GREECO
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Sector Report

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This basic report exists only in an electronic version.

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1 Executive summary

1.1 Introduction

Since the industrial revolution the energy sector has been responsible for the extraction, transformation and supply of energy. While the energy sector has become a fundamental pillar in modern society it is also the main responsible for Greenhouse Gas (GHG) emission as being predominantly based on fossil fuels. Furthermore, this sector is not only facing global challenges related climate change but also securing energy supply, mitigating pollution and public-health hazards and preventing energy poverty.

Many years of debate regarding how to secure energy supply in a sustainable manner have pinpoint different directions. Despite of great challenges relating their deployment Renewable Energy Sources (RES) are regarded as the most beneficial, at least from an environmental point of view. This perspective is regarded to RES's potentials to reduce GHG emissions and therefore considered as a key element in achieving ambitious emission reduction targets. While the demand of RES technology is increasing, strong RES industries are nevertheless appearing as important actors in national and global economies implying important opportunities for nations and regions to generate employment and value added.

The development of the energy sector in European Member States (MS) reflects the transformation processes embedded in *'green economy'* models namely the substitution of fossil fuels, the incorporation of residues as a source of energy and increasing energy efficiency. Whereas RES ultimately create new business markets that reconcile limited use of natural resources with economic growth, RES technologies may play a fundamental role as pillar in future economies.

The following study covers territorial aspects of substitution, efficiency and recycling in the transformation of energy in European countries, as a mean to bring understanding on the current state and development of RES and drivers behind this development but also policies and support schemes on RES deployment. This study attempts also to provide regional potentials on RES as a mean to identify regions with opportunities for green growth in the energy sector.

1.2 Structural business characteristics

At EU27 level activities related electricity, gas, steam and air conditioning supply are most significant corresponding to approximately 75% of the sector while the mining and quarrying of energy producing materials and manufacture of coke and refined petroleum products correspond to 19% and 6% respectively. Furthermore, the energy sector stands for approximately 2.7% of the EU27's GDP. Countries with largest GVA in the energy sectors are the UK, Germany, Norway and the Netherlands, often regarded to the size of the economy and the presence of considerable oil and coal extraction industries.

In terms of the energy sector's share in the national economies Norway is by far the most dependants as it corresponds to 22% of the national GDP. The energy sector also appears as significant in eastern European countries mainly Slovakia, Romania and the Czech Republic with shares just above 5%.

The national distribution of employment follows a slightly different pattern relative the GVA, as Eastern European countries tend to show higher values. In the EU27, activities relating to the supply of electricity, gas, steam and air conditioning supply correspond to 67% of the energy sector followed by the mining and quarrying of energy producing materials by 25%. In terms of the sector's share in the national employment, Eastern European countries show higher shares. This east-west division becomes more evident when looking at the sector's productivity where the majority of Eastern European countries show lower values compared to Western countries. Productivity in the energy sector is increasing in all European countries mainly in Eastern ones where reductions in employment is taking place, primarily in coal mining activities but also refining and energy supply activities.

At regional level, structural indicators were available for the electricity, gas, steam and air conditional supply sector. In this context, the regional distribution of both employment and GVA reveals that this activity is particularly important for rural areas in Norway and Sweden and Spain and for most regions in Eastern European countries. However, the concentration of value added and job creation of energy supply activities is often concentrated in urban regions.

1.3 Production and consumption of energy

Gross inland energy consumption in the EU-27 has increased by approximately 6%, between 1990 and 2010, a process characterized by a shift in the structure of the primary energy consumption towards and increased use of natural gas (50%), nuclear (31%) and renewable energies (143%) and the detriment of coal (-38%) and oil (-2.5%). Still fossil fuels clearly dominate in the gross inland consumption of energy, representing approximately 76%, followed by nuclear energy (13%) and RES (10%).

Countries with highest energy demand are Germany (336,093TOE), France (268,576TOE) and the United Kingdom (212,629TOE). The energy mix in European countries varies individually depending of the availability and accessibility to local and imported energy sources, as well as policies addressing the energy sector. It is clear that European economies are very dependent of coal, gas and oil fuels as these resources combined correspond to more than 70% of the gross energy consumption in most countries excepting in Latvia, Lithuania, Switzerland, Norway and Sweden.

The gross inland consumption of RES in the EU27 has increased about 101,418TOE to a total of 172,140 TOE between year 1990 and 2010, approximately 10% of the total gross inland energy consumption. It has been primarily the consumption of bioenergy that has increased the most during that period, corresponding today 69% of total RES consumption, followed hydro-and wind power which stand for 18% and 7% respectively.

The consumption of RES among MS varies significantly due to a series of political, socioeconomic and geophysical circumstances, which had had further repercussions on national goals set on the share of RES in final energy consumption. Sweden, Latvia, Finland and Austria are among MS with highest shares of renewables in the EU. MS such as Sweden, Finland, Spain and Germany predict that they will increase the share of RES far beyond their targets.

1.4 Drivers and enablers

Drivers in RES deployment are regarded to governments needs to improve energy security, encourage economic development, particularly associated with agricultural sectors and innovation and high-tech-manufacturing, and to protect the climate and the environment from the impacts of fossil fuels combustion and exploitation. Further, these drivers are embedded within a political and legal context and are composed by a series of other drivers of great territorial implication.

Drivers relating to security of supply are among others natural capital, energy prices, land-use, settlement structure, accessibility to energy resources and consumer behaviour. Natural capital and energy prices are critical for energy development. The availability of energy resources has not only given shape to energy system in territories but also represent the basis for future development. Energy prices determine often the type of energy carrier and the intensity it is consumed, according to what is affordable for consumers. Consumer behaviour plays also a key role in terms of security of supply in territories, not only due to consumers' capacity to purchase energy but also their cultural ties and perception on different energy sources' reliability and environmental implications.

Despite of not often being viewed as such, exploitation of energy sources is a land-use practice, which can either coexists with other activities, such as in the case of wind power in relation to agriculture, or have antagonistic impacts such as in the case of coal mining. Settlement structure and population density are also territorial aspects having repercussions on the type of energy carrier that is made available, how the energy is transformed (in a centralized or decentralized way) and transmitted to consumers and the scale energy generated.

