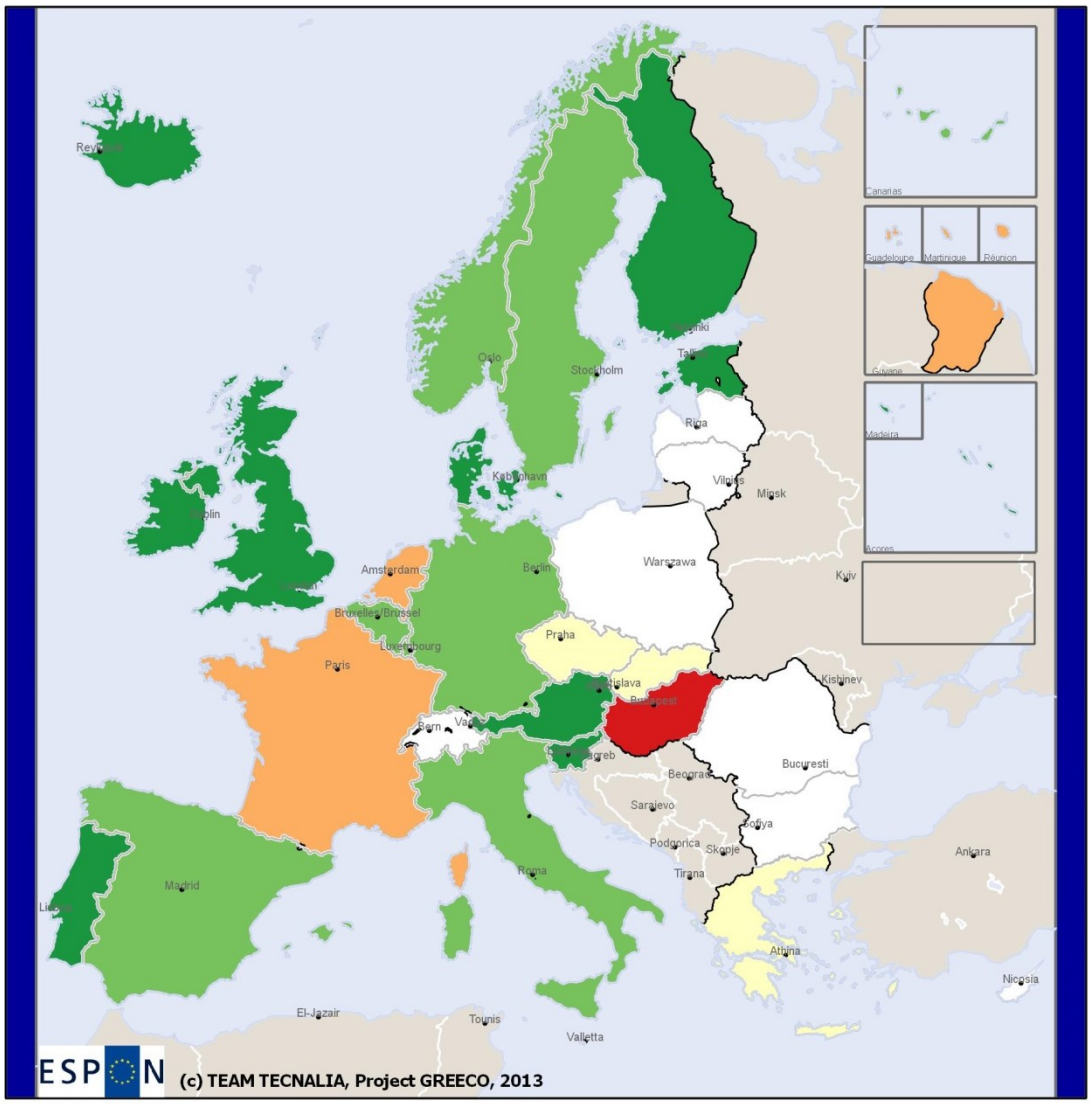



**Figure 2** Governments environmental and energy R&D appropriations and outlays (% of GDP). *Data source: Eco-innovation Observatory; Data origin: Eurostat (gba_nabsfin07)*




**Map 1** Governments environmental and energy R&D appropriations and outlays (% of GDP). Percentage of change between 2004 and 2011 (*Source: Eco-Innovation Observatory).*

Even if the availability of national funds has decreased in the context of the economic crisis, the EU support for eco-innovation has not decreased. Recently, the European Commission has set up a Smart Specialization Platform to provide advice to EU Member States and regions for the design of their innovation strategies for smart specialization and many regions have already registered. Moreover, customer demand for eco-innovative products and services (i.e. green and sustainable) is foreseen to speed up in the coming years. The current global market, has been estimated at €1.15 trillion a year and the expectations are it could almost double with the average estimate for 2020 being around €2 trillion a year (Ecorys 2012).


**Figure 3** Regions registered in the S3 platform. *Source: Smart Specialization Platform*

However, the support given by Regional Policy to research and innovation does not have an exact correspondence with their interest in innovation, i.e. Smart Specialization. This support tends to be larger in more advanced regions reinforcing a virtuous circle of innovation-driven growth, as shown in the map below.

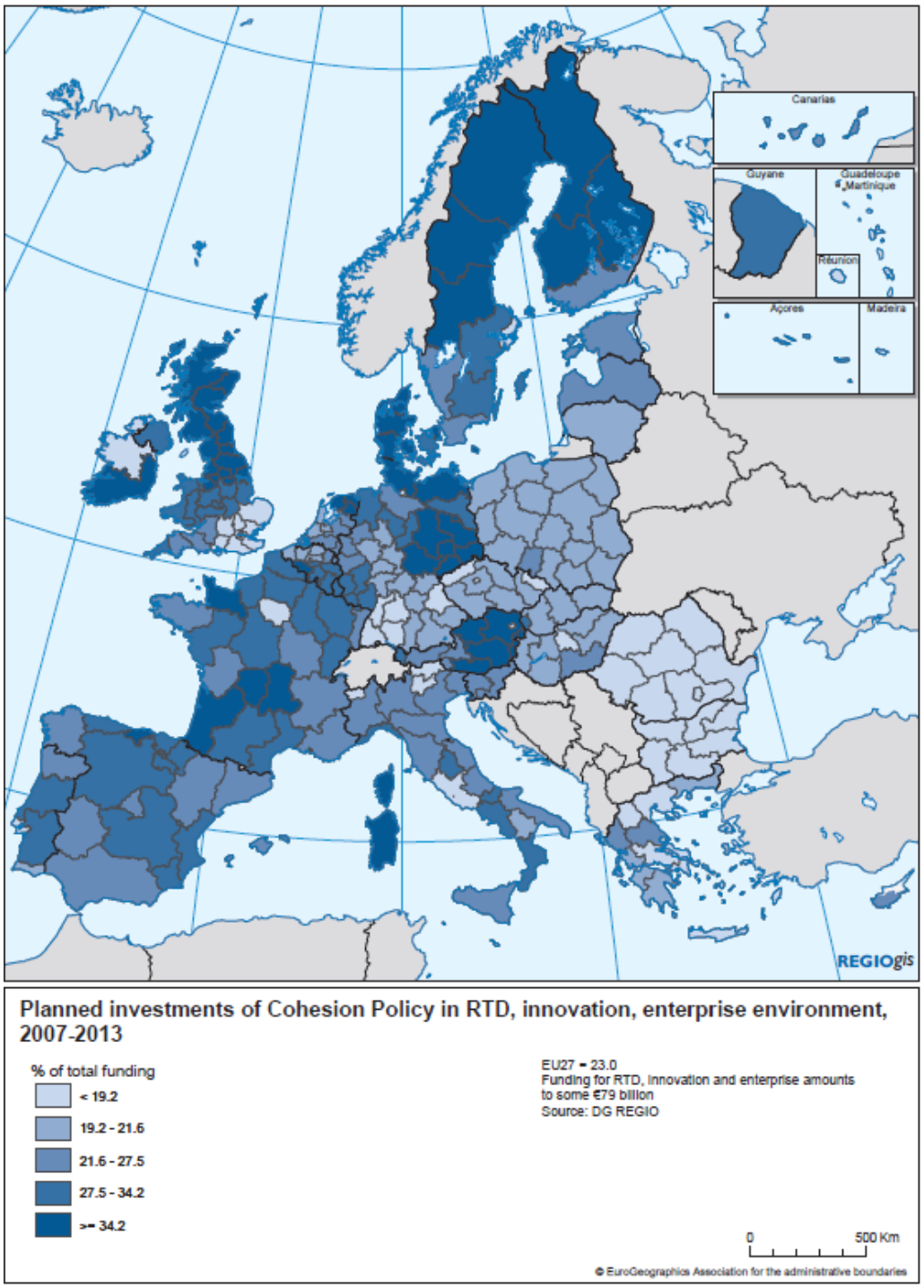
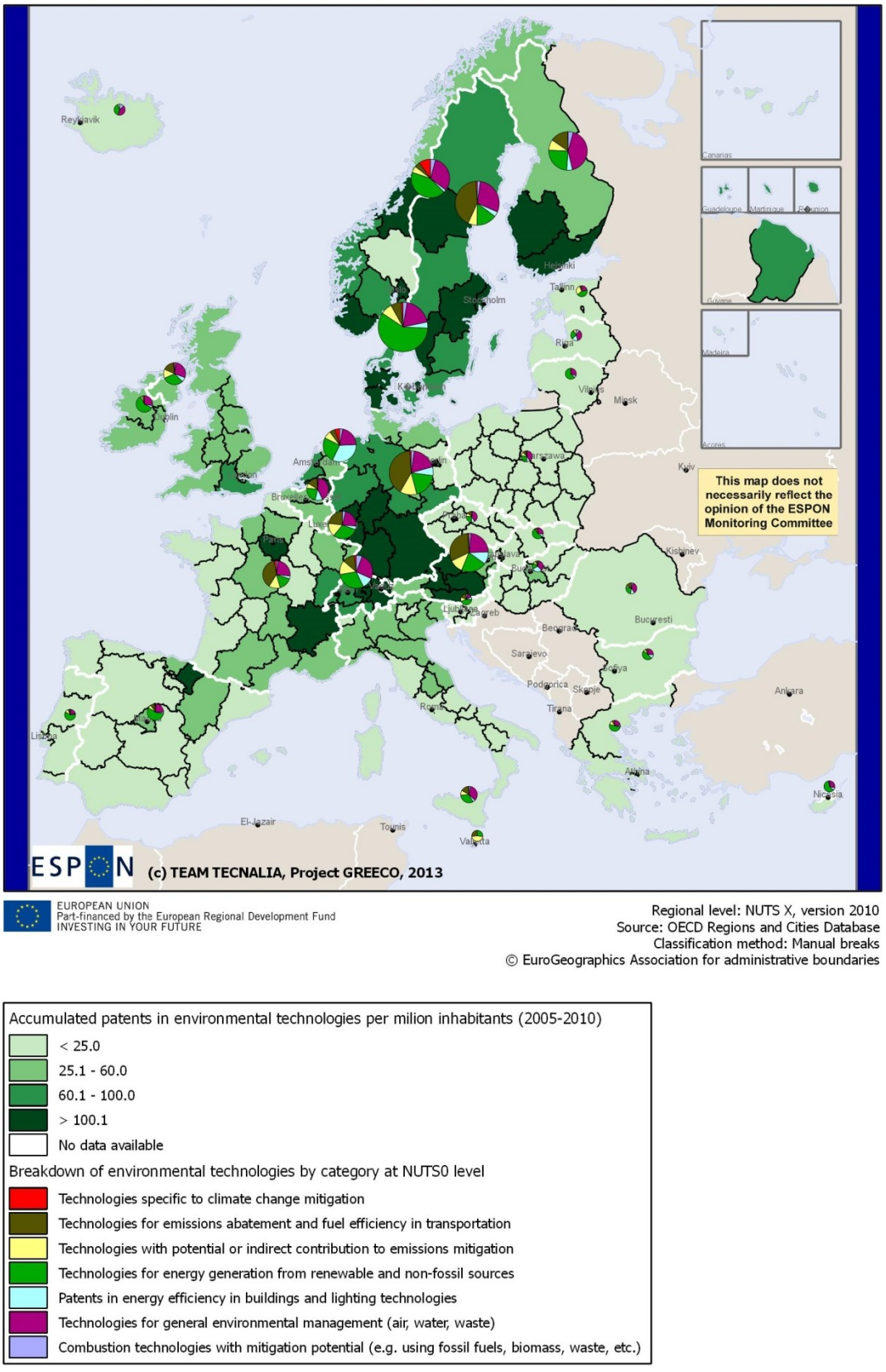



**Figure 4** Planned investment of Cohesion Policy in RTD, innovation, enterprise environment 2007-2013. *Source: European Commission (EC) (2010a)*

When it comes to the patents in environmental technologies[3], which are a relevant output of eco-innovation, the regional pattern is different to that of the support given by Regional Policy to research and innovation (see figure above and map below). Apparently, environmental technology related research, does not have a direct correlation with the support given to general research and innovation. In such a context, there are regions which have a medium-low support to general research and innovation (such as Andalusia and Catalonia in Spain)

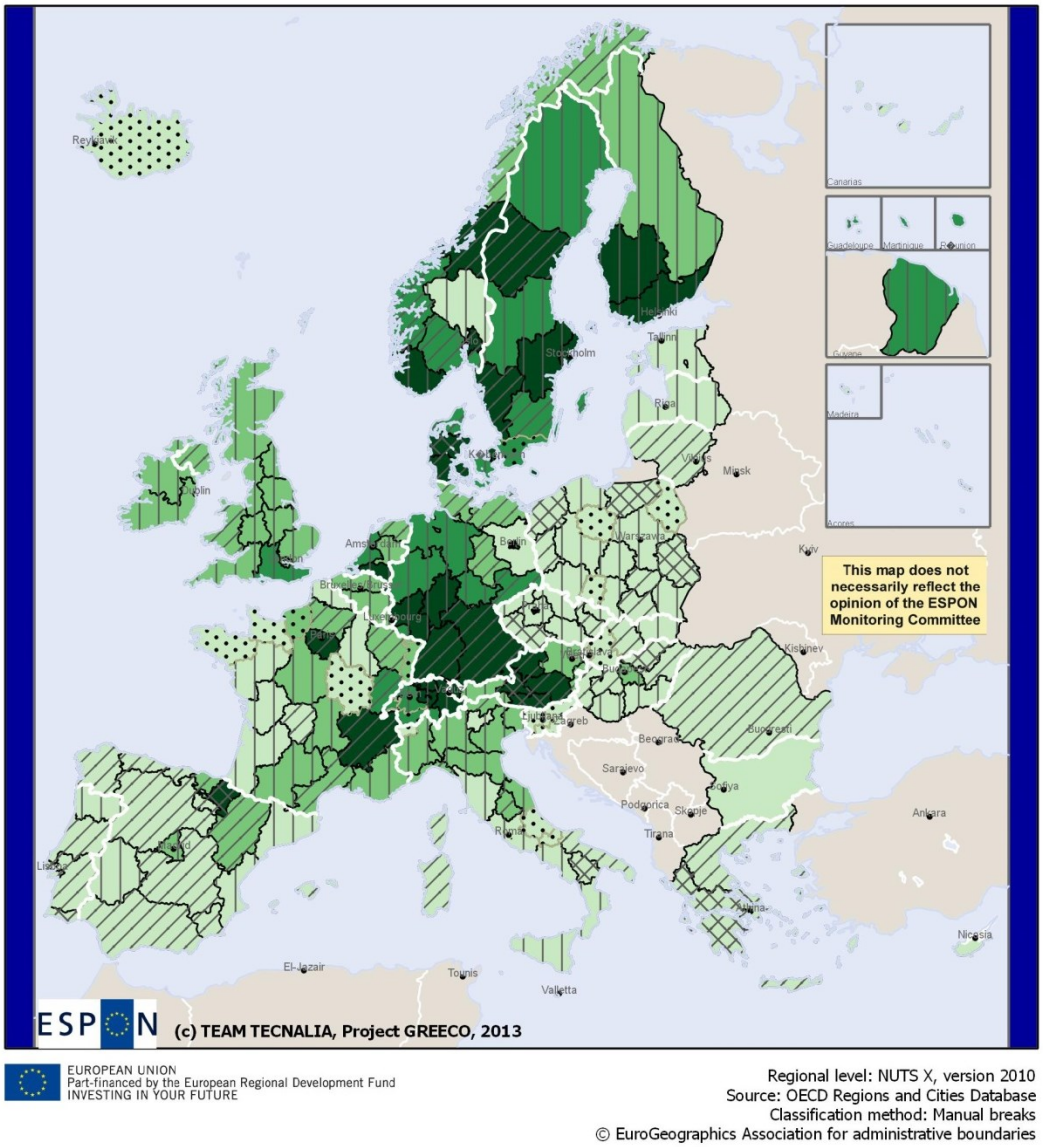
[3] Environmental technologies comprising "*all technologies whose use is less environmentally harmful than relevant alternatives*". This definition is based on the definition given in Chapter 34 of Agenda 21 for environmentally sound technologies.

with a higher than expected number of patents in environmental technologies, while regions with a higher support to general research and innovation (such as Irish and British regions) have a lower number of patents in environmental technologies.