Producers' accessibility to energy resources and markets is given by actual distance between these two, and the infrastructure available that enables transmission and trade of energy. The availability of proper infrastructure is particularly vital for RES deployment, as it enables both the transmission of electricity from wind and solar power stations, which requires grids capable to withstand shifting power loads, and the transport of biomass from rural to urban and industrial areas.

Within an energy development context, economic development is understood as an adaptation process towards changes in the availability and cost of energy and the value creation derived from the commercialization of new commodities and solutions that enable the utilization of new energy sources. Important territorial elements in economic development are technological capital, constituting the base for new technologies, and human capital needed for innovation on technological and institutional solutions for the commercialization and operation of new energy infrastructures. Due to the high costs of development and commercialization required by RES technologies, significant economic capital is required. Here, a balance between technology-push by governments and market-pulls forces from business are required for supporting RES technologies until they reach maturity in markets. The availability of economic capital is however becoming unreliable as upheavals in the financial sector are slowing down new investment and the implementation support mechanisms on RES.

Environmental and landscape impacts of energy exploitation, transformation, transmission and consumption are clearly important territorial elements in energy development. As a driver, climate change mitigation is a central pillar in the European energy sector. Also important in this context are the negative impacts of fossil fuel exploitation, particularly coal mining which often implies irreversible degradation of soils, water resources and the landscape. Landscape impacts are nevertheless becoming topic of debate on RES deployment. This involves among others, visual impact of infrastructures such as windmills, power lines, dams, etc., as well as the impacts related to biomass harvesting in agriculture and forestry.

1.5 Legal and policy framework for energy supply

Despite energy related challenges initially acted as factor of European integration, energy policy did not developed into a coherent common policy area until the Lisbon reform in 2009 when the formal barriers in the Treaty on the Functioning of the European Union (TFEU) were removed. This event established shared competences between the EU and its MS in energy policy together with other related areas including internal market, the environment and transport policy. Current European energy policy does not have a regional dimension as being targeted to MS. EU's energy and regional policies have instead a common ground in the Europe 2020 strategy.

Two main drivers behind the creation of a common energy European policy have been recognized in the literature review, namely environmental concerns related to the impacts of production and consumption of energy and the need of an Internal Energy Market (IEM). The 1990's marked a new phase in energy policy, characterized by the EU Commission's efforts to define the principles and procedure aspects of Environmental Policy Integration (EPI) when many policy measures were adopted at European level concerning the promotion of energy efficiency and renewable energy as well as common rules and access conditions to natural gas and electricity networks and improvement of network interconnections.

While the first three pillars for the energy sector namely, security of supply, the IEM, and the environment were formally introduced in 1994, the first strategy and action plan to promote the market penetration of RES was introduced in 1997. This last event set the goal of doubling the share of renewable energy in the EU's energy and reducing CO_2 emissions. Today's pillars in European energy policy are specifically to increase security of supply, ensuring competitiveness and promoting sustainability and combating climate change, which are accompanied by the targets set by the 'Climate and energy package' agreed in 2008, on 20% RES consumption, 20% reduction on GHG and 20% reduction in primary energy.

Most central legislation supporting RES is the Renewable Energy Directive 2009/28/EC which includes a 20% RES in the final energy supply by 2020 for the European Union and individual legally binding targets for MS. MS shall also put national policies in place in order to achieve the national targets and establish a National Renewables Energy Action Plan (NREAP). The SET-plan of 2007 has put forward an important strategy for supporting energy research and demonstration of low-carbon technologies which since 2010 gives support to several RES initiatives among others on bioenergy, fuel cells and hydrogen, and solar and wind power. Support is also granted trough the Emission Trading Directive that sets aside 300 million allowances for subsidising installation of RES technology that is not commercially available.

Direct European support on RES deployment and R&D are available in through several programme including the Structural Funds and Cohesion funds, the Seventh Framework Programme on Reach and Technological Development (FP7), the Intelligent Energy Europe Programme and the LIFE programme. From a regional perspective the Structural and Cohesion fund are of most importance in providing financial aid to sustainable energy projects.

At national level MS have implemented individual support mechanisms on RES deployment and production according to their specific socio-economic, political and geophysical context. This implies that the level of support and rules on these mechanism vary individually among MS. The most common support mechanisms are feed-in tariffs, feed-in premiums and quota obligations systems.

1.6 Potentials

Under construction

1.7 Conclusions

Given that European energy sector is facing new challenges relating climate change mitigation, security of supply and economic instability an adaptation process is currently taking place leaning towards the substitution of fossil fuels, recycling of residual energy and materials and efficiency in transformation and transmission of energy.

The on-going restructuring process in European MS implies an increase in productivity has taken place in the energy sector. Eastern European countries are in particular not only witnessing an increase of productivity but also they are predicted to experience major increases of RES relative to current levels. This suggests that RES deployment may play an important role in revitalizing not only the energy sector but also the economy as a whole in these countries. A 'green' development in the energy sector will require however that energy policies are adapted to structural, socioeconomic and geophysical characteristics of regions in order to enable favourable conditions for deployment and development of RES technologies and the creation of new jobs. This implies nevertheless that energy policy should be based on a clear understanding of national and regional priorities and the energy sector's interactions with other sectors.

Despite of improvements on energy efficiency and increased demand of RES, MS still are heavily dependent on fossil fuels which constitute approximately 76% of the energy mix for the EU27. RES development in the European energy mix is taking place in parallel to increases in energy generation from nuclear plants and natural gas, which clearly indicates that RES deployment will continue experiencing hard competition. Therefore, it is central that future RES policies are developed under scenarios that reflect not only the complexity in future energy markets but also the externalities of the utilization of different energy sources, both in terms of social and environmental costs. Here, it will be important to phase out subsidies on environmentally harmful fossil fuel technologies.

Given the 'green economy' concept in the GREECO project the best suitable indicator to measure the sectors 'green' performance, is the share of RES in the final energy. Neither the share of RES nor any other energy related indicators are available at regional level. Regional data on energy supply, demand, intensity and efficiency as well as structural business characteristics are therefore needed, not only for conducting research but most important to be applied as a tool for helping policymakers understand the territorial dimension of RES and other energy sources and their implications. European energy policy should emphasise on the creation of a common long-term monitoring mechanisms that enable the evaluation of the state and development of the energy sector at regional level. This should include the creation of common assessment methodologies and definitions as well as improvements in data quality.

The territorial dimension of the energy sector and RES deployment is given by driving factors and enabling conditions. Here, three overall drivers were identified namely security of supply, economic development and environmental protection which are embedded within a political and legal context. Within these drivers a series of other drivers are found, each inducing specific territorial dynamics in ways energy sources are exploited, transformed, transmitted and consumed. What, where and how energy sources are exploited, transformed, transmitted and consumed are key questions that directly relate to security of supply alongside with aspects that directly relate volatility and affordability of energy. The literature emphasises on the long-term character of energy development which suggests that policy frameworks for the energy sector should become more coherent, robust and predominantly stable so that long term investment conditions are guaranteed. This approach applies particularly on regulatory frameworks that foster innovation. Furthermore, cooperation in the area of energy should reach out to different actors at all governance levels. This not only implies the creation of new means of communication and cooperation but most important new and effective coordination between both public authorities and private actors.

Climate change mitigation has key role in European energy development since the 1990's and will continue playing that role in the European political agenda. Considering the challenges that the energy sector is facing, sustainable energy production will require that energy related activities must prevent natural resource depletion and take advantage of synergies with other land-use functions of critical importance for economies and society.

European energy policy has today crystalized into the 'Climate and energy package' and become an integral part of the 2020 strategy as it pursues economic growth through value added creation in the field of energy. However, European energy policy does not have an explicit regional dimension as it exclusively refers to EU's and MS's targets for the energy sector. At the same time energy policy has a clear local and regional impact and therefore this policy field has become of strategic importance for regions. This suggests that European energy policy may need an increasing regional impetus in the future.

At European level, the RES Directive and the European Emission Trading System give the foundations for stimulating RES development at EU level. RES are also supported by several EU funding programmes, including Structural and Cohesion funds, the FP7 and the Intelligent Energy Europe programme among others. The Structural and Cohesion funds are however the European policy instrument that explicitly targets regions in the area of sustainable energies. Considering the importance of the energy sector, its potentials and the limited availability of funds targeting regions in the field of energy, also increase regional support should increase in absolute terms.

At national level MS have implemented individual constellations of various support mechanisms created not only to overcome economic barriers related to RES deployment and increase their competitiveness but also to overcome non-economic ones including administrative hurdles, grid access, market design, social acceptance, etc. In this context, polices should continuing seeking balance between government's pull and market's pulls as been necessary for RES technologies to reach maturity. Furthermore, flexibility in national support mechanisms is required because the effectiveness of different support mechanisms is rather dependant of individual national and regional characteristics.

2 Introduction: Conceptual elements of the green economy in the energy sector

2.1 Definition of 'energy sector'

In this study the energy sector is defined as the sector that relates to the extraction, transformation and supply of energy. The coverage of the energy sector corresponds to NACE Rev.2[1] divisions 05, 06, 19 and 35 + Group 09.1 + Class 08.92 and 07.21 according to the classification applied by EUROSTAT, IEA, UNECE and OECD (EUROSTAT, et al., 2011). This classification covers therefore extraction of coal, lignite, crude oil, natural gas and peat, mining of uranium and thorium ores as well as the manufacture of coke and refined petroleum products and the supply of electricity, gas, steam and air conditioning as described in Table 1. Due to limitations on data availability the mining related activities (NACE Rev. 2 05, 06, 7.21 and 8.92) data on mining and quarrying of energy producing materials (NACE Rev.1 CA) has instead been used in this report.

Table 1 Economic activities in the energy sector (NACE Rev.2 classification) (EUROSTAT, 2008)

Code	Name	Description
05	Mining of coal and lignite	This division includes the extraction of solid mineral fuels through underground or open-cast mining and includes operations (e.g. grading, cleaning, compressing and other steps necessary for transportation etc.) leading to a marketable product. This division does not include coking, services incidental to coal or lignite mining or the manufacture of briquettes.
06	Extraction of crude petroleum and natural gas	This division includes the production of crude petroleum, the mining and extraction of oil from oil shale and oil sands and the production of natural gas and recovery of hydrocarbon liquids. This division includes the activities of operating and/or developing oil and gas field properties. Such activities may include drilling, completing and equipping wells; operating separators, emulsion breakers, desalting equipment and field gathering lines for crude petroleum; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property
7.21	Mining of uranium and thorium ores	This class includes: - mining of ores chiefly valued for uranium and thorium content: pitchblende etc. - concentration of such ores - manufacture of yellowcake
8.92	Extraction of peat	This class includes: - peat digging - preparation of peat to improve quality or facilitate transport or storage
19	Manufacture of coke and refined petroleum products	This division includes the transformation of crude petroleum and coal into usable products. The dominant process is petroleum refining, which involves the separation of crude petroleum into component products through such techniques as cracking and distillation. This division includes the manufacture of gases such as methane, propane and butane as products of petroleum refineries. This division also includes the manufacture for own account of characteristic products (e.g. coke, butane, propane, petrol, kerosene, fuel oil etc.) as well as processing services (e.g. custom refining).
35	Electricity, gas, steam and air conditioning supply	This section includes the activity of providing electric power, natural gas, steam, hot water and the like through a permanent infrastructure (network) of lines, mains and pipes. The dimension of the network is not decisive; also included are the distribution of electricity, gas, steam, hot water and the like in industrial parks or residential buildings. This section includes the operation of electric and gas utilities, which generate, control and distribute electric power or gas and the provision of steam and air-conditioning supply; and excludes the (typically long distance) transport of gas through pipelines.