**Map 2** Accumulated patents in selected environmental technologies per million inhabitants at various territorial levels (2005-2010). *Source: OECD*

The reason behind this fact could be that in the regions with medium-low support to general research and innovation (such as Andalusia and Catalonia in Spain) but a higher than expected number of patents in environmental technologies, the share of patents in environmental technologies as a percentage of total patents in the region is higher than in those regions with a higher support to general research and innovation but a lower number of patents in environmental technologies (see Map 3, below).




**Map 3** Accumulated patents in selected environmental technologies and their share as a percentage of total patents (2005-2010). *Source: OECD*

Hence, measurement and monitoring of eco-innovation or green research is not an easy task. First, eco-innovation as such does not have a straight forward correlation with NACE Rev. 2 codes. There are certain NACE codes which can be considered green or environmental, the environmental goods and services sector (EGSS). But the EGSS scope is rather narrow in terms of eco-innovation and green research. On the one hand, being green or environmental does not imply that there is an innovation or research component involved. On the other hand, EGSS only focus on production side activities dealing with either environmental protection (goods and services of either a preventive or remedial nature such as reducing emissions, reducing environmental risk or clearing up environmental damage) or resources management (protection activities of natural resources, for example activities for biodiversity and landscape protection). Therefore, EGSS do not capture all activities included under the umbrella of the eco-innovation definition put forward by the Eco-AP.

Furthermore, according to Conte (2010), an identification of "green" or "environmentally-friendly" data on R&D and innovation faces analytical and empirical shortcomings. First, there is no clear methodology helping us to define the concept of "green" R&D, that is, the extent to which the R&D activities in different sectors set the environmental-related objectives as their main priorities. On the other hand, there is a lack of comparable cross-country data on investments in environmental friendly technologies.

Against this backdrop, the table below summarizes the most remarkable assessments in the EU with regard to both innovation and eco-innovation and at different territorial levels.

**Table 3** Overview of European innovation related assessments.

| | Focus | Territorial scale | Characteristics |
|---|---|---|---|
| Innovation Union Scoreboard (IUS) | Innovation | National | Most recent assessment: 2011<br>3 dimensions (24 indicators):<br>1- Enablers: Human resources, open, excellent and attractive research systems and finance and support);<br>2- Firm activities: Firm investments, Linkages & entrepreneurship and Intellectual assets);<br>3- Outputs: innovators and economic effects |
| Regional Innovation Scoreboard (RIS) | Innovation | Regional | Most recent assessment: 2012<br>Same dimensions as IUS. It uses as many IUS indicators as possible, depending on availability at the regional level (12 in total). |
| European Eco-innovation Scoreboard (Eco-IS) | Eco-innovation | National | Most recent assessment: 2012<br>5 pillars (16 indicators):<br>1- Eco-innovation inputs,<br>2- Eco-innovation activities,<br>3- Eco-innovation outputs,<br>4- Environmental outcomes,<br>5- Socioeconomic outcomes |
| KIT - Knowledge, Innovation, Territory | Innovation | Regional | Rather than a regional innovation scoreboard as such, KIT aimed at identifying territorial patterns of innovation. In doing so it identified 5 regional typologies:<br>1- European science-based pattern<br>2- Applied science pattern<br>3- Smart technological application pattern<br>4- Smart and creative diversification pattern<br>5- Imitative innovation pattern |
| Regional Competitiveness Index (RCI) | Competitiveness | Regional | It analyses competitiveness, taking into account physical and social infrastructure, the skills of the work force and the efficiency and fairness of the institutions retain, with a |

| | | | |
|---|---|---|---|
| | | | focus on economic performance. It has 11 pillars, one of which is innovation. |

When it comes to the current report, the most relevant are:

- RIS: it is a regional innovation scoreboard;
- EIS: even if national, it is an eco-innovation specific scoreboard ;
- KIT: it provides a unique insight into territorial patterns of innovation, beyond scoreboard.

## 2.1 Regional Innovation Scoreboard (RIS)

The Regional Innovation Scoreboard (RIS)[4] provides a picture of innovation performance across EU, Croatia, Norway and Switzerland regions at NUTS 2 level. The methodology applied, replicates the methodology used in the Innovation Union Scoreboard (IUS). This methodology, considers three research dimensions:

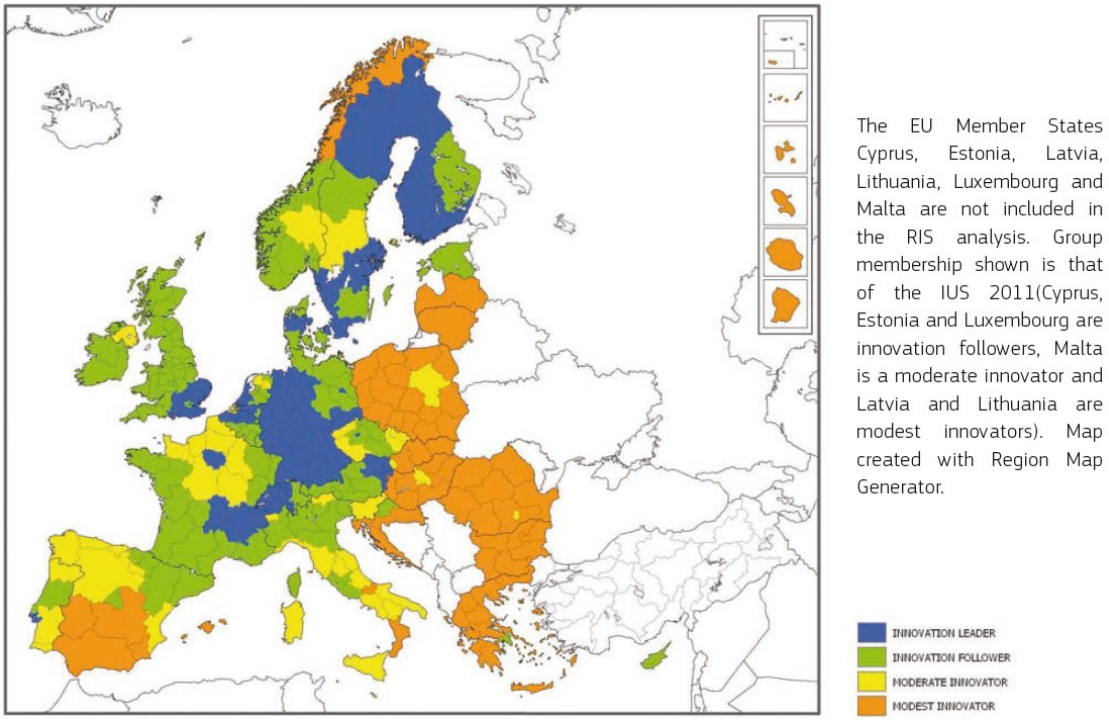
- Enablers capture the main drivers of innovation performance external to the firm and it differentiates between:
  - ”Human resources” measures the availability of a high-skilled and educated workforce.
  - ”Open, excellent and attractive research systems” measures the international competitiveness of the science base.
  - ”Finance and support” measures the availability of finance for innovation projects and the support of governments for research and innovation activities.
- Firm activities capture the innovation efforts at the level of the firm and it differentiates between:
  - ”Firm investments” both R&D and non-R&D investments that firms make in order to generate innovations.
  - ”Linkages & entrepreneurship” measures entrepreneurial efforts and collaboration efforts among innovating firms and also with the public sector.
  - ”Intellectual assets” captures different forms of Intellectual Property Rights (IPR) generated as a throughput in the innovation process.
- Outputs capture the effects of firms’ innovation activities and it differentiates between:
  - ”Innovators” measures the number of firms that have introduced innovations onto the market or within their organisations, covering both technological and non-technological innovations and the presence of high-growth firms.
  - ”Economic effects” captures the economic success of innovation in employment, exports and sales due to innovation activities.

However, data availability at regional level is less than at national level. For this reason, RIS only takes account of 12 of the 24 indicators used in IUS.

The RIS assessment, ranks regions in four groups according to regional innovation performance:

- Innovation leaders
- Innovation followers
- Moderate innovators
- Modest innovators

[4] http://ec.europa.eu/enterprise/policies/innovation/policy/regional-innovation/index_en.htm

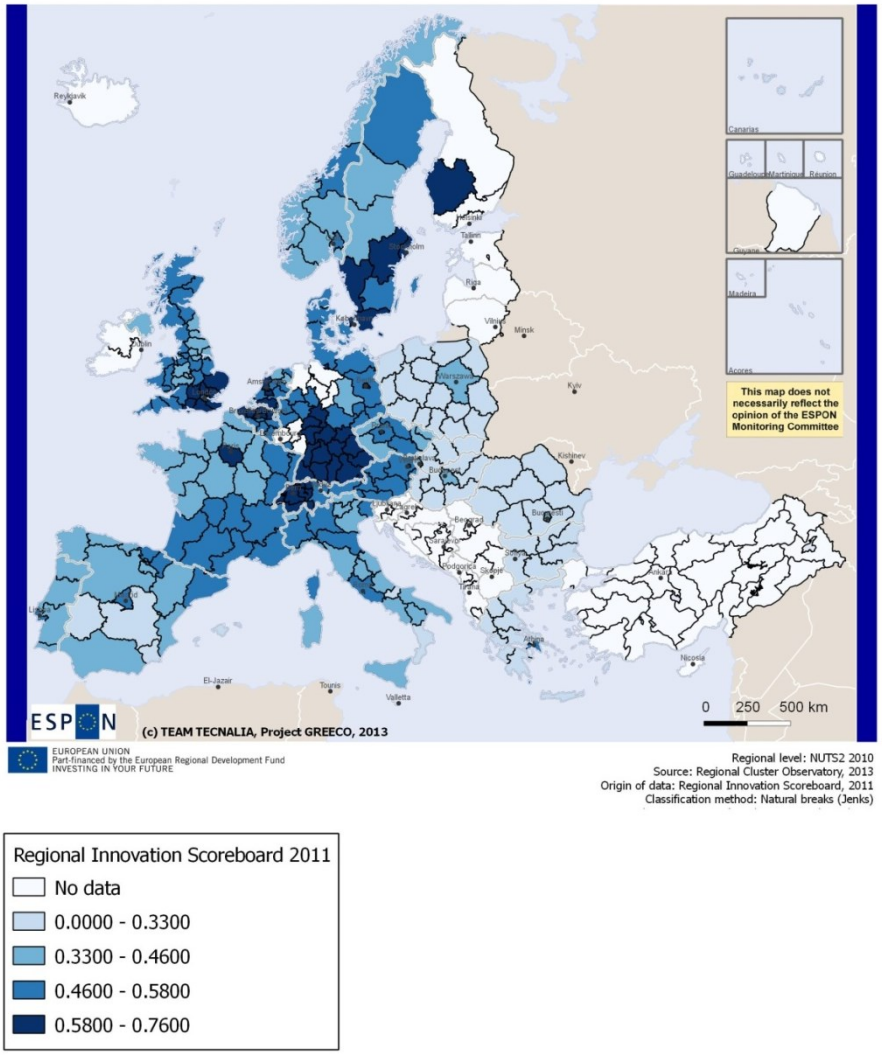



**Map 4** Regional Innovation Scoreboard. (*Source: RIS 2012*)

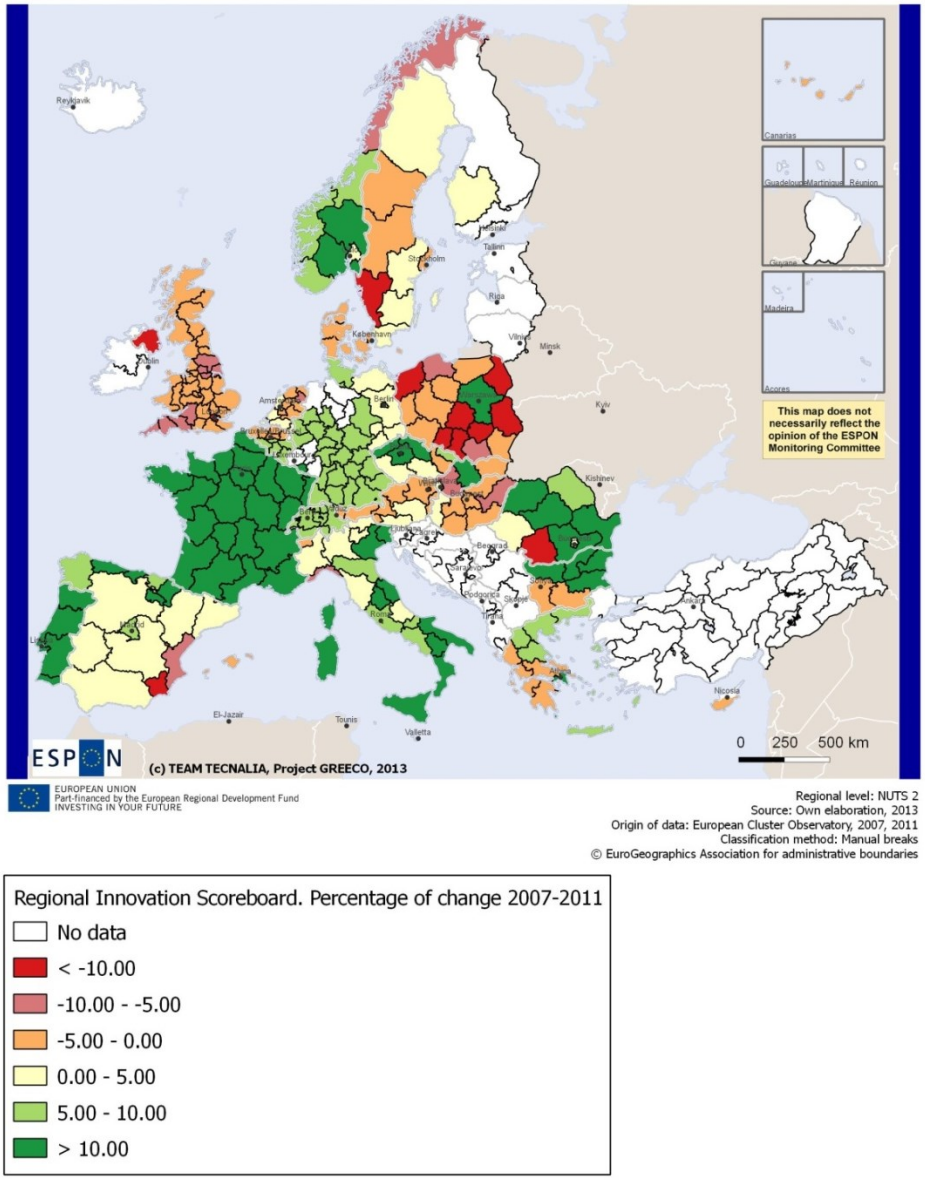
Most of the top regional performers are located in country leaders and followers, as identified by IUS, that is to say, Austria, Belgium, Denmark, France, Germany, Finland, Ireland, Netherlands, Sweden, Switzerland and UK. On the contrary, most of the moderate and modest innovators are in Eastern and Southern Europe. However, it should be noted that innovation followers are also observed in countries which are predominantly low performers, e.g. Czech Republic, Italy, and Spain. All in all, most countries have regions at different levels of performance, which underlines the need of regional, tailored policies to foster innovation.

The below map, displays the calculations made by the European Cluster Observatory5 for the Regional Innovation Scoreboard in 2011, which are clearly coherent to the RIS 2012 results. Since the RIS 2012 datasets have not been made available yet and the European Cluster Observatory has made the Regional Innovation Scoreboard calculations for the 2007-2011 period, GREECO will be making use of those data to analyze the evolution of regional innovation performance.

[5] http://www.clusterobservatory.eu/index.html




**Map 5** Regional Innovation Scoreboard. (*Source: European Cluster Observatory, RIS 2011*)




**Map 6** Regional Innovation Scoreboard. Percentage of change in performance between 2007 and 2011. (*Source: European Cluster Observatory, RIS 2011 and RIS 2007*)

It is remarkable that while top performers are located in Austria, Belgium and Denmark, among others, if we focus on the change in performance, regions in these countries are, either reaching a performance limit (percentage of improvement below 5%) in some cases, or slowing down, the case of UK being especially remarkable. However, it is encouraging that all French and Portuguese regions are speeding up in innovation performance. In the case of Spain, there is a clear differentiation between northern regions and others, especially Mediterranean regions, the latter lagging behind. With the exemption of France and Germany, for most countries the change in innovation performance differs widely within countries. Therefore, local conditions influence the deployment and implementation of innovative practices and culture.

Finally, it is also worth highlighting that most innovation leaders and high performing followers have a balanced performance across the three dimensions (Enablers, Firm Activities, Outputs). Along these lines, the place based policies, should be oriented towards achieving a balanced performance. In some regions, enablers' factors should be reinforced (skilled and educated workforce, competitiveness, finance and support measures, etc.), in others output's factors should be enhanced. For instance, by setting measures which facilitate market penetration of innovative products or services.

## 2.2 Eco-innovation scoreboard (Eco-IS)

The Eco-Innovation Scoreboard (Eco-IS) is developed by the Eco-Innovation Observatory (EIO), which is an EU funded platform aimed at collecting and analysing eco-innovation information, across the EU.

The Eco-IS is the first and only tool to evaluate and show eco-innovation performance across the 27 EU Member States (NUTS 0) in a systematic way. Eco-IS via its composite Eco-innovation index demonstrates the eco-innovation performance of a country compared with the EU average and with the EU top performers. The methodology applied considers five research dimensions and 16 indicators from 8 different sources:

- Eco-innovation inputs
- Eco-innovation activities
- Eco-innovation output
- Environmental outcomes
- Socio-economic outcomes

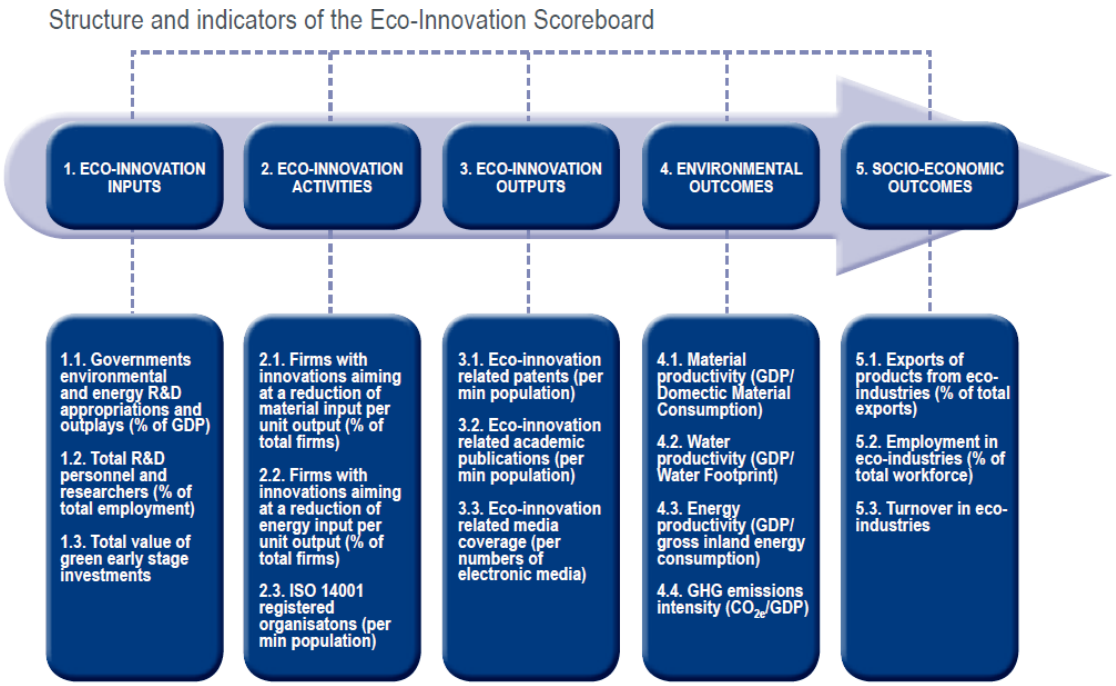



**Figure 5** Eco-innovation Scoreboard 2012: dimensions. *Source: EIO 2013*

Leaving aside fact that RIS is innovation oriented with a regional focus and Eco-IS is eco-innovation specific with a national focus, it is worth noticing that conceptually 3 of the 5 Eco-IS dimensions, coincide with the RIS (and IUS) research dimensions:

| **RIS** | | **Eco-IS** |
|---|---|---|
| Enablers | ⟷ | Eco-innovation inputs |
| Firm activities | ⟷ | Eco-innovation activities |
| Outputs | ⟷ | Eco-innovation outputs |
| | | Environmental outcomes |
| | | Socio-economic outcomes |

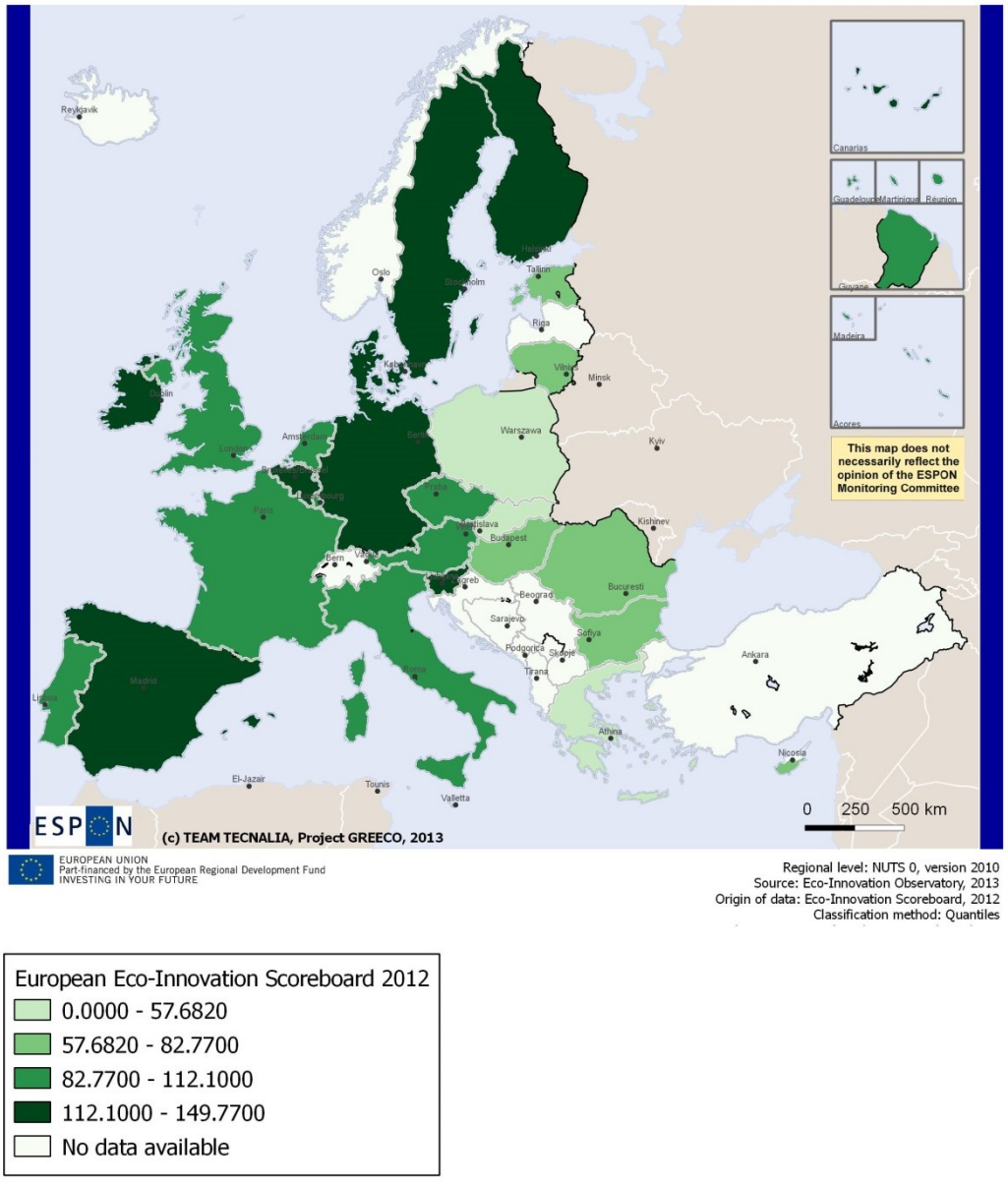
Therefore, both show very similar country rankings. That is to say, it could be derived that barriers and drivers for innovation and eco-innovation are quite similar.

As displayed above, the Eco-IS captures different aspects of eco-innovation in order to provide a holistic view of economic, environmental and social performance and hence,

identify strengths and weakness of EU countries. The aim is to compare relative performance of Member States in key areas (dimensions) related to eco-innovation, including investments, company performance and economic and environmental outcomes.

The Eco-IS understands eco-innovation as a tool to deliver sustainable development by resource efficiency, that is why most eco-innovation activities and environmental outcomes are resource-related. In addition, the EIO characterises the green economy as an economic system that prospers within the boundaries of sustainable resource extraction and use.

Moreover, it is remarkable that the Eco-IS gives a prominent position to environmental and socio-economic dimension, both green economy spheres within GREECO. In addition, the territorial sphere does not have a dimension of its own, but the EIO analyses territorial diversity and its relation with eco-innovation performance. For instance, the EIO has identified that top eco-innovation performers, tend to have high environmental pressures per capita and are not achieving reduction targets yet. This could suggest that territories invest more or less in eco-innovation depending on their environmental status. With regard to achieving reduction targets, this could be caused because of the time lag between eco-innovation developments, deployment and subsequent impact.




**Map 7** Eco-IS: Overall Eco-innovation Performance in 2012. (*Source: Eco-IS 2012).*

The Eco-IS ranks regions in four groups according to national overall eco-innovation performance:

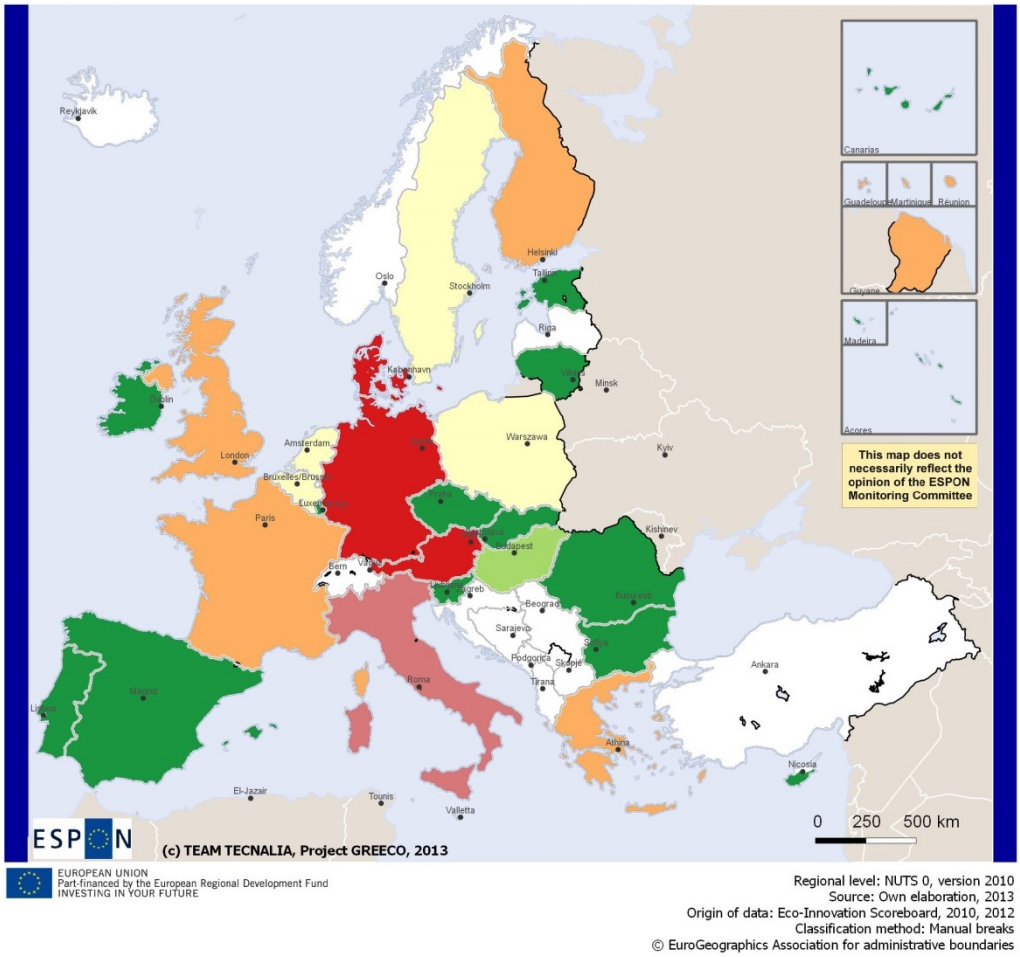
- EU Leaders
- Good EI achievers
- Average EI Performers
- Countries catching up in EI

It is remarkable that the countries comprising each of the group have remained stable since the previous Eco-IS version. However, positions within the group have changed in some cases, for instance:

- *Better performance*: Bulgaria and Romania due to improved performance in the indicators of eco-innovation outputs (eco-innovation related media coverage) and eco-innovation activities (ISO 14001 registered organisations).
- *Performance dropped*: Latvia, Malta and Hungary because of the performance decrease regarding eco-innovation inputs (governments R&D appropriations and outlays) and environmental outcomes (e.g. water and energy productivity). In addition, Luxemburg and Austria also dropped positions due to changes in eco-innovation outputs and eco-innovation activities.

Along these lines, even if some of the countries, such as Germany, remain as top-performers, they score lower than in previous years (see figure below). With an overall score of 120, Germany's eco-innovation performance is well above EU average (which equals 100). But it has dropped three places and its distance to Finland increases. Nonetheless, caution is required in comparing 2010, 2011, and 2012 indices, as the basket of indicators in the 2011 scoreboards has been modified. While bearing the limitations of such comparisons in mind, it is striking that four of the five EU countries which have undergone the bailout process, have increased their eco-innovation performance between 2010 and 2012. Even if a more thorough research would needed to confirm it, a preliminary hypothesis could be that these countries are favouring green employment. E.g. in Spain the Law on Sustainable Economy entered into force in 2011, and the Empleaverde Programme (Green Employment Programme) was launched in 2007 by the Biodiversity Foundation[6], among other measures. The Empleaverde Programme aims at stimulating the generation of green jobs and the transformation of traditional jobs into green jobs.

[6] The Biodiversity Foundation is a public foundation under the Ministry of Agriculture, Food and Environment.




**Map 8** Eco-IS: Percentage of change in Eco-innovation Performance between 2010 and 2012. (*Source: Eco-IS 2012).*

## 2.3 Territorial patterns of Eco-innovation

The current section is devoted to analyse what is the territorial scattering of green research and (eco)innovation across the European regions and to try to shed some light on the factors behind such scattering.