[1] Statistical classification of the economic activities in the European Community (NACE Rev.2) EC-EUROSTAT 2008)

2.2 Green growth and the energy sector

While energy has been a major driver in economic development, the energy sector is today facing global challenges, mainly secure energy supply (energy security), combating climate change, mitigating pollution and public-health hazards and addressing energy poverty. These challenges are mainly direct consequences of global economies' predominant dependence on fossil fuels, which accounted to about of 84% of global greenhouse gas emissions in 2009 (United Nations , 2011) (OECD, 2011). Continuing deterioration of natural assets caused by the energy sector could hamper the ability of economies to meet the needs of a growing population (OECD, 2011).

Today's energy consumption is rooted back in the industrial revolution conceived during the 18th century when fossil fuels started becoming a main energy source in the industrialized world. Since then, this ample availability of fossil fuels boosted a rapid technological development which in turn busted highly productive agriculture and industrial production as well as transport and improved quality of life. Despite of the effects of shortages on energy supply have taken place in the past, it was not until the 1970's when the consequences of energy scarcity were acknowledged at global scale as rising oil prices proven to have severe negative impacts on national economies. Today, increasing energy demand alongside with continued rising energy prices expose countries to energy security risks associated with the reliability and affordability of energy (United Nations , 2011).

Negative environmental consequences resulting from the utilization of fossil were evident already during the industrial revolution, mainly as local air population. The release of both black carbon particles resulting from incomplete combustion of fossil fuels, and other polluters such as sulphur and nitrogen oxides, photochemical smog precursors and heavy metals have shown being detrimental effect on public health. Through time, emissions of these pollutants have been reduced thanks to technological solutions but still remaining an important hazard to human health and ecosystems (United Nations , 2011).

The impact of CO_2 emissions on global temperatures received international recognition mainly during the 90's unveiling a greater future challenge for world's economies. The fact that CO_2 emissions are unavoidable in fossil fuel combustion implies that fossil fuel consumption has to be reduced to such extent that CO_2 emissions decrease to levels that prevent further increases of global temperatures. According to the Intergovernmental Panel on Climate Change (IPCC, 2007) the concentration of GHGs should be cut by 50% by 2050 compared with 2005 in order to limit the rise of average global temperature to 2 degrees Celsius. Nevertheless, increases on world's primary energy demand are expected to continue approximately by 1.4% per year up to 2035 (United Nations , 2011).

Since the 70's many countries have taken actions to reduce oil dependency particularly in electricity and heat generation including nuclear energy, coal power plants and the exploitation of Renewable Energy Sources (RES). The deployment of nuclear energy has been extensive in Europe, though involving several problems including high investment costs and technical, political, and social concerns about nuclear waste disposal, increased proliferation and the scale and nature of nuclear accidents (Rasmussen, et al., 2010). Increased utilization of coal has caused several problems including not only air pollution and acid rain, but more challenging high CO_2 emissions. More recently, the detrimental effects of coal mining on the landscape and the environmental are becoming severe implying the displacement of communities, the destruction of natural areas and contamination of water reservoirs (Mamurekli, 2010).

After more than 40 years of debate on the sustainability of different energy alternatives, RES are still regarded as the most beneficial, at least from an environmental point of view. According to the United Nations Environmental Programme (2011, p. 44) RES can contribute to achieving ambitious emission reduction targets alongside with significant improvements in energy efficiency. A target of 450ppm CO_2 concentration would demand that renewables will stand for 27% of the required CO_2 reductions, while the remaining part would result primarily from energy efficiency and alternative mitigations measures such as carbon capture and sequestration (CCS) (International Energy Agency, 2010).

Two types of RES have so far been extensively exploited namely hydro power and biomass. Hydropower has certainly been important but it is presently reaching its limits in Europe not only due to limitations in the availability of hydrological resources but also due to the fact that further deployment may imply the displacement of communities and severe landscape changes in nature valued areas (Rasmussen, et al., 2010).

Biomass still shows great potentials in Europe. Problems related to its harvest and utilization has however been stressed not only due to limitations in forest and agricultural land productivity but also ecological reasons and conflicts with food security supply. Effective methods for the exploitation of forest biomass as an energy source in countries like Sweden and Finland have proven to provide high outputs by becoming oriented towards harvesting logging residues. Also residues from wood mills and pulp and paper factories are recovered and used as a source of energy. Alongside with substituting fossil fuels, these practices have brought two new approaches in the energy supply sector, namely recycling of energy and materials and increasing energy efficiency in energy generation. At least in Sweden this process was originally not regarded as an environmental measure but instead as a response to increasing energy prices. This particular development has proved that the efficient utilization of RES not only encompasses environmental benefits but also economic ones (Galera-Lindblom, et al., 2012).

Wind energy has also proven to be an outstanding renewable energy source since its large-scale deployment was initiated mainly in Denmark during the 80's. Experiences in wind energy deployment and generation have progressively been accumulated and further developed and adopted in many European countries including Spain and Germany. More recently, solar energy technologies are becoming available in markets both as solar panels and collectors for buildings and houses and large scales installations (Müller, et al., 2011).

Thanks to technological development RES technologies are becoming highly energy and cost efficient. Nevertheless new RES technologies are making the exploitation of new RES such as wave and tidal energy possible. While the demand of RES technological solutions is increasing, strong RES industries are currently appearing as important actors in national and global economies implying increasing employment and value added (Ragwitz, et al., 2009). As later explain in this report, the growth of RES industries and their macroeconomic benefits have been noticed by politicians which in turn have positioned RES development in the forefront of European policy.

2.3 The energy sector and the GREECO approach

The introduction to the energy sector presented above illustrates transformation processes embedded in green economies namely:

- throughput substitution (of fossil fuels);
- residue recycling and;
- materials and energy flow productivity (energy efficiency).

These dimensions are clearly reflected in the three pillars of European energy policy, specifically security of supply, ensuring competitiveness and promoting sustainability, and combating climate change. The long term character embedded within the green economy concept, referring specifically to the long term availability of basic resources, is in-line with contemporary concepts of security of supply adopted by the energy sector in many Member States. The recycling dimension in the green economy concept is further reflected both in security of supply and energy efficiency as these strategies seek among others to utilize residual materials as a source of energy, and the recovering and reduction of process energy.

Ultimately the application of the green strategies in the energy sector brings up the creation of new jobs and value added. This view is shared by the OECD (2011, p. 6) which highlights four key elements that provide the economic rationale for applying green growth strategies to the energy sector:

- Economic costs of environmental damage and poorly managed natural resources associated to the use of fossil fuels and unsustainable practices.
- Innovation to achieve environmental and economic objectives.
- Synergies between environmental and productivity growth objectives.
- Opportunities for new markets and industries.

The fact that RES industries today not only have a strong position in national economies but also show greater potentials in the future implies that RES deployment will play a fundamental role as pillar in green economies. This implies that RES ultimately create new markets that reconcile limited use of natural resources with economic growth. Taking the energy sector as a whole, and acknowledging its' vital role for all sectors in modern economies, indicate that this sector will conceive the backbone for a future green economy.

Against this background, the following study covers aspects of substitution, efficiency and recycling in the transformation of energy. Aspects related to the consumption of energy by end consumers are however not extensively scrutinized but instead further investigated in the other sector reports in the GREECO project. In light of the fact that RES are considered key resources in achieving green growth the following study will focus on these resources as a mean of replacing fossil fuels, referred here as the process of substitution. Efficiency in the transformation and transmission of energy is also covered in here, basically as a precondition for the deployment of RES. Aspects of job and economic value creation are investigated in the view of European policies to support RES and efficiency in the generation, transformation and transmission of energy.

2.4 Review of key aspects in green growth in the energy sector

This study focus on three key activities performed by the energy sector namely the exploitation, transformation/generation and transmission of energy. For the transformation/generation of energy both process of substation and efficiency are scrutinized. Substitution implies the replacement of fossil fuels with RES particularly biomass, wind energy, solar energy, hydropower, solar energy and wave and tide energy. Recycling in the energy sector corresponds to the process of substation, in this particular case the recycling of biomass from municipal and industrial waste, and the recovering of process energy.

Efficiency in the transformation of energy refers to the deployment of efficient technologies for transforming of primary energy into electricity and other commercial energy carriers. Transmission refers here to the means of transporting and distributing energy. From a green economy perspective, improvements in the transmission of energy imply measures to minimize energy losses and enable the integration of renewable energy generation and its distribution.

2.5 The energy sector's relation to other sectors

The energy sector's relations to other sectors are of twofold. The energy sector is traditionally dependant of mining of energy products such as oil, coal, lignite and uranium as well as the availability of technology and knowledge necessary for the exploitation, transformation, generation and transmission of energy. From a supply perspective the energy sector closely relates to all sectors in economies as these are completely dependent of energy for performing their activities. From a social perspective the availability and affordability of energy carriers such as electricity and gas is a critical element of quality of life.

This traditional view of the energy sector is today shifting as consequence of the introduction of RES as a major source of nations' energy mix. This applies particularly the energy sectors relation to agriculture and forestry because these are becoming providers of biomass that is transformed into electrical power, heat and refined biofuels. Moreover, the energy sector is becoming more dependant of access to land necessary for the deployment of RES infrastructure such as wind turbines and solar installations. Therefore landowners as well as enterprises related to forestry and agriculture are becoming new important actors in the energy sector.

Structural changes related to the increasing RES in the energy sector are generating new territorial dynamics. Being a sector often steered at national level, the energy sector is not only becoming a common European policy area but also of strategic importance for regional policy. These dynamics are explained more extensively in the chapter on drivers and enablers.

3 Current state and performance of the European energy sector

3.1 Structural business characteristics of the energy sector

3.1.1 Patterns

Due to lack of regional data on the energy sector it was not possible to get an analysis at this level. However, data was accessible for most European countries at national level which provided a good overview on the sector's structural characteristics.

The main indicators scrutinized are employment and Gross Value Added (GVA) at basic prices made available by EUROSTAT in 2012[2]. The largest geographic coverage of this data was found for year 2009 which was issued as a point of departure for this review. However, for some countries data was only available until year 2007, as indicated in the diagrams and tables presented in this section.

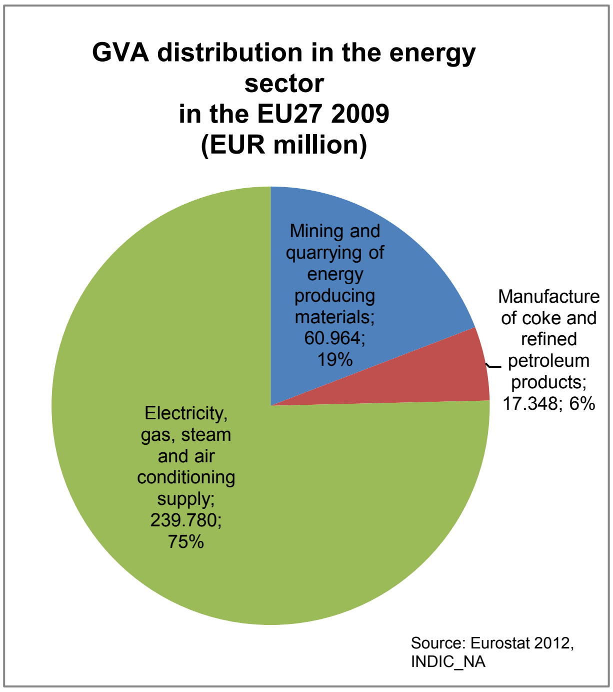


Figure 1 GVA distribution in the energy sector in the EU27 2009

At EU27 scale activities related electricity, gas, steam and air conditioning supply (NACE Rev.2 35) are most significant corresponding to approximately 75% of the entire sector while the mining and quarrying of energy producing materials (NACE Rev.1 CA) and manufacture of coke and refined petroleum products (NACE Rev.2 19) correspond to 19% and 6% respectively. Furthermore, the energy sector's GVA (as defined in this study) corresponds to approximately 2.7% of the EU27's GDP. A look at this indicator presented in Figure 2 shows that major GVA is found in countries with large economies such as the Germany, and the Netherlands, or oil and gas producing countries such as Norway and the UK.