(Eco)innovation is especially relevant for Europe, which is a developed economy and as such has moved very close to the technology frontier and needs to be innovative in order to maintain competitive advantage. This requires relationships between firms, science infrastructure, producers and users, inter-firms and last but not least between firms and the wider institutional environment. Furthermore, such mechanisms are strongly influenced by spatial proximity. That is to say, the level of innovative capability of a region influences directly the ways in which technology is diffused within the region. Moreover, research has shown that knowledge production tends to be geographically concentrated. (Annoni et al., 2010). Along these lines, the ESPON *KIT - Knowledge, Innovation, Territory* project has empirically identified five differentiated territorial patterns of innovation, namely:

**Table 4** Territorial patterns of innovation in Europe (*Source: KIT Final Report*)

| Pattern | Description | Geographical distribution |
|---|---|---|
| European science-based pattern | *Characteristics*: Strong knowledge and innovation producing regions, specialized in general purpose technology, with a high generality and originality of science-based local knowledge, and a high R&D endowment.<br>*Regional preconditions*: high level of scientific human capital (i.e. share of inventors on population), highly educated human capital (i.e. share of population holding a tertiary degree), high accessibility and high receptivity (i.e. the capacity of the region to interpret and use external knowledge) | Mostly located in Germany, with the addition of Wien, Brussels, and Syddanmark in Denmark |
| Applied science pattern | *Characteristics*: Strong knowledge producing regions characterized by applied science, with a high degree of knowledge coming from regions with a similar knowledge base. R&D activity is high also in this cluster of regions.<br>*Regional preconditions*: Similarly to regions in the European science-based area, these regions show high level of knowledge creation and acquisition pre-conditions, although to a lesser extent. | Mostly agglomerated and located in central and northern Europe, namely in Austria, Belgium, Luxembourg, France (i.e. Paris), Germany, Ireland (i.e. Dublin) Denmark, Finland and Sweden with some notable exceptions at East such as Praha, Cyprus and Estonia and at South such as Lisboa and Attiki. |
| Smart technological application pattern | *Characteristics*: A high product innovation rate is registered, with a limited degree of local applied science, and a high creativity which allows to translate external basic science and applied science knowledge into innovation. R&D endowment is much lower than in the previous two cases.<br>*Regional preconditions*: not as much concentrated as in the previous two groups, but they show a relevant scientific and highly educated human capital, as well as receptivity, creativity and entrepreneurship. | Mostly agglomerated regions in EU15, such as the northern part of Spain and Madrid, Northern Italy, the French Alpine regions, the Netherlands, Czech Republic, Sweden and the UK |
| Smart and creative diversification pattern | *Characteristics*: Low degree of local applied knowledge, some internal innovation capacity, high degree of local competences, which suggest that the not negligible innovation activities carried out in the area mainly rely upon tacit knowledge embedded into human capital.<br>*Regional preconditions*: Moreover, regions in this area are strongly endowed with characteristics such as creativity and attractiveness that help to absorb knowledge and to adapt it to local innovation needs. | Mainly located in Mediterranean countries (i.e. most of Spanish regions, Central Italy, Greece, Portugal), in agglomerated regions in Slovakia and Poland, a few regions in northern Europe, namely in Finland and the UK. |

| Pattern | Description | Geographical distribution |
|---|---|---|
| Imitative innovation pattern | *Characteristics*: Low knowledge and innovation intensity. *Regional preconditions*: Entrepreneurship, creativity, a high attractiveness and a high innovation potential, can be considered as local pre-conditions enabling the acquisition of external innovation. | Mostly regions in Eastern Europe, such as, Bulgaria and Hungary, Latvia, Malta, several regions in Poland, Romania, and Slovakia, but also in Southern Italy. |

That is to say that innovation tends to be higher in core-regions and systematically lower in lagging regions. The reasons for this are twofold. On the input side, core regions provide greater potential diversity of specialization opportunities and greater potential home market. On the output side, they provide higher level of connectedness. (McCann et al. 2011).

The above, even if the classification differs, coincides with the results of the Regional Innovation Scoreboard (henceforth RIS 2012), which acknowledges that most innovation leaders and followers are found in Austria, Belgium, Denmark, France, Germany, Finland, Ireland, Netherlands, Sweden, Switzerland and UK but also in parts of Czech Republic, Italy, Norway and Spain and in individual regions in Croatia, Greece, Hungary, Poland, Portugal, Romania and Slovakia. With regard to moderate and modest innovators, this would be located mainly in Eastern and Southern Europe.

It is worth noticing that the territorial distribution of innovation coincides with that of econ-innovation (see figure below), which could imply that the pattern, barriers and drivers, for eco-innovation and innovation are similar.

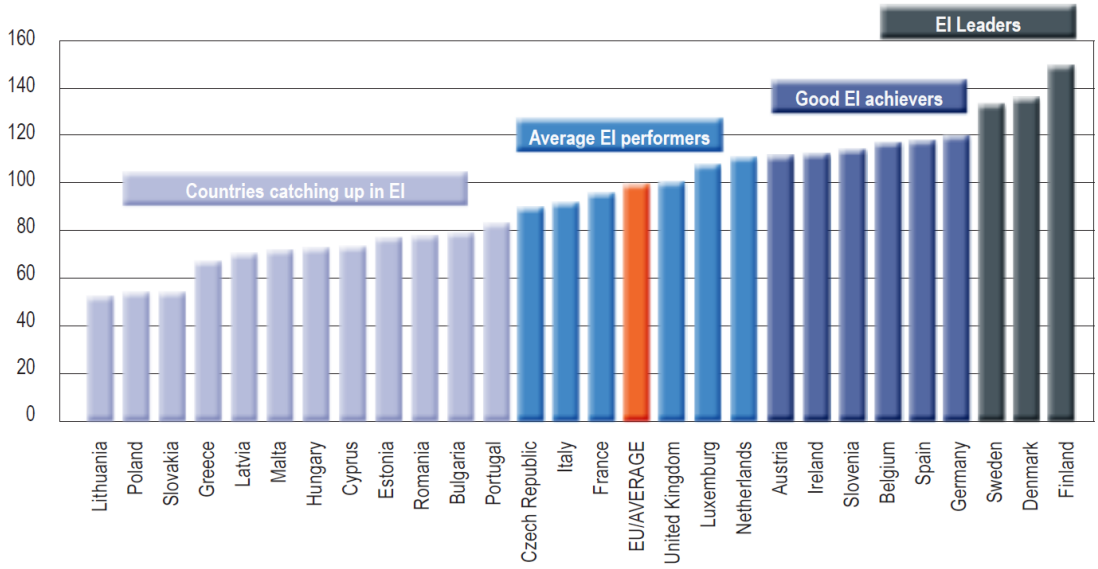



**Figure 6** Eco-innovation Scoreboard 2012: the overall index. *Source: EIO 2013*

However, the countries performing best with regard to eco-innovation as whole are not necessarily the countries achieving higher environmental performance. In fact, there is a moderate correlation between relatively high eco-innovation performance and high levels of both per capita material consumption and GHG emissions. The reason for this could be the time lag between when the eco-innovation and carried out and when the impact is perceived. An additions reason for such an outcome could be the trend to focus on technologies, instead of on increasing resource productivity and on concentrating eco-innovation developments in niches, instead of in wide-spreading such developments. If eco-innovation investments and hence developments where aligned with more structural conditions (i.e. resource

consumption and emissions), the environmental outcomes would most likely be enhanced (EIO 2013).

When it comes to geography, as abovementioned, geographical proximity matters in business performance and in the creation of innovation (e.g. it leads to different types of spillovers, productivity and efficiency, but most importantly knowledge spillovers). In addition, at the regional level, geographical concentrations of linked industries, like clusters, are of increasing importance. In fact, regional clusters could lead to higher competitiveness for firms that are part of them due to the higher innovation rate and availability of specialized resources (Annoni et al., 2010).

Finally, since regions are increasingly becoming important engines of economic development, innovation policy is increasingly designed and implemented at regional level. Nevertheless, for a successful implementation and monitoring of such policies, regional data on innovation indicators are lacking (RIS 2012). It should be noted that eco-innovation strategies on the one hand strengthen regional economies and on the other hand, reduce regions' dependency on non-renewable resources and thus increases resilience (Massard et al. 2012). Even if a number of factors (e.g. taxes, legislation) fall out of the scope of regional stakeholders, regional authorities play a leading role in fostering regional economies through eco-innovation, e.g. through purchasing policies. (EURADA 2009).

# 3 Drivers and enablers for eco-innovation

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One of the most urgent challenges facing the EU and the world is the need for a shift towards a low-carbon and resource efficient economy. Today's key environmental challenges (mega-challenges):

- biodiversity threats;
- climate change and its consequences;
- water pollution and scarcity;
- air pollution;
- resource (including energy) scarcity,

combined with the growing population and the rise of emerging economies lead to a rising competition over natural resources, higher prices and environmental depletion. These represent the greatest challenge for the EU as whole and a great opportunity for eco-innovation. Eco-innovation is closely linked to the way we use our natural resources and to how we produce and consume. For this reason, it is a tool to deliver sustainable growth and reverse the environmental depletion trend, while providing societal and commercial benefits. However, incremental eco-innovations may not be enough to achieve a timely transition to a resource efficient Europe in time. It should be noted that new technologies may play a role beyond displacing established products; but they also enlarge markets and provide new functionality (Utterback and Acee 2005).

The knowledge and innovation capacity of regions depends on many factors – the business culture, work force skills, education and training institutions, innovation support services, technology transfer mechanisms, R&D and ICT infrastructure, the mobility of researchers, business incubators, new sources of finance and the local creative potential. Along these lines, the five predominant drivers for eco-innovation are regulation, demand from users (increasing environmental awareness), capturing new markets (raising competitiveness), cost reduction, and last but not least corporate image. Many authors argue that the next "wave of innovation" will be "green" and concentrate innovation efforts on achieving sustainability, consequently the next decades will be a stress test of the potential of the green economy to exploit synergies of socio-economic and environmental objectives (EIO 2013).

However, eco-innovation has until now penetrated to the markets relatively slowly, with the exception of renewable energy as a result of energy and climate policies. The fundamental drivers and barriers are similar for innovation and eco-innovation, as confirmed by OECD research. However, the barriers tend to be more severe for businesses focusing on eco-innovation (European Commission (EC) 2011b). In addition, the patterns of eco-innovation are also heavily influenced by other factors, notably the environmental policy framework (OECD 2010) and the failure of market prices reflecting environmental costs and benefits (European Commission (EC) 2011b and EIO 2013). The latter, may be addressed by means of strong policy frameworks, market-based instruments (like resource taxes) and the establishment of targets for resource use (EIO 2013).

**Table 5** Constraints on green growth by environmental challenges (OECD 2010)

| Climate Change | Health impacts of pollution |
|---|---|
| • Inadequate infrastructure<br>• Low human and social capital<br>• Incomplete property rights<br>• Subsidies and preferences to incumbents<br>• Negative externalities<br>• Low returns to R&D<br>• Barriers to competition<br>• Norms and habits<br>• Information externalities and split incentives | • Inadequate infrastructure<br>• Low human and social capital<br>• Subsidies and preferences to incumbents<br>• Negative externalities<br>• Low returns to R&D<br>• Barriers to competition<br>• Norms and habits |
| **Biodiversity loss** | **Water scarcity** |
| • Low human and social capital<br>• Incomplete property rights<br>• Subsidies and preferences to incumbents<br>• Negative externalities | • Inadequate infrastructure<br>• Low human and social capital<br>• Incomplete property rights<br>• Subsidies and preferences to incumbents |

The barriers faced by eco-innovation are often intertwined, e.g.: a lack of top management commitment leading to a lack of support of eco-innovation might be caused by various factors: lack of information from the financial department to top management concerning the profitability of environmental technologies implementation (energy efficiency, etc.); lack of confidence in performance of new technologies; lack of awareness of long-term benefits (Ashford, 1993).

It should be noted that the existence and the intensity of barriers differ among sectors (Montalvo et al. 2012) and among countries.

**BOX 4: Barrier disparities within the EU (EIO 2013):**

Financial barriers, are less important in the UK, lack of priority and political will is of greater relevance there. For new Member States, the lack of funds within enterprises are more important than in the old Member States.

Addressing these barriers could be even more challenging in the EU than for countries like the US or Japan because it requires engagement and coordination across 27 Member States.

A number of studies have made evident that eco-innovation plays a clear role in environmental protection and sustainability. Hence, there is an increasing interest from policy-makers in fostering their diffusion, in special because eco-innovations still face a number of market and non-market barriers, which hinder further deployment. Along these lines, factors affecting adoption as a primary condition to diffusion and exploitation of eco-innovation and their likely interrelation, they can derive from many different areas, such as: government policy (e.g. the impact of regulation could be negative if the conditions required to apply certain schemes are not appropriate), economics (e.g. lack of differentiation creates problems with respect to capital access since traditional investment banking protocols do not include eco-innovation definitions and there is a lack of expertise appropriate to evaluate the economic and financial aspects of a cleaner production project efficiency and investment), markets (e.g. unfair market competition of products manufactured with 'cleaner' process vs. similar products manufactured with 'pollutant' processes), communities and social pressure (e.g. when pressure groups demand industry environmental compliance by any mean (e.g. end-of-pipe), and not necessarily via adoption of eco-innovation and smart manufacturing methods), attitudes and social values (e.g. firm managers or investors who do not see the benefits of sustainable entrepreneurship), technological opportunities and technological capabilities and organizational capabilities (e.g. the dominance of 'pollutant' technological paradigms plus the cost of replacing a complete production process in sectors, such as iron and steel, cement, and pulp and paper, is extremely high –therefore, there is little room for change) (Montalvo, 2008).

It should be noted that most of the areas above could be both drivers and barriers to innovation depending on the circumstances, time and context in which they are considered. For instance, Public Policy is one of the major drivers of environmentally responsible behaviour in industry is the intervention of public policy (both command-and-control and voluntary schemes) (Montalvo, 2008). Recent analyses suggest that the different types of innovations (e.g. product, process, organisational, and marketing) are strongly correlated amongst each other and thus, imply that the potential effects of regulation upon final products and services (and the processes producing them) have often an intrinsic indirect character. That is, any potential effect of regulation on any type of innovation is likely to trigger change in the sectors subject to regulation. This is a subject that has not been explored in-depth in the literature of regulation and innovation and deserves further research and analysis (Montalvo et al. 2012).

Against the backdrop of the above statements, the main drivers for eco-innovation may be summarised as follows.

**Table 6** Overview of the main driving forces for eco-innovation.

| Driver / enabling condition | Barrier / challenges | Type |
|---|---|---|
| *Economic and market drivers:*<br>- capturing new markets (and secure existing markets),<br>- cost reduction<br>- Expected future increases in energy prices<br>- Current high energy prices (as an incentive to innovative, to use less energy and decrease the cost)<br>- Current high material prices (as an incentive to innovate to use less material and decrease the cost) Secure or increase existing market share<br>- Expected future material scarcity (as an incentive to develop innovative, less material-intensive substitutes)<br>- Increased market demand for green products<br>- Access to existing subsidies and fiscal incentives<br>- Cost reduction (by resource efficiency), energy costs in especial<br><br>*Cooperation:*<br>- Good business partners<br>- Technological and management capabilities within the enterprise<br>- Good access to external information and knowledge, including technology support services<br>- Knowledge spillovers (enabler, rather than driver): collaboration with research institutes, agencies and universities<br>capturing new markets (and secure existing markets),<br>cost reduction,<br>and image<br><br>*Regulatory drivers*<br>- Comply with existing regulation<br>- Expected future regulations imposing new standards<br>- Environmental Management tools (facilitates identification of hotspots)<br><br>*Improve corporate image* | *Financial barriers:*<br>- Market failures: prices do not reflect environmental costs and thus foster eco-innovation, monopolies, etc.<br>- EHS and harmful subsidies<br>- Lack of funds within companies and insufficient access to existing subsidies and fiscal incentives<br>- Uncertain demand from market, combined with long payback periods<br><br>*Knowledge / technology barriers:*<br>- Lack of qualified personnel and technological capabilities within the enterprise<br>- Limited access to external information and knowledge, including a lack of well-developed technology support services<br>- Lack of collaboration with research institutes and universities<br>- Technical and technological lock-ins (e.g. old technical infrastructures)<br><br>*Governance barriers:*<br>- Existing regulations and structures not providing incentives to eco-innovate<br><br>*Systemic deficiencies - Environment not a priority:*<br>- Reducing energy use is not an innovation priority<br>- Reducing material use is not an innovation priority<br>- Lack of customer awareness, resulting in low demand of eco-innovation | Eco-innovation specific |

| Driver / enabling condition | Barrier / challenges | Type |
|---|---|---|
| *Environmental orientation / awareness*<br><br>*Institutional support / regulatory drivers:*<br>- funding relevant research, supplying finance tailored to differing stages of technology development and using demand-side instruments such as standards, regulations and public procurement<br><br>*Cooperation:*<br>- Network involvement<br>- Public-private cooperation<br>- Motivation and knowledge | *Financial and market barriers:*<br>- Inadequate availability of risk capital<br>- Lack of market demand<br>- Financial (R&D costs, lack of investment, etc.)<br>- Consumer-side (tight product specifications, which could be altered by new technology)<br>- Supply-side (lack of support: advertisement, maintenance, etc.)<br>- Costs of eco-innovation<br>- Barriers to trade and investment --> need to be reduced to facilitate diffusion and market penetration<br>- Market failures: negative externalities, split incentives<br>- Barriers to competition<br>- Low returns to R&D<br>- Lack of clear and stable market signals<br><br>*Knowledge / technological barriers:*<br>- Insufficient research efforts<br>- Technological (current technological constraints, as well as, skepticism)<br>- Labour-force (lack of skills<br><br>*Governance barriers:*<br>- Regulation (uncertain framework, focus on end-of-pipe solutions)<br>- Incomplete property rights, subsidies<br>- Inadequate infrastructure<br><br>*Managerial lack of commitment, reluctancy, lack of experience*<br><br>*Inertia in economic, human and physical systems à leading to low returns* | Eco-innovation field: environmental technologies |
| *Competition, remaining competitive*<br><br>*Regulatory drivers:*<br><br>- Policies and innovation support initiatives should not focus on R&D activities alone. Some very innovative industries rely heavily on technology transfer and the use of new technologies developed in upstream industries.<br><br>*Cooperation:*<br><br>- Knowledge spillovers, which are spatially bounded → tight links between innovation actors (universities, R&D centres, companies): networks, clusters, public-private cooperation, etc.<br>- Interaction among innovation actors** | *The innovation paradox:* the more a region needs innovation to remain competitive, the more difficult it is to invest efficiently:<br>- financial constraints,<br>- human resources and skills,<br>- knowledge creation and diffusion,<br>- cooperation between firms and informal networks,<br>- demand factors,<br>- competition,<br>- innovation culture,<br>- and aspects of regulation and taxes | Innovation as a whole |

*Sources:* Adapted from:

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## 3.1 The role of policy in driving eco-innovation

Due to the aforementioned barriers, public support is needed to foster eco-innovation. Moreover, the main driver for changing traditional production and consumption patterns and pursue an environmentally friendlier development, has been environmental legislation. As such, environmental legislation has been the engine of eco-innovation and for the surge of strong industries in the EU in the fields of water, air pollution, waste management, recycling, and climate change mitigation.