The energy sector's GVA gives a good indication of its magnitude in national economies. The contribution of the energy sector in national economies shows that Norway is clearly more dependent than any other country presented in Figure 3, as the share of the sector's GVA corresponded to 22% of the GDP in 2009. The energy sector seems also playing an important role in national economies in Slovakia (5.7%), Romania (5.54%), the Czech Republic (5.4%), the Netherlands (5.3%), the UK (4.1%) and Poland (4.29%).

Which activity in the energy sector contributes the most is dependent of factors previously mentioned but also the value of the fuel that is produced, being oil extraction clearly the activity that provides highest revenues. However, in the majority of countries the sector responsible for electricity, gas and hot

[2] National Accounts by 64 branches - aggregates at current prices [nama_nace64_c] & and the Structural Business Statistics [ss_na_ind]

water supply is more significant. On the contrary, the sector that manufactures refined fuels appears not only as the less extensive, in terms of GVA, relative to the other two activities but also has shown a negative trend in many countries between year 2000 and 2009.

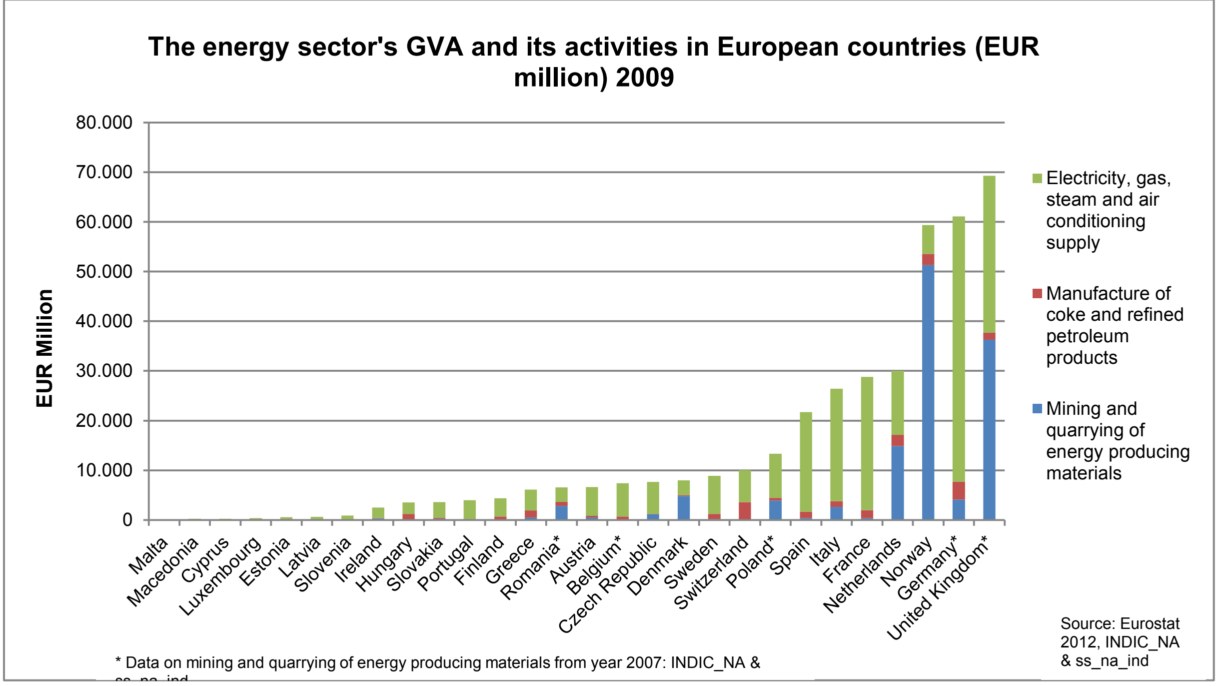


Figure 2 Gross Value Added of the energy sector and its activities in European countries (EUR million) 2009