If it was not for environmental legislation, incentives for a resource-efficient economy are scarce. The reason behind is that prices do not reflect the real value of natural resources. Therefore, policy support is needed to adjust the economic and fiscal framework to provide incentives to become more resource efficient (i.e. greener). For instance, instead of value-added taxation, it may be more efficient to tax natural resource's use before goods for final use have been produced, while lowering taxation of labour accordingly.

Along these lines, it is worth highlighting that environmental policy can also direct research and development efforts and set the pace of technological change, e.g. the REACH regulation lists substances of very high concern (SVHC) and chemical companies across the world follow the REACH when developing products which should meet the requirements of EU markets (European Commission (EC) 2011b).

However, a non-flexible regulatory framework may also be counter-productive and create lock-ins and barriers to eco-innovation. Therefore, legislation should be so that it provides incentives and a predictable framework to foster investments.

**BOX 5: Eco-innovation policy across the EU (EIO 2013):**

Most EU countries view eco-innovation as a new and emerging field, but few have addressed the need for a more systemic approach to public support to eco-innovation. Eco-innovation is not yet considered as a strategy for social and economic transformation. So far, the overwhelming focus has been on providing financial support for research on and deployment of environmental technologies, without a more fundamental effort to adapt overall framework conditions and to create a level playing field for eco-innovators. There are very few public initiatives in Europe that explicitly support system eco-innovations.

For the above reasons, the European Commission launched already in 2004 the Environmental Technologies Action Plan (ETAP) and in 2011 the Eco-Innovation Action Plan (Eco-AP), in order to overcome such barriers. Moreover, eco-innovation is also rooted in the EU 2020 strategy, which promotes structural change with a sustainability orientation.

**BOX 6: Policy background of the Eco-AP:**

- Europe 2020 Strategy.
- Europe 2020 Flagship Initiatives:
  - Industrial Policy for a Globalized Era
  - Agenda for New Skills and Jobs
  - A resource-efficient Europe
- Roadmap to a Resource Efficient Europe
- Innovation Union – turning ideas into jobs, green growth and social progress

Since the Eco-AP is a novel policy it is early to assess its impact and efficiency. Nonetheless its potential for enhancing regional cohesion is huge, since the Commission has proposed a strong innovation component within the provisions of the 2014-2020 Cohesion Policy. However, most countries have not implemented a policy framework to support eco-innovation, since it still perceive it as an emerging field (EIO 2013).

Regardless the novelty of the Eco-AP, there are already a number of initiatives promoting eco-innovation and thus the transition to a more sustainable, resource-efficient, greener Europe. In this context, it is worth highlighting the European Innovation Partnerships (EIPs), which are theme / challenge specific and pursue to bring together relevant actors (at EU, national and regional level) and coordinate existing instruments (e.g. investments, strategies) to speed up research outcomes.


**Figure 7** European Innovation Partnerships (EIPs). *Source: http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip*

Of the five active EIPs, three seek enhancing environmental performance and hence have a straight forward link with eco-innovation: Water, Raw Materials and Agricultural Sustainability and Productivity.

In addition, the EU has also put forward the Knowledge and Innovation Communities (KICs), which bring together different actors of the innovation chain, from businesses and research organizations to investment communities and governments. The goal is KICs to become drivers of sustainable economic growth and competitiveness. In fact, two of three KICs designated in 2009 are driven by environmental challenges: Climate KIC (Climate Change) and KIC InnoEnergy (Sustainable Energy).

Against this backdrop, the EU has also provided a financing framework for eco-innovative solutions. As part of the European Economic Recovery Plan, the Commission is launching three Public-Private Partnerships (PPPs). The three PPPs represent a powerful means of boosting research efforts in three large industrial sectors – automotive, construction and

manufacturing – which have been particularly affected by the economic downturn and where innovation can significantly contribute towards a more green and sustainable economy.

In addition, market based instruments (MBIs)[7] are increasingly being considered for environmental protection (one of the three pillars of Sustainable Development, which is the ultimate goal of green economy) where regulatory approaches have had limited success in preventing environmental damage or traditional policy tools have not proofed so efficient. In recent years in Europe, increasing interest has been paid to the market based instruments for resource efficiency.

In this context, market based instruments may be categorised as follows:

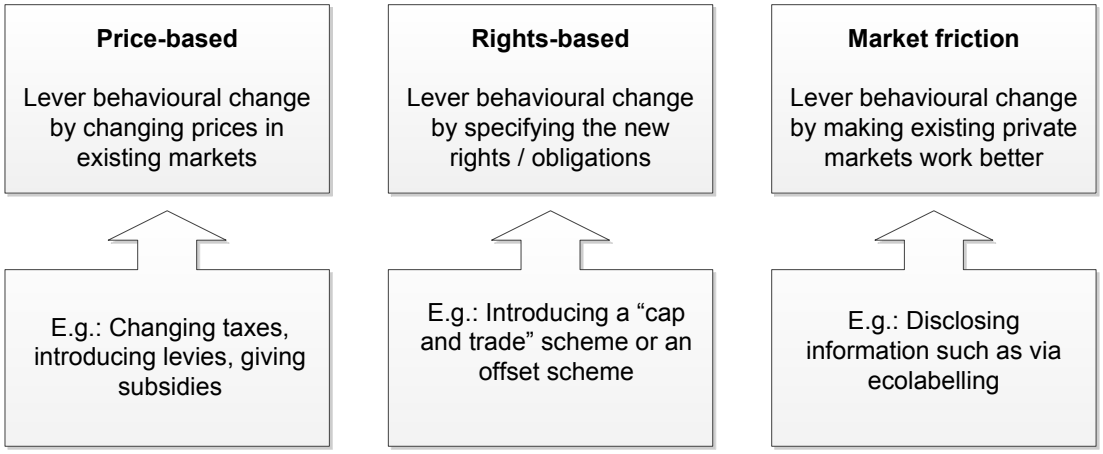



**Figure 8** Typologies of Market Based Instruments. *Source: Whitten et al.*

*Price-based instruments:*

In relation to price-based instruments, environmental taxes saw a decline in the 2000s in Europe, probably partly due to higher international energy prices but also partly due to the emergence of the EU Emisstion Trading System, which would fall under the category of rights-based MBIs (Ekins et al.). The hypothesis is that such a policy instrument could contribute to a greener economy impacting on the three pillars of sustainable development: environmental improvement, the generation of economic activity and employment and the stimulation of green technologies and new environmental industries.

Environmental taxes brought in approximately 290 million of EUR of revenue in 2010. The revenue from these taxes started to decrease in mid-2000s, having a low in 2008, when the economic crisis started. However, total taxes experienced a slight upturn in 2010.

[7] Market based instruments (MBIs) may be defined as .instruments or regulations that encourage behaviour through market signals rather than through explicit directives (Stavins 2000).

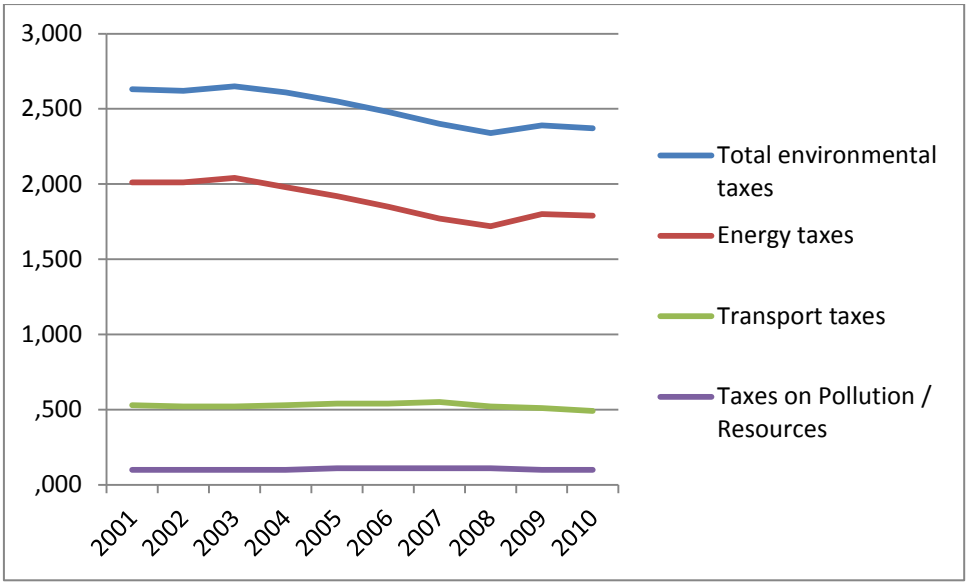



**Figure 9** EU27 Environmental Tax Revenue as a percentage of GDP. *Source:Own elaboration with Eurostat data (ENV_AC_TAX).*

Revenues from environmental taxes in the EU-27, accounted for 2.37% of GDP and for 6.19% of total revenues from taxes and social contributions (TSC) in 2010. It is remarkable that in terms of total tax revenues, the EU is above 2008 level (even if there has been a slight decrease in 2010). On the other hand, in terms of their share in GDP, they have remained approximately stable. This could suggest that these taxes are less volatile than others during a recession. However, this development, measured at the weighted EU average level, hides substantial differences between the Member States. Even in leading countries such as Denmark and the Netherlands, environmental tax revenue growth is not quite keeping pace with GDP growth (Rademaekers et al. 2011).

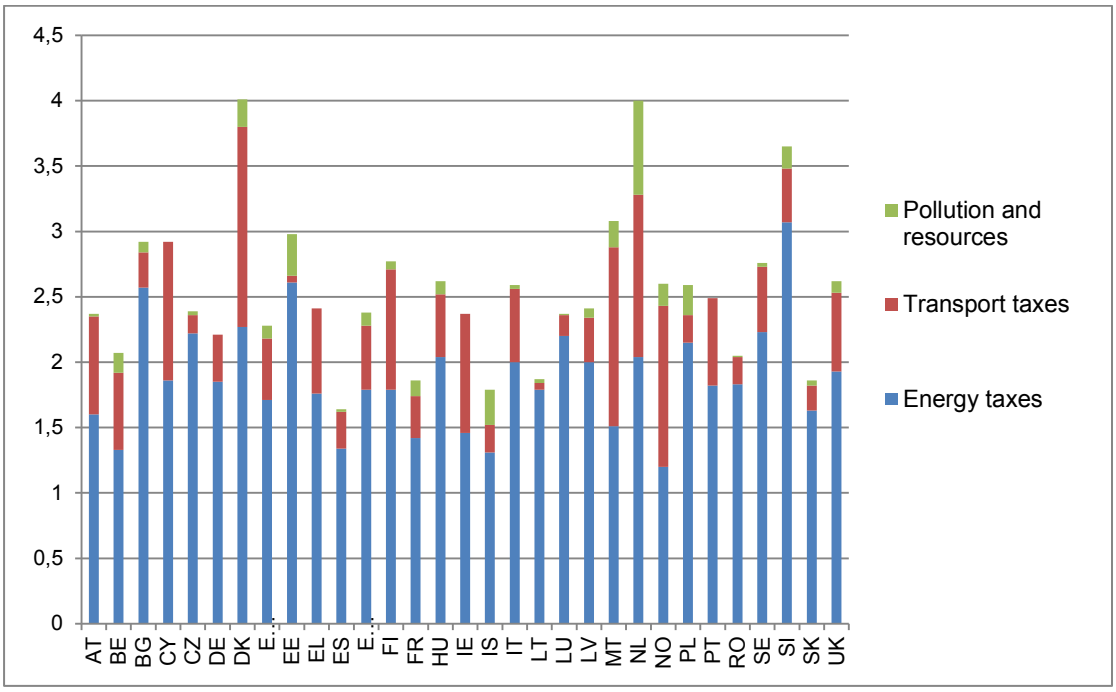



**Figure 10** Environmental Tax Revenue as a percentage of GDP in year 2010. *Source: Own elaboration with Eurostat data.*

In the EU the environmental taxes, which are taken account of, are charged on energy, followed by transport and to a lesser extent pollution and resources. This coincides with the trend in environmental taxing world-wide identified by the OECD. The OECD has also

recognized that the taxes charging the source of pollution would leave a greater range of possibilities for innovation, while it would be more complicated when sources are dispersed and varied (OECD (2010). Taxation, Innovation and the Environment. OECD, Paris).

Subsidies or economic incentives are the other approach of price-based economic instruments, since they intend to foster certain type of behaviour. Along these lines, in the context of the global economic crisis, several governments have included subsidies for greening industry and cleaner technologies. In 2008 the EU launched the European Economic Recovery Plan, which identified an important number of green initiatives with a focus on energy-saving and climate-change related measures. This plan also foresaw providing incentives for the construction and auto industries to develop greener cars and energy-efficient buildings. The non-paper developed by DG ENV in the context of the above plan, provided an analytical overview of "green" efforts in Member States. The “green stimulus” provided by individual Member States is mostly focused on energy efficiency, renewable energy and greening transport.

Moreover, in 1992 the European Community launched a voluntary environmental scheme to enhance consumer trust, the EU Ecolabel. This label is a third party verification which certifies the environmental performance of a product or services. In other words, it certifies the environmental benefits of the product or service in relation to the rest of products or services in its category (best-in-class). In a context of increasing environmental awareness, these labels, potentially, provide competitive advantage to eco-innovative products and services (with better environmental performance than others in its category).