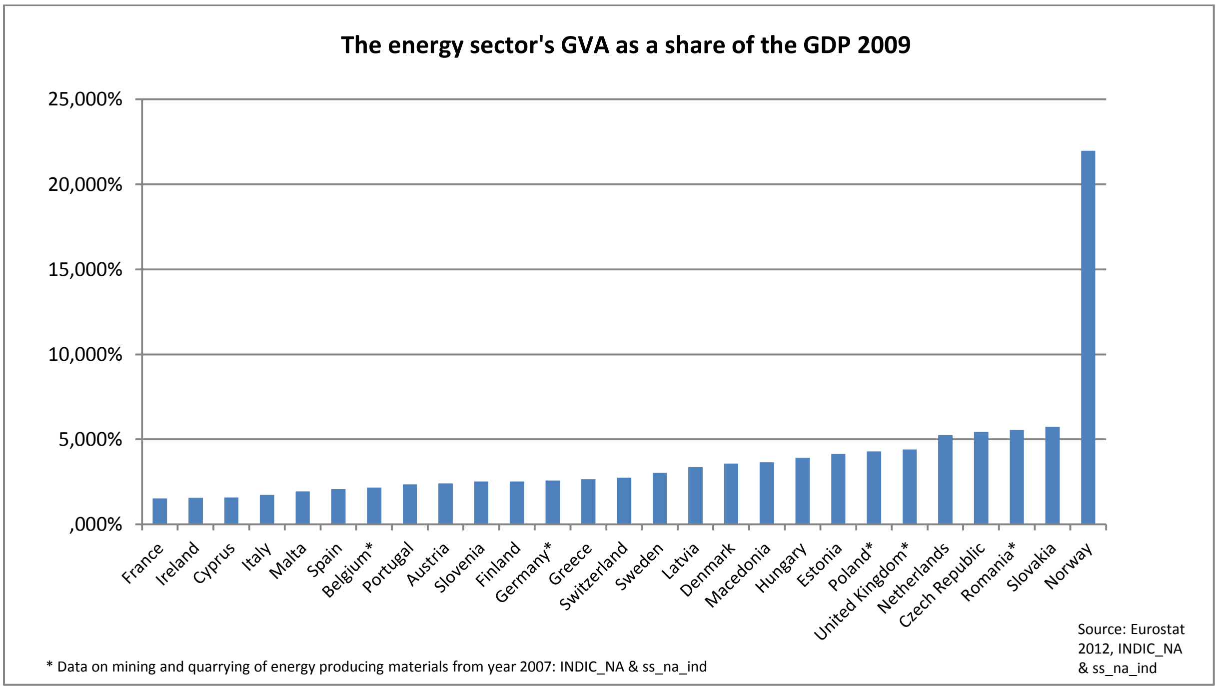


Figure 3 Share of the energy sector's value added at factor cost in the GDP 2007

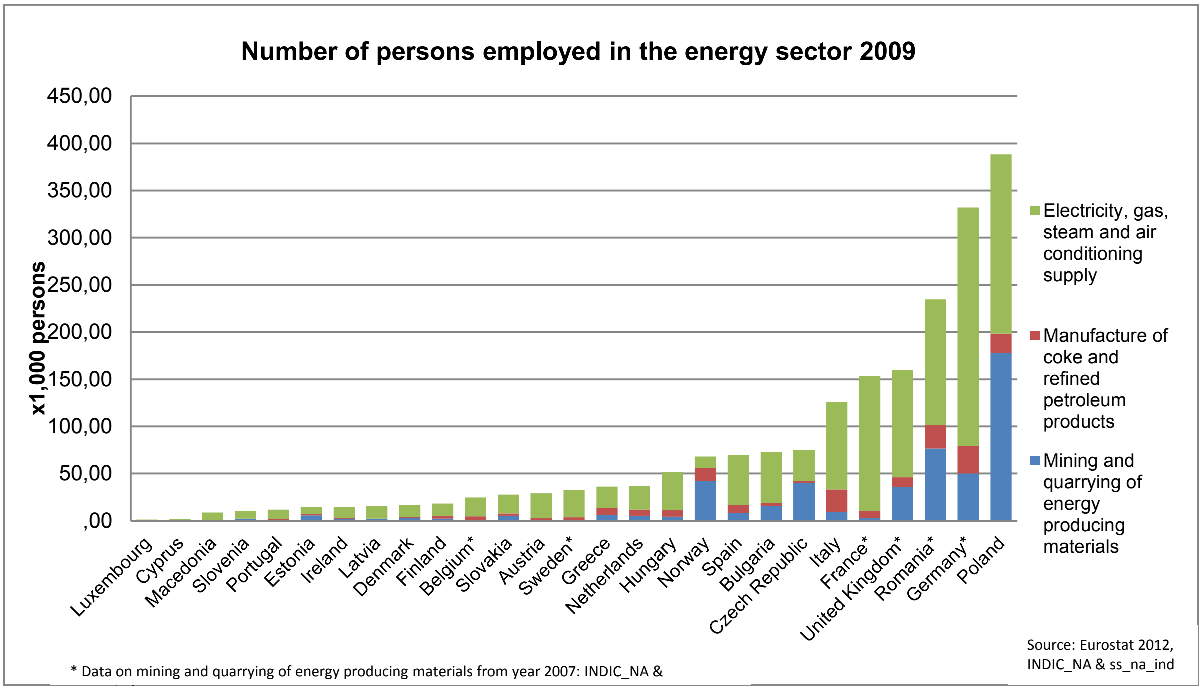


Figure 4 Number of persons employed in the energy sector 2007

The employment generated by the energy sector in the investigated countries shows a similar pattern to the GVA as illustrated in Figure 4. Specifically the energy sector provides most employments in Poland (388,300), Italy (125,800), Germany (332,100), Romania (133,600) and the UK (113,900).

In terms of the different subsectors contributions in the energy sector's employment levels, the electricity, gas and hot water supply sector is the most important source of employment followed by the mining and quarrying of energy producing materials. The contribution of the activities in the total employment in this sector is important especially in Norway (2.72%), Romania (2.54%), Estonia (2.5%), Poland (2.45%) and Bulgaria (2.23%) as illustrated in Figure 6.