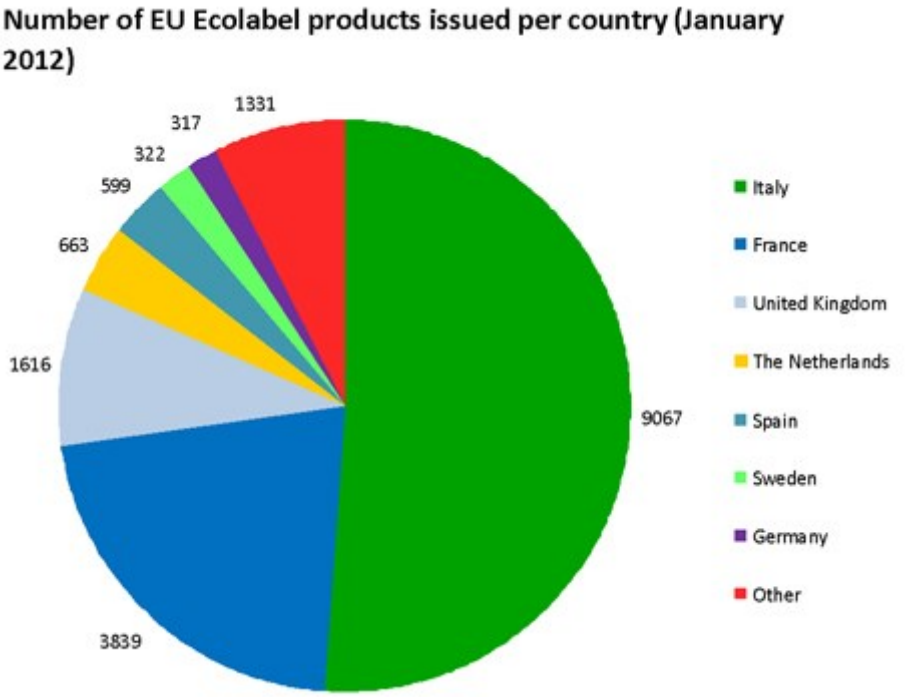
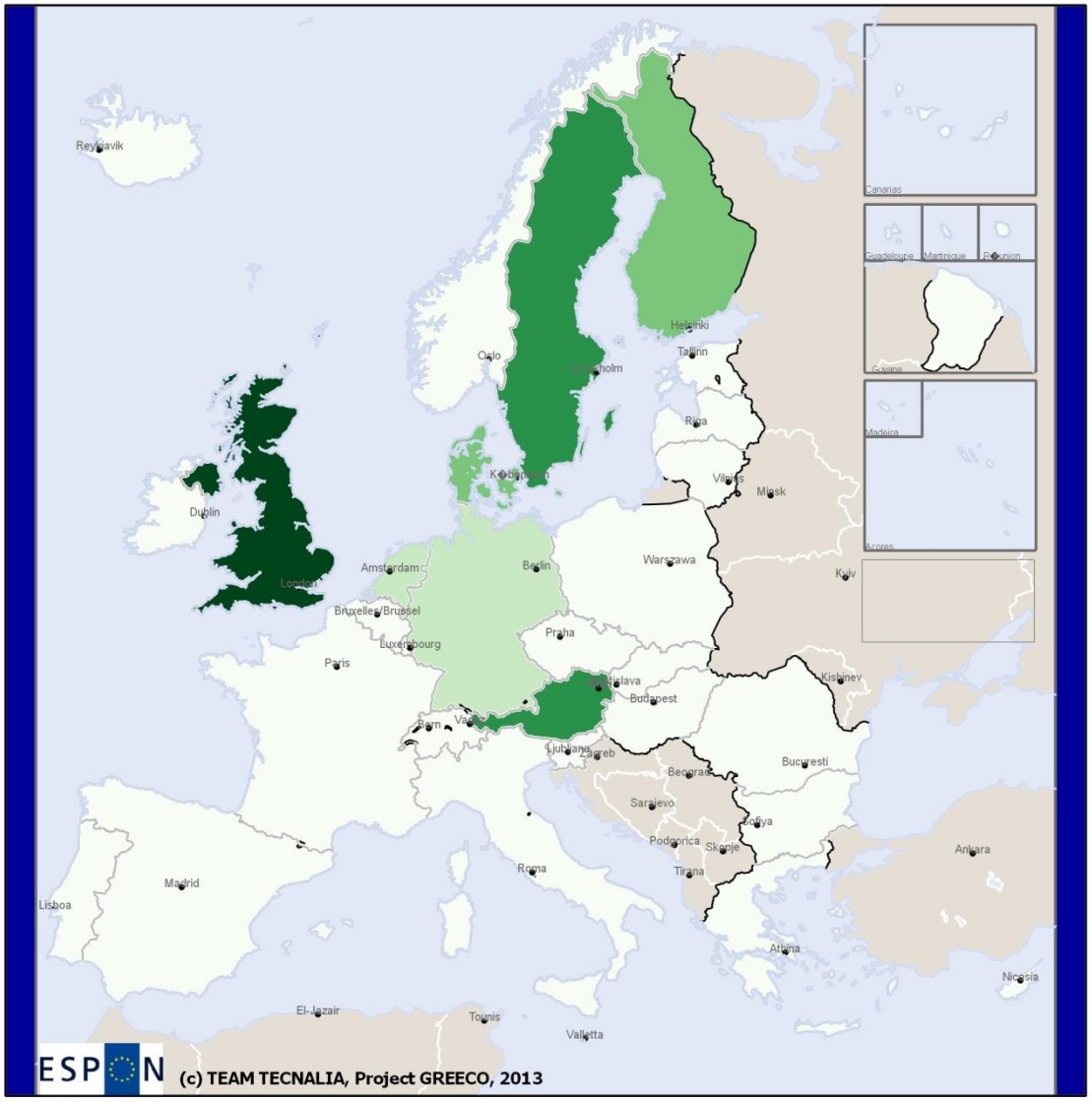



**Figure 11** Number of eco-labels awarded in the EU (January 2012). *Source:* *http://ec.europa.eu/environment/ecolabel/facts-and-figures.html*

In addition, public procurement is politically seen as a market-based instrument that plays a key role in the Europe 2020 strategy of turning the EU into a smart, sustainable and inclusive economy (European Commission (EC) (2010b)). Along these lines, the production of environmentally friendlier products or services (i.e. eco-innovative) could potentially be stimulated by the market power of public bodies, through Green Public Procurement (GPP) policies and legislation. Below, the share of GPP in total public procurement in the UK, Sweden, Finland, Germany, The Netherlands and Austria measured by PWC.




**Map 9** Percentage of Green Public Procurement as a share of total Public Procurement in 2007 (*Source: PWC (2009)).*

On a more practical level, the EU's objectives are also implemented down to the EU 7th Framework Programme for Research and Innovation (FP7). Especially the Specific Programme Cooperation includes several relevant funding themes, including environmental research and energy (efficiency) research. The FP7 environmental theme contains strands such as conservation, sustainable management and recycling of natural and human-made

materials. The major emerging issue in EU RDI policy is the phase-out of FP7 and the emerging Horizon 2020 – The framework programme for Research and Innovation (H2020). Starting 2014, H2020 supersedes FP7, while it is foreseeable that some of the themes found in the H2020 proposal might be introduced to FP7 during its last year. In principle, under H2020, the Competitive Industries objective will provide major investment in key industrial technologies, maximise the growth potential of European companies by providing them with adequate levels of finance and help innovative SMEs to grow into world-leading companies.

The CIP Eco-innovation programme seeks to provide funding for projects in various sectors that mitigate environmental impacts or promote a more efficient use of resources. Priority areas include material recycling, buildings, the food and drink sector as well as greener business. In addition the LIFE + programme supports environmental and nature conservation projects throughout the EU.

With regard to access to finance for eco-innovative SMEs in their early stages, according to EIM (2011) beyond policy tools, access to finance could be improved by risk-sharing instruments, such as venture capital, debt financing, business angels, etc. The debt financing model is predominantly used, since venture capital is mostly directed towards energy themes (generation and efficiency). Besides, business angels are more difficult to co-finance than venture funds. Therefore the instruments in place at the EU-level to co-finance venture funds are more frequently used, e.g. the European Investment Fund, which has invested in cleantech.

When it comes to regions, policy support should be tailored to reflect regional diversity. This is especially relevant for less developed regions, since they are usually faced by the "*regional innovation paradox*": the more a region needs innovation to maintain and improve the competitive position of its businesses in an increasingly globalized economy, the more difficult it is to invest there effectively and to absorb public funds to promote innovation (Grillo et al. 2011).

While the main reason seems to be the unavailability of public funds, the explanation lies in the nature of regional innovation systems and institutional capacity (innovation actors). In addition, regional innovation strategies face specific challenges. They have often been used as economic redistributive mechanisms, rather than allocate resources in priority areas. Moreover, the priority areas selected have also imitated / replicated other regional contexts, instead of making evidence-based decisions taking into account the regional context (Barca 2009).

In such a context, in January 2011, the European Commission published a Communication calling on EU Member States and regions to make greater use of cohesion funds to finance projects promoting sustainable growth. In addition, regions hold the knowledge about local innovation systems and networks, as well as, the understanding of local challenges and assets. Therefore, they are best positioned to tackle those challenges and mobilize stakeholders (European Commission (EC) – DG REGIO (2012)).

According to a recent WWF Germany report, the allocation of cohesion funds to sustainable growth measures would increase if the funding allocated to innovations was channeled to eco-innovation.

**BOX 7: COM (2011) 17 final - Regional policy contributing to sustainable growth in europe 2020:**

This communication sets the frame for regions to use policy to develop a resource efficient, low carbon, climate resilient competitive economy, by investing more and using funds more effectively.

It consists of a two-pillar approach to maximize the contribution of Regional policy to Europe 2020 and the Resource Efficiency Flagship Initiative:

- Pillar one: Investing more in sustainable growth. Focused on:
  - Transition to a low-carbon economy: focus on investments in energy efficiency, buildings, renewables and clean transport
  - Ecosystem services: focus on preserving and maximising the potential of the natural environment
  - Eco-innovation: focus on mobilising innovation partnerships and information technology
- Pillar two: Investing better. Devoted to:
  - Integrating sustainability throughout the project life-cycle
  - Checking investments against climate resilience and resource efficiency
  - Better governance

In summary, the key questions about regional innovation policies are no longer about what to do or why, but chiefly about how and who should do it and through which mechanisms, including policy monitoring and evaluation by means of appropriate indicators, which are still lacking for characterizing and measuring regional innovation policies (Grillo et al. 2011).

Finally, it is worth noticing that a single region cannot achieve the needed changes, but Europe as a whole, with its experience, track-record and economic power has a realistic chance to lead this transition towards a greener, more resource-efficient economy and future, tackling current sustainability challenges (European Commission (EC) – DG REGIO (2012)).

# 4 Concluding remarks

The present decade has seen a major upsurge of the relevance that eco-innovation has at the highest political levels. Discussions at the heart of the European Commission, European Parliament, the OECD, United Nations and a vast number of Member States are a clear example of this. Nonetheless topics related to eco-innovation have been in the policy agenda for more than a decade now (e.g. OECD, Vinnova, Sweden's innovation agency founded in January 2001, etc).

Part of the current debate is focused on the role that eco-innovation can have as a driver for a cleaner and fairer economy. Major global initiatives and strategies have taken account of this (e.g. UN's Greener Economy, OECD's Green Growth strategy, etc). In Europe, the 2020 strategy sets specific targets for environmental and energy policies.

Many expectations have been created around this topic, but two of them can be hitherto seen of greater importance. Firstly, eco-innovation is seen as a key tool to tackle some of the grand challenges faced by mankind, primarily those related to climate change and ecological degradation. Along these lines, five megatrends have been acknowledged to determine the future development of eco-innovation related to environmental technologies in particular: (1) demographic change – increasing population, (2) urban growth, (3) globalization – increasing economic integration, (4) scarcity of resources, (5) climate change (Roland Berger 2012). Secondly this type of eco-innovation holds the promise to create jobs and new skills, and ultimately to foster economic growth.

Eco-innovation will be the driving force of the transition towards a greener economy. On the one hand, it will enable traditional industries and companies to shift behaviour and pursue a sustainable strategy. On the other hand, it consists of the eco-industry sector. However, it faces barriers and obstacles which may hinder an effective deployment.

**Policy message 1: Lower financial barriers.**

There are a variety of financial factors which may hinder the deployment of eco-innovative developments. If it was not for environmental legislation, incentives for a resource-efficient economy are scarce. The main reason behind is that prices do not reflect the real value of natural resources. Therefore, policy support is needed to adjust the economic and fiscal framework to provide incentives to become more resource efficient (i.e. greener). For instance, instead of value-added taxation, it may be more efficient to tax natural resource's use before goods for final use have been produced, while lowering taxation of labour accordingly.

- Market failures, i.e. prices do not reflect environmental costs and thus foster monopolies and hinder eco-innovation.
- EHS and harmful subsidies
- Lack of funds within companies and insufficient access to existing subsidies and fiscal incentives (R&D costs, lack of investment, etc.)
- Uncertain demand from market, combined with long payback periods
- Inadequate availability of risk capital
- Barriers to trade and investment need to be reduced to facilitate diffusion and market penetration
- Low returns to R&D

**Policy message 2: Overcome knowledge barriers**

When the right networking framework is in place (e.g. clusters, associations, formal networks, etc.), knowledge spillovers occur maximising innovation widespread and outputs. However, when this is not the case, (lack of) knowledge is a prominent deterrent of green research and eco-innovation. This may take place in the following manners:

- Lack of qualified personnel and technological capabilities within the enterprise
- Limited access to external information and knowledge, including a lack of well-developed technology support services

- Lack of collaboration with research institutes and universities
- Technical and technological lock-ins (e.g. old technical infrastructures)

That is why supporting Eco-innovation to bridge the gap between research and the market is essential.

**Policy message 3: Comprehensive policy mix to support eco-innovation**

Decades of research have managed to unveil national, sectoral, regional and technological differences in innovation systems. Keeping sectoral specificities in mind, regulation has played a key role in promoting the use of eco-innovation. But for years the policy focus is oriented towards abatement of greenhouse gas emissions, recycling and renewable energy provision and efficiency. Areas such as material efficiency, radical eco-design and the provision of new eco-materials fall behind. Therefore, a comprehensive policy mix to support both the demand and supply of eco-innovation is preferable to individual one-off support measures (European Commission (EC) – DG REGIO (2012)). Clearly, smart policy support is needed in terms of creating adequate framework conditions for supporting eco-innovation deployment and major sustainability transformations. There is real policy urgency for bridging those critical steps for innovations to reach the market.

**Policy message 3: Adjust eco-innovation support measures to the receptor**

Recent analyses suggest that strategic eco-innovators developing emerging eco-innovations are different to other eco-innovators as they have clear first mover strategies. This type of eco-innovators has a different innovation dynamics due the fact that they are in a stage of the innovation cycle that has high uncertainty and risks. This type of eco-innovators is not yet consolidated, but they are often high-growth, SMEs.

Besides, most research and policy advice in this field has not made a clear differentiation between eco-innovation users and developers. Current approaches fall short because of an inadequate understanding of innovation and environmental strategies of firms at the micro level. Smart policy advice should be able to identify and to provide differentiated messages for three main groups of eco-innovators: users, developers for in-house use, and strategic developers for commercialisation – yet these groups are to some degree complementary. The first group is represented by those firms (mostly manufacturing) that adopt innovations developed elsewhere in order to improve their process efficiency and to reduce cost, among a few other factors. The second group may have the same motivation, but decides to go through R&D and engineering efforts in order to develop or adapt eco-innovations. The third group corresponds to eco-innovators with the clear strategy to develop an eco-innovation that is ought to be sold in the marketplace (Montalvo et al. 2012). The reason for such differentiation is simple: their strategic orientation is different and their resources and capabilities for innovation also differ.

For this reason, there is no one-size-fits-all support measure to enhance eco-innovation implementation.

**Policy message 4: Stress the role of regions and cities in fostering eco-innovation**

Regions are increasingly becoming important engines of economic development and innovation policy is increasingly designed and implemented at regional level. Even if a number of factors (e.g. taxes, legislation) fall out of the scope of regional stakeholders, regional authorities play a leading role in fostering regional economies through eco-innovation, e.g. through purchasing policies. (EURADA 2009). In addition regions have a great oversight of both local assets (e.g. renewable resources, clusters, know-how, etc.) and environmental challenges. In such a context, eco-innovation strategies may strengthen regional economies and reduce regions' dependency on non-renewable resources and thus increases resilience（Massard et al. 2012). These strategies should be defined in a smart way, capitalizing local strengths and addressing local challenges by means of policy instruments available at the regional level, e.g. green public procurement, promoting regional R&D, awareness raising, etc. (European Commission (EC) – DG REGIO (2012)).

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# 6 ANNEX: Territorial dimension of Eco-innovation – A snapshot

**Table 7** Territorial factors of Eco-innovation.

| Are the following territorial factors important in relation to greening of the sector: | | | |
|---|---|---|---|
| 1. | ***Settlement types*** | ***y/n*** | ***Why? Why Not?*** |
| i. | Urban areas | ***Y*** | For eco-innovation, spatial proximity plays a key role, since it leads to different types of spillovers, productivity and efficiency, but most importantly knowledge spillovers). In addition, at the regional level, geographical concentrations of linked industries, like clusters, are of increasing importance. In fact, regional clusters could lead to higher competitiveness for firms that are part of them due to the higher innovation rate and availability of specialized resources. Therefore, eco-innovative activities tend to be concentrated in urban areas.<br>It is worth mentioning that (eco)innovation also occurs in peripheral rural areas to some extent, however, the assessment and study of such activities is still challenging (i.e. difficult to collect robust data, sparse population of businesses) (Davies 2010). |
| ii. | Rural areas | ***N*** | |
| iii. | Urban-rural interactions | ***N*** | |
| | | | |
| *2.* | ***Land and land-based resources*** | ***y/n*** | ***Why? Why Not?*** |
| i. | Land consumption or dependence | ***Y*** | Currently a lack of incentives (resources' prices usually do not reflect environmental costs) might hinder eco-innovation. Nonetheless, at the same time these resource constraints, i.e. overuse of , especially, materials and energy, the EU's import dependency, etc. have also pushed forward eco-innovation. Furthermore, eco-innovation can contribute towards making businesses more competitive businesses, markets resilient and societies resource efficient.<br><br>In this context, it is worth mentioning that the countries performing best with regard to eco-innovation as whole are not necessarily the countries achieving higher environmental performance. In fact, there is a moderate correlation between relatively high eco-innovation performance and high levels of both per capita material consumption and GHG emissions(EIO 2013). The reason for this could be the time lag between when the eco-innovation and carried out and when the impact is perceived. An additional reason for such an outcome could be the trend to focus on technologies, instead of on increasing resource productivity and on concentrating eco-innovation developments in niches, instead of in wide-spreading such developments. If eco-innovation investments and hence developments where aligned with more structural conditions (i.e. resource consumption and emissions), the environmental outcomes would most likely be enhanced (ibid). |
| ii. | Material Consumption or dependence | ***Y*** | |
| iii. | Energy consumption or dependence on specific energy types or systems | ***Y*** | |
| iv. | Management of ecosystem services (types of ecosystems/landscapes; spatial characteristics of ecosystems; options for maintaining and developing these services) | ***Y*** | |
| | | | |
| *3.* | ***Market relations (Production; consumption; export, import) and innovation*** | ***y/n*** | ***Why? Why Not?*** |
| | i. Local/regional markets | ***Y*** | The world's 'green market' has been assessed at about €1 trillion in 2005 and this 'green economy' will |

| Are the following territorial factors important in relation to greening of the sector: | | | |
|---|---|---|---|
| ii. | National markets | ***Y*** | double to €2.2 trillion by 2020. (BMU and UBA 2009). In this assessment, the BMU and UBA study took into account areas such as energy efficiency, sustainable mobility, material efficiency and recycling, all of which are of analyzed by GREECO. In addition, the EU is one of the global leaders in exploiting technological and economic opportunities in eco-industry and cleantech (Ecorys 2009). According to Ecorys' estimates, over one third of the €600 billion a year global eco-industry market belongs to the EU. Along these lines, the EU is especially strong in pollution abatement, waste management and integrated chain management. Moreover, Germany has been the global leader in clean energy technology sales. However, the current and potential contribution of European SMEs in the eco-industry and cleantech market has not yet been estimated (EIO 2012). Even if the global market is large, when it comes to EU SMEs, almost 90% ot their export destinations are either within the EU27 or European countries outside the EU27 (European Commission (EC) - Flash Eurobarometer (2007))<br>For the green economy, in particular, structural barriers such as systemic lock-ins and market failure have a direct impact on companies' choices and may hinder disruptive eco-innovation efforts (EIO 2013). Assuming that regional stakeholders can mediate the emergence of new markets, this offers regions very interesting perspectives with regard to eco-innovation market penetration (EURADA 2009). |
| iii. | EU markets | ***Y*** | |
| iv. | Global markets | ***Y*** | |
| | | | |
| *4.* | ***Inter- and intra-territorial relations*** | ***y/n*** | ***Why? Why Not?*** |
| i. | Within territories (place based; local cultures; relating to territorial/national policies) | ***Y*** | When it comes to intra-territorial relations, attention should be paid to the intraregional mobility of researchers and how this leads to increasing knowledge and innovation. Evidence has showed that competitive regions and regions with a higher R&D share benefit more from intraregional connectedness, researcher mobility and networks, in terms of inventive capacity than transition and convergence regions (KIT Final Report). |
| ii. | Between territories (networks; competition) | ***Y*** | |
| iii. | Across territories (cross-border supply and demand) | ***Y*** | |
| | | | |
| *5.* | ***Place-based factors*** | ***y/n*** | ***Why? Why Not?*** |
| i. | Competitiveness through strong local economies | ***Y*** | (Eco)innovation depends on place-based factors, in fact, it tends to be higher in core-regions and systematically lower in lagging regions. The reasons for this are twofold. On the input side, core regions provide greater potential diversity of specialization opportunities and greater potential home market. On the output side, they provide higher level of connectedness. (McCann et al. 2011). In addition, factors such as local knowledge, R&D endowment, human capital, accessibility, entrepreneurship and creativity, condition the (eco)innovative performance of regions (KIT Final Report). |
| ii. | Multi-functionality | ***N*** | |
| iii. | Tacit/experiential knowledge | ***Y*** | |
| iv. | PROXIMITY | ***Y*** | |
| | | | |
| 6. | ***Consumer relations*** | ***y/n*** | ***Why? Why Not?*** |
| i. | Are development and innovation consumer-demand driven? | ***Y*** | There are different types of ecoinnovation, ranging from product, process, organisational, marketing, and social to system. Thus, eco-innovative developments may be (and actually are) driven both by consumers |

| Are the following territorial factors important in relation to greening of the sector: | | | |
|---|---|---|---|
| ii. | Are development and innovation producer driven? | ***Y*** | and producers. . In all cases, the interaction between producers and consumers are crucial to the successful up-scaling and diffusion of eco-innovations. In addition, increased consumer awareness leads to many creative business models (EIO 2013 and OECD 2012). |
| iii. | Are development and innovation based on well-defined territorial conditions or on open access? | ***N*** | |
| | | | |
| *7.* | ***Accessibility and mobility*** | ***y/n*** | ***Why? Why Not?*** |
| i. | Transport connections (transport of materials; transport of labor) | ***N*** | When it comes to accessibility, geographical proximity matters in business performance and in the creation of innovation (e.g. it leads to different types of spillovers, productivity and efficiency, but most importantly knowledge spillovers). In addition, at the regional level, geographical concentrations of linked industries, like clusters, are of increasing importance. In fact, regional clusters could lead to higher competitiveness for firms that are part of them due to the higher innovation rate and availability of specialized resources (Annoni et al., 2010). |
| ii. | Regional Accessibility (access to markets; access to supply of materials; access to public services) | ***Y*** | |
| iii. | Information connections (use of communication and information services; need of interaction; questions of consumer and producer cultures) | ***Y*** | |
| | | | |
| *8.* | ***Policy and governance by territorial level*** | ***y/n*** | ***Why? Why Not?*** |
| i. | Scale of sector-based policy support | | First, it should be noted that even if within GREECO green research and eco-innovation is analyzed as sectors, in order to provide a deeper insight, when it comes to policy support it is cross-sectoral by definition, rather than a sector by itself.<br>On the one hand, authorities at all governance levels can foster the process of change and of becoming more eco-innovative (EIO 2013). In this context, it is of special relevance the EcoInnovation Action Plan (EcoAP) of the European Commission.<br>On the other hand, regions are increasingly becoming important engines of economic development, innovation policy is increasingly designed and implemented at regional level. Nevertheless, for a successful implementation and monitoring of such policies, regional data on innovation indicators are lacking (RIS 2012). It should be noted that eco-innovation strategies on the one hand strengthen regional economies and on the other hand, reduce regions' dependency on non-renewable resources and thus increases resilience (Massard et al. 2012). Even if a number of factors (e.g. taxes, legislation) fall out of the scope of regional stakeholders, regional authorities play a leading role in fostering regional economies through eco-innovation, e.g. through purchasing policies. This is all the more feasible since many products, services and business models in this field have not reached their maturity or decline stage yet and the degree of long-term product and service survivability varies considerably across countries(EURADA 2009). However, there is no one-size-fits-all solution for the right policy-mix to foster eco-innovation. The appropriateness of the policy-mix will rely on the innovation characteristics of the region (KIT Final Report). Along these lines, it is of especial relevance that this territorial dimension of innovation, has recently been acknowledged by EC policy documents (European Commission (EC) – DG REGIO (2012)) |
| | • From the EU Level | ***Y*** | |
| | • From the national level | ***Y*** | |
| | • From the regional level | ***Y*** | |
| | • From the local/municipal level | ***N*** | |
| ii. | Role of other EU policies with territorial dimension | ***N*** | |
| iii. | Private versus public sector – led development. Are consumer organizations advocating for developing the green economy. At what political scale are they located? | ***N*** | |

# 7 ANNEX: Eco-innovation non-policy factors – A snapshot

Green research and eco-innovation is by definition a "green sector". Therefore, the barriers and drivers applicable to this sector are specific for the green economy.

Green research and eco-innovation is not a traditional vertical sector. In fact, it also takes place in traditional vertical sectors (e.g. the R&D department of a manufacturing factory). For this reason this sector interacts and has an impact in all other sectors analyzed by GREECO.

**Table 8** Economic and market drivers

| **Factor** | Economic and market drivers |
|---|---|
| **Description** | Rising competition over resources, higher prices and environmental depletion play a key role in driving eco-innovation. Either as direct cost reduction (savings) or as indirect cost reduction (increasing productivity), resource efficiency is fundamental for cost reduction by:<br>• increasing energy efficiency<br>• reducing emissions and waste<br>• maximising material efficiency: doing more with less and wasting not<br>• reducing vulnerability to material scarcity, changing prices, energy security, etc<br>In addition, increasing environmental awareness of users, implies that environmental friendlier products, i.e. eco-innovative products, will capture new markets. |
| **Specificity for the green economy** | N.A. |
| **Provable impact on the green economy spheres** | **Economic: positive impact (+)**<br>An enhanced resource efficiency at firm level represents a cost reduction and thus a positive economic impact. In addition, eco-innovative products may enable capturing new markets.<br><br>**Environmental: positive impact (+)**<br>By definition an enhanced output of eco-innovative developments will bring environmental benefits. However, attention should be paid to the "rebound-effect"<br><br>**Social: positive impact (+)**<br>Environmentally friendlier developments will be positive for the society as a whole.<br><br>**Territorial: unknown (o)** |
| **Trade-offs: mixed +/- impacts on green economic spheres?** | |
| **Externalities: impact on other sectors / case studies** | |
| **Interactions with other factors** | Financial barriers and economic drivers are inter-related. However, while the first is demand-side driven, the latter is supply-side driven. |
| **Causal level of operation (proximate/direct versus underlying/indirect factors)** | |

| Factor | Economic and market drivers |
|---|---|
| **Spatial level of operation (internal versus external factors)** | External<br><br>Economic drivers can be labelled as an external driver, whose manifestation on specific territories might vary. |
| **Type of market force involved** | Supply-side factor |
| **Policy recommendations: making the link between policy and non-policy factors** | • Foster benchmarking, labeling, etc.<br>• Correct pricing of resources<br>• Raising awareness<br>• Technical assistance programmes<br>• Access to finance<br>• Investment in technology breakthroughs |
| **Possible indicators** | Change in time of:<br>• Domestic material consumption (DMC)<br>• Raw Material Consumption (RMC)<br>• Energy consumption<br>• Waste generation by EWC<br>in all sectors. |

**Table 9** Financial barriers

| Factor | Financial barriers |
|---|---|
| **Description** | Economic incentives and financial barriers are two sides of the same coin affecting eco-innovation deployment. The difference between the two is that the latter is external and demand-side driven. In fact, financial factors may hinder the deployment of eco-innovative developments:<br>- Market failures, i.e. prices do not reflect environmental costs and thus foster monopolies and hinder eco-innovation.<br>- EHS and harmful subsidies<br>- Lack of funds within companies and insufficient access to existing subsidies and fiscal incentives (R&D costs, lack of investment, etc.)<br>- Uncertain demand from market, combined with long payback periods<br>- Inadequate availability of risk capital<br>- Barriers to trade and investment need to be reduced to facilitate diffusion and market penetration<br>- Low returns to R&D |
| **Specificity for the green economy** | |
| **Provable impact on the green economy spheres** | **Economic: negative impact (-)**<br>In the short term it could occur that it is less costly for companies not to invest in eco-innovation. However, in the long run they will become less productive and competitive and will have a negative economic impact.<br><br>**Environmental: negative impact (-)**<br>The hindering of investments in eco-innovation clearly has a negative impact in the environment.<br><br>**Social: negative impact (-)**<br>The lack of investment in eco-innovation hinders the growth of green jobs in the sector.<br><br>**Territorial: unknown (o)** |

| Factor | Financial barriers |
|---|---|
| **Trade-offs: mixed +/- impacts on green economic spheres?** | |
| **Externalities: impact on other sectors / case studies** | |
| **Interactions with other factors** | Financial barriers and economic drivers are inter-related. However, while the first is demand-side driven, the latter is supply-side driven. |
| **Causal level of operation (proximate/direct versus underlying/indirect factors)** | |
| **Spatial level of operation (internal versus external factors)** | External / internal<br><br>Financial barriers may vary widely depending on regional assets. |
| **Type of market force involved** | Demand-side factor |
| **Policy recommendations: making the link between policy and non-policy factors** | • Improve access to finance<br>• Reduce barriers to trade and investment<br>• Support cradle to cradle approaches, e.g. life cycle perspective, ecodesign, etc.<br>• Promote benchmarking and labeling to raise awareness and foster market penetration<br>• MBIs: taxes, subsidies, etc.<br>• R&D investment: Increased funding for the innovation chain (e.g. research, development, deployment, information-sharing)<br>• Reform of harmful subsidies (also a policy recommendation for the regulatory framework) |
| **Possible indicators** | • Environmental Protection Expenditure.<br>• Public investment in R&D<br>• Private investment in R&D<br>• Venture capital investments. |

**Table 10** Regulatory framework drivers

| Factor | Regulatory framework drivers |
|---|---|
| **Description** | Compliance with environmental regulations is perceived as being a strong driver towards enhancing environmental performance of companies by eco-innovation. In addition, the current policy context in the EU is supporting eco-innovation from different angles explicitly as the Eco-AP and implicitly as the environmental performance regulations the flagship initiatives on resources, etc.<br>Moreover, expected future regulations (e.g. the role REACH played) also drive eco-innovation. However, it should be noted that an uncertain regulatory framework would have a counter-productive effect, by hindering investments. |
| **Specificity for the green economy** | |

| Factor | Regulatory framework drivers |
|---|---|
| **Provable impact on the green economy spheres** | **Economic: positive impact (+)**<br>**Environmental: positive impact (+)**<br>**Social: positive impact (+)**<br>**Territorial: positive impact (+)**<br><br>The right policy-mix has the potential for delivering positive impacts in all green economy spheres. |
| **Trade-offs: mixed +/- impacts on green economic spheres?** | |
| **Externalities: impact on other sectors / case studies** | |
| **Interactions with other factors** | It should be noted that regulatory framework can condition the rest of factors because it sets the framework. |
| **Causal level of operation (proximate/direct versus underlying/indirect factors)** | It is a flexible factor, depending on the policy measure it could direct (e.g. taxes, subsidies), or rather indirect (e.g. capacity building). |
| **Spatial level of operation (internal versus external factors)** | Internal / External<br><br>Regulatory drivers may vary depending on regional assets, but also are driven by the European framework. |
| **Type of market force involved** | Demand-side |
| **Policy recommendations: making the link between policy and non-policy factors** | • Foster benchmarking, labeling, etc.<br>• Foster voluntary agreement schemes-<br>• Promoting investment and spending in areas that stimulate a green economy<br>• Addressing environmental externalities and market failures<br>• Limiting government spending in areas that deplete natural capital<br>• Rules, regulations, standards. E.g. Improve waste separation policies Monitoring and impact assessment of policies<br>• Enforcement incentives (e.g. adequately priced fines for noncompliance, correct pricing of resources)<br>• Reform of harmful subsidies (also a policy recommendation for the regulatory framework)<br>• Regulatory and control mechanisms;<br>• Economic or market-based instruments;<br>• Fiscal instruments and incentives;<br>• Voluntary action, information and capacity building: technical assistance programmes, awareness rising, etc. |
| **Possible indicators** | • Existence of regional / national eco-innovation strategies.<br>• Existence of voluntary agreement schemes.<br>• Existence of funding schemes for eco-innovative companies, SMEs in special. |

**Table 11** Knowledge barriers

| Factor | Knowledge barriers |
|---|---|
| **Description** | When the right networking framework is in place (e.g. clusters, associations, formal networks, etc.), knowledge spillovers occur maximising innovation widespread and outputs. However, when this is not the case, (lack of) knowledge is a prominent deterrent of green research and eco-innovation. This may take place in the following manners:<br>• Lack of qualified personnel and technological capabilities within the enterprise<br>• Limited access to external information and knowledge, including a lack of well-developed technology support services<br>• Lack of collaboration with research institutes and universities<br>• Technical and technological lock-ins (e.g. old technical infrastructures) |
| **Specificity for the green economy** | |
| **Provable impact on the green economy spheres** | **Economic: negative impact (-)**<br><br>**Environmental: negative impact (-)**<br><br>**Social: negative impact (-)**<br><br>**Territorial: negative impact (-)**<br><br>The foreseen impact of an efficient networking framework is that knowledge spillovers will take place and that synergies will be exploited, enhancing economic returns, reducing environmental depletion (by means of widespread of eco-innovations) and thus having a positive social and territorial impact. |
| **Trade-offs: mixed +/- impacts on green economic spheres?** | |
| **Externalities: impact on other sectors / case studies** | |
| **Interactions with other factors** | The knowledge barriers are mainly interrelated with the regulatory framework, because the latter may facilitate and foster the creation of networks at the regional level. |
| **Causal level of operation (proximate/direct versus underlying/indirect factors)** | Underlying / indirect<br><br>Knowledge barriers are a factor hindering the widespread of eco-innovative developments but it is not a direct causality. |
| **Spatial level of operation (internal versus external factors)** | Internal<br><br>Knowledge barriers are present and have an influence especially at regional level. |
| **Type of market force involved** | Supply-side factor |
| **Policy recommendations: making the link between policy and non-policy factors** | • Promote clusters.<br>• Create knowledge exchange networks. |
| **Possible indicators** | • Existence of eco-innovation cluster. |

# 8 ANNEX: Eco-innovation Sector Policy Analysis – A snapshot

The main driver for changing traditional production and consumption patterns and pursue an environmentally friendlier development, has been environmental legislation. As such, environmental legislation has been the engine of eco-innovation and for the surge of strong industries in the EU in the fields of water, air pollution, waste management, recycling, and climate change mitigation.

When it comes to policy oriented explicitly to eco-innovation, most countries have not implemented a policy framework to support eco-innovation, since they still perceive it as an emerging field (EIO 2013). Nonetheless, at EU level the Eco-Innovation Action Plan (Eco-AP) was launched in 2011. So far it is the only piece of policy dealing directly with eco-innovation.

**Table 12** Eco-AP.

| | | |
|---|---|---|
| **Type of policy and hierarchy** | Communication | |
| **Name** | Eco-innovation Action Plan (Eco-AP)<br>*COM (2011) 899 final - Innovation for a sustainable Future - The Eco-innovation Action Plan (Eco-AP)* | |
| **Description** | • Provides the definition of what is eco-innovation;<br>• Describes the barriers and drivers for eco-innovation for SMEs (based on the Flash Eurobarometer Survey)<br>• It puts forward actions and subsequent milestones necessary to speed up eco-innovation:<br>○ Action 1: Environment policy and regulation for promoting eco-innovation<br>○ Action 2: Demonstration projects and partnerships for eco-innovation<br>○ Action 3: Standards and performance targets for key goods, processes and services to reduce their environmental footprint<br>○ Action 4: Finance and support services for SMEs<br>○ Action 5: International cooperation<br>○ Action 6: New skills and jobs | |
| **Targets** | • The main target is to support and accelerate eco-innovation in the EU | |
| **Territorial implication** | **Characterisation** | Average to strong |
| | **Description** | • The Eco-AP foresees the need to work together with not only Member States, but also regions.<br>• There are milestones for each territorial level. |
| **Indicators** | Not foreseen explicitly. However since the Eco-AP has well defined actions and milestones the follow-up of these could be used as indicators for monitoring the implementation of the plan. | |
| **Distance to target (Graph or map should be provided in support of the distance to target analysis)** | N.A. | |
| **Policy effectiveness** | **Characterisation** | Presumably high |
| | **Description** | It is too early to assess the effectiveness of this policy. Nonetheless, it is expected to be highly effective since it takes into account synergies with other EU-wide policies and instruments. |

| | | |
|---|---|---|
| **Transformative character of policy** | **Characterisation** | Transformative-Radical |
| | **Description** | This communications seeks to overcome barriers to eco-innovation by using a wide variety of tools:<br>• environmental policy and legislation to drive eco-innovation<br>• supporting projects and partnering<br>• developing new standards boosting eco-innovation<br>• mobilising financial instruments and support services for SMEs<br>• promoting international cooperation<br>• supporting the development of emerging skills and jobs and related training programmes to match the labour market needs |
| **Green economy implication** | **Characterisation** | Positive strong (++++) |
| | **Description** | • This directive aims to reduce environmental depletion and boost employment in green sectors by supporting eco-innovation. |

# 9 ANNEX: Data processing - Patents in selected environmental technologies

### *9.1.1 Data source and methodology:*

The regional pattern of patents in environmental technologies[8] at NUTS2 level has been obtained basing on the data available at the Science, Technology and Patents database of the OECD (http://stats.oecd.org/#) for TL3 regions. For the exact location of the data in the OECD navigation tree, see figure below.

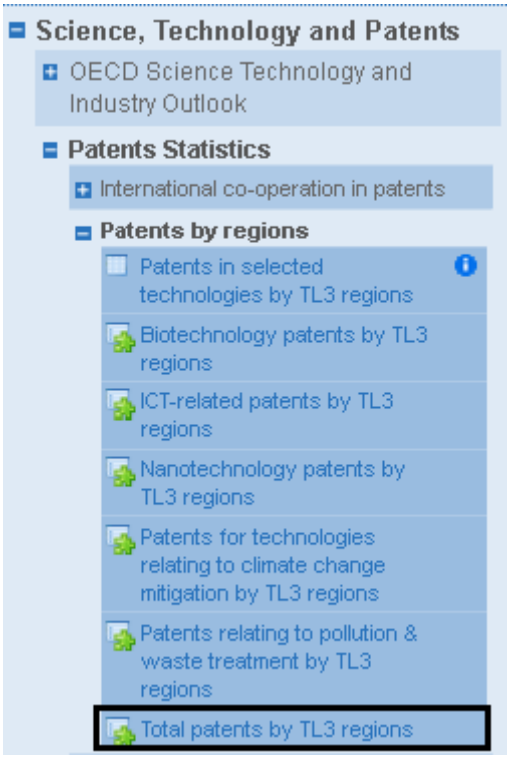


**Figure 12** Location of data in OECD database navigation tree.

This database holds patents for worldwide regions in the following technology fields, Biotechnology, ICT, Nanotechnology, Medical technology, Pharmaceuticals and Selected environment-related technologies. For the sake of the Green Research and Eco-innovation sector report, the focus has been on the selected environment-related technologies because of their univocal relation.

[8] Environmental technologies comprising "*all technologies whose use is less environmentally harmful than relevant alternatives*". This definition is based on the definition given in Chapter 34 of Agenda 21 for environmentally sound technologies.

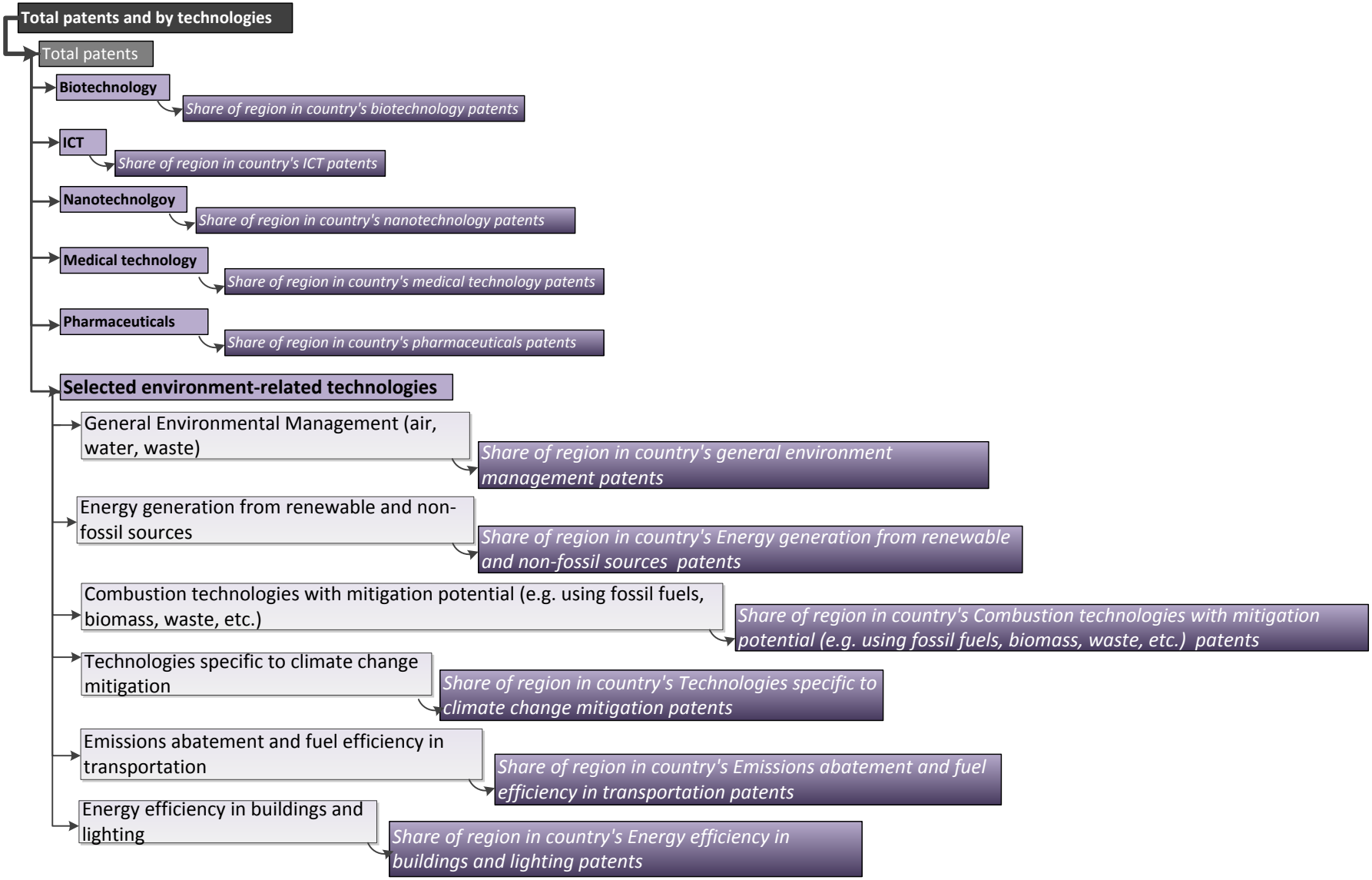


**Figure 13** Selected environment-related technologies breakdown.

### *9.1.2 Data processing*

For Belgium (BE), Greece (EL) and The Netherlands (NL) the data were available at NUTS0 and NUTS 2 and with the NUTS 2006 classification. But, for most European countries the data were only available at NUTS0 and NUTS3 level and with the NUTS 2006 classification. However, for Germany (DE) the data are arranged by 97 Spatial planning regions, instead of NUTS. For these reasons, the data required some processing before their mapping, namely the aggregation at NUTS2 level and the implementing the correspondence between NUTS2006 and NUTS2010 classifications. This process lead to the loss of some of the data, because they could not be assigned to NUTS2010 NUTS2 regions. That is why, to avoid "no data regions", in addition to the NUTS2 map, another map has been built where some of the regions are at NUTS1 level. Further details on the process are provided below.

The data processed cover the 2005-2010 period.

For all countries but Germany the process was as follows:

- For each of the selected environment-related technologies the data for the 2005-2010 period were added.
- The correspondence between NUTS2006 and NUTS2010 classification was done manually.
    - For the NUTS2006 regions which split into two different NUTS2010 regions, the data is considered as "not available", because it is unknown how many of the patents would correspond to each region. This is the case for:
        - NUTS2006 FI18 → splits into NUTS2010 FI1C and FI1B
        - NUTS2006 ITC45 → splits into NUTS2010 ITC4C and ITC4D
        - NUTS 2006 ITE34 → splits into NUTS2010 ITI34 and ITI35
        - NUTS 2006 UKD22 → splits into NUTS 2010 UKD62 and UKD63
        - NUTS 2006 UKE43 → splits into NUTS 2010 UKE44 and UKE45
        - NUTS 2006 UKF23 → splits into NUTS 2010 UKF24 and UKF25
        - NUTS 2006 UKG34 → splits into NUTS 2010 UKG36 and UKG37
        - NUTS 2006 UKG35 → splits into NUTS 2010 UKG38 and UKG39
        - NUTS 2006 UKH22 → splits into NUTS 2010 UKH24 and UKH25
    - For the NUTS2006 regions which combine into a NUTS2010 region, the data were added.
        - NUTS2006 FI13 and FI1A → combine into NUTS2010 FI1D
        - NUTS2006 FI182 and FI183 → combine into NUTS2010 F1B1
    - For the NUTS2006 regions which simply change their nomenclature, this change was done:
        - All greek regions, since GR becomes EL
        - NUTS 2006 UKD52, UKD53, UKD4 → become NUTS2010 UKD72, UKD73, UKD74, respectively.
    - For the NUTS2006 for which there was a boundary shift with nomenclature change, the nomenclature has been changed and the data have been kept, but making clear that the data version is that of 2006. This is the case for:
        - NUTS2006 ITD → NUTS2010 ITH
        - NUTS2006 ITD5 → NUTS2010 ITH5
        - NUTS2006 ITD59 → NUTS2010 ITH59
        - NUTS2006 ITE → NUTS2010 ITI
        - NUTS2006 ITE3 → NUTS2010 ITI3
        - NUTS2006 ITE31 → NUTS2010 ITI31
        - NUTS2006 NL331 → NUTS2010 NL337
        - NUTS2006 NL334 → NUTS2010 NL338
        - NUTS2006 NL335 → NUTS2010 NL339
        - NUTS2006 NL336 → NUTS2010 NL33A
        - NUTS2006 UKD2 → NUTS2010 > UKD6

        - NUTS2006 UKD21 → NUTS2010 UKD61
        - NUTS2006 UKD5 → NUTS2010 UKD7
        - NUTS2006 UKD51 → NUTS2010 UKD71
- Data at NUTS3 level were aggregated at the corresponding NUTS 2 (except for BE, EL and NL).
- The share of environment-related patents in relation to the total patents in the region was calculated.

For Germany was as follows:

Taking into account the correspondence table between 97 Spatial planning regions and NUTS2010 classification provided by Spiekermann & Wegener, this correspondence was manually done.

- Only 3 spatial planning regions found a direct correspondence with NUTS2010 NUTS3 regions: DE600, DE501, DE300 (Hamburg, Bremen and Berlin).
- Against this backdrop it was analyzed if a correspondence could be found between groups of spatial planning regions and NUTS2010 NUTS2 regions. However, in this process some data were lost, due to the fact that some spatial planning regions belonged to more than one NUTS2 region. This was the case for:
    - DE22
    - DE23
    - DEB1
    - DEB3
    - DE71
    - DE91
    - DE92
    - DE93
    - DE94
    - DEB1
    - DEB3
    - DED4
    - DED5

With regard to the data being fractional numbers, the reason is that:

> *"Counts are based on the list of IPC codes (International Patent Classification, 8th edition) that are given in each patent document, and use fractional counts.*
> *The relative **shares of regions** in patents filed by countries are also provided in the dataset, for total patents and the three technology domains.*
> *In addition, the **rate of successful regionalisation** is presented at the country level to assess the performance of the allocation of patentee's addresses into regions (number of patents with a valid region over total number of patents taken by the country)."*[9]

9 http://stats.oecd.org/OECDStat_Metadata/ShowMetadata.ashx?Dataset=PATS_REGION&Coords=[TECHNO]&ShowOnWeb=true&Lang=en

www.espon.eu

The ESPON 2013 Programme is part-financed by the European Regional Development Fund, the EU Member States and the Partner States Iceland, Liechtenstein, Norway and Switzerland. It shall support policy development in relation to the aim of territorial cohesion and a harmonious development of the European territory.

ISBN