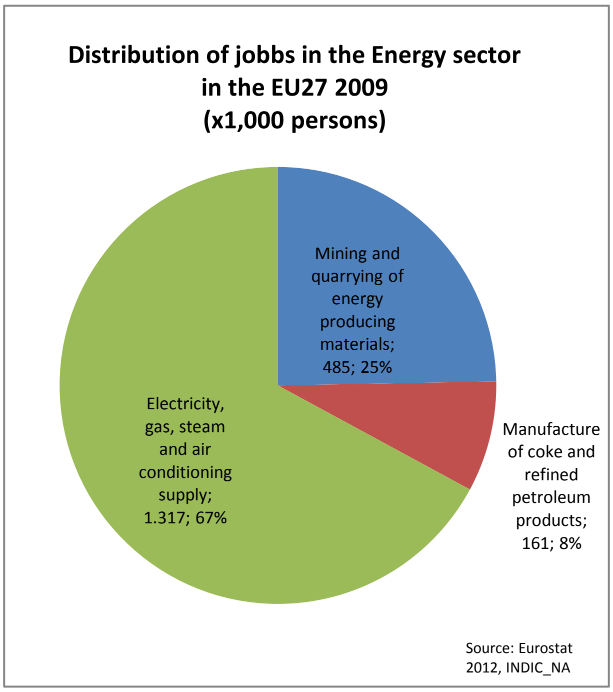


Figure 5 Distribution of jobs in the energy sector in the EU27 2009

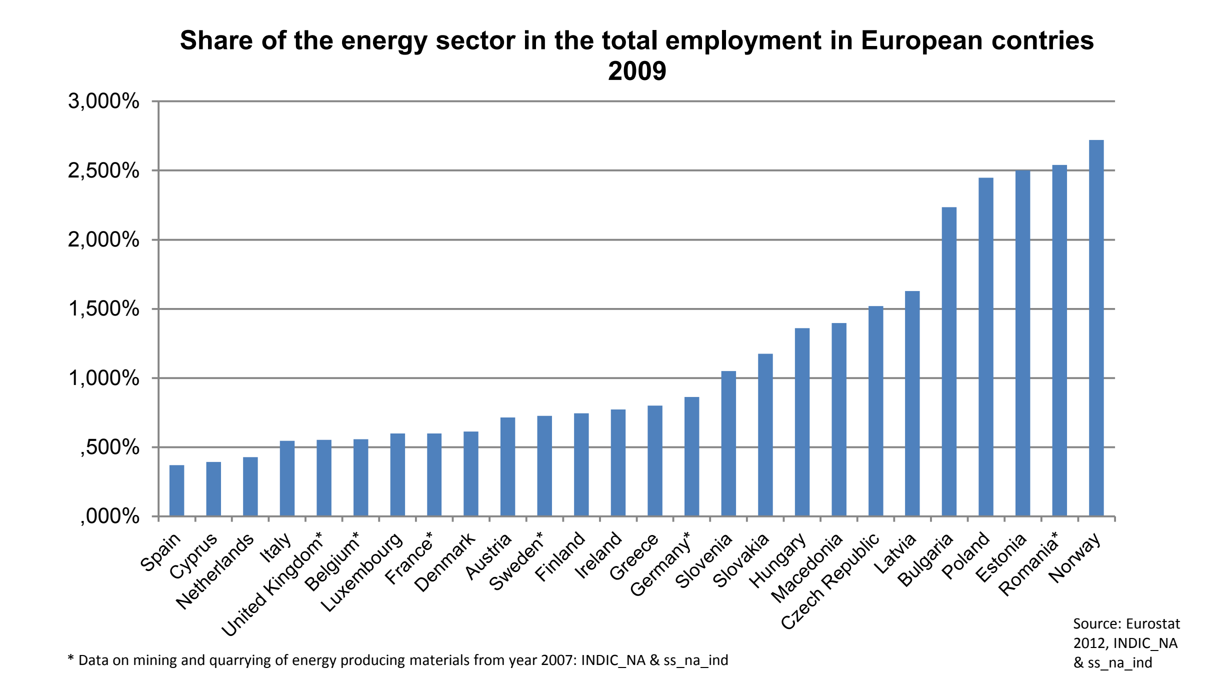


Figure 6 Share of the energy sector in the total employment in European countries 2007

3.1.2 Trends

According to Figure 7 the energy sector's GVA has increased in all the countries investigated between year 2000 and 2009 being most pronounced in Germany, the Netherlands, Norway, Spain, Poland and the Czech Republic. An observation is that in the Netherlands and Norway in particular these increases are partly regarded to oil extraction activities, while for other countries increases are experienced mainly in energy supply activities.

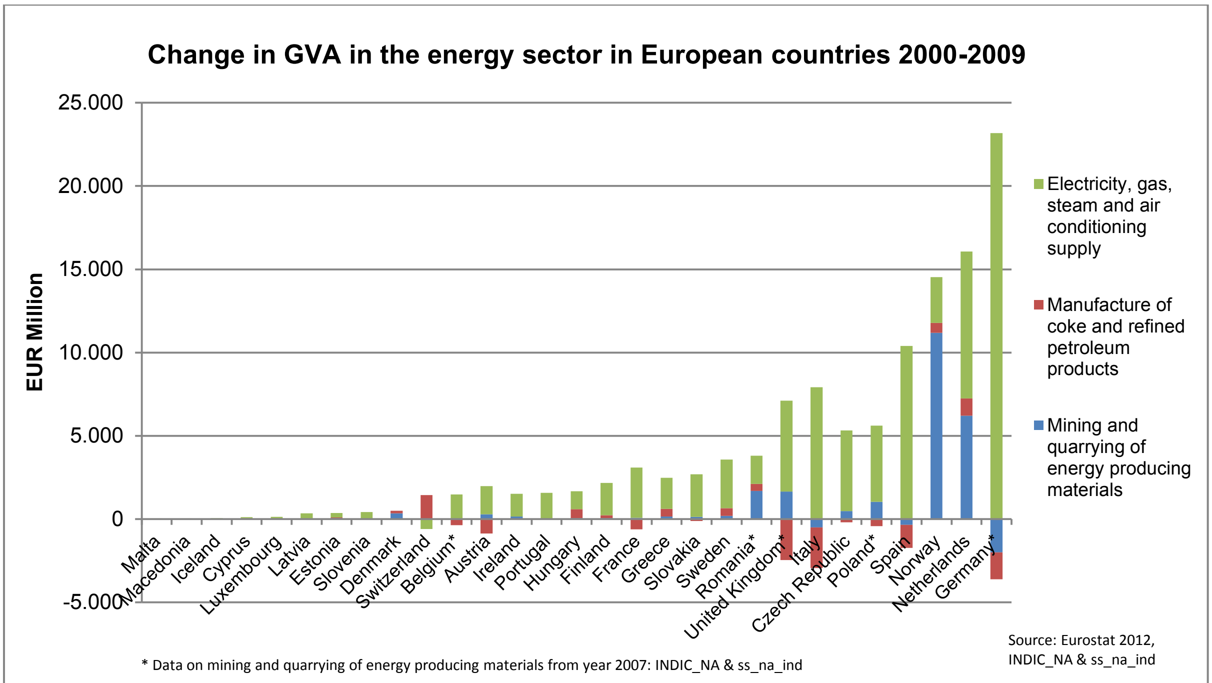


Figure 7 Change GVA in the energy sector in European countries 2002-2006

While GVA levels in the energy sector are increasing the number of persons employed in the energy sector has shortened in the majority of these courtiers.

It is therefore clear that the energy sector is not an exception to other sectors' development in European economies characterized by decreases in labour intensity and increases in value added.

In the context of green economies, the trends visible in Figure 8 are particularly interesting because major job losses are occurring in mining and quarrying of energy producing materials, especially in countries with strong coal mining industry such as Romania, Germany, Poland and the Czech Republic. Also significant job losses are evident in refining industries and supply of electricity, gas and hot water industries. However, few countries are the exception to this trend namely Cyprus, Ireland, Spain, Norway and Sweden. Both Sweden and Spain are interesting because they have made significant investments in renewable energies during the same period which could have contributed to these increases. In Norway on the contrary, new jobs have been created mainly in the oil and refining industry, as a consequence of increased global oil demand and increases in production capacity.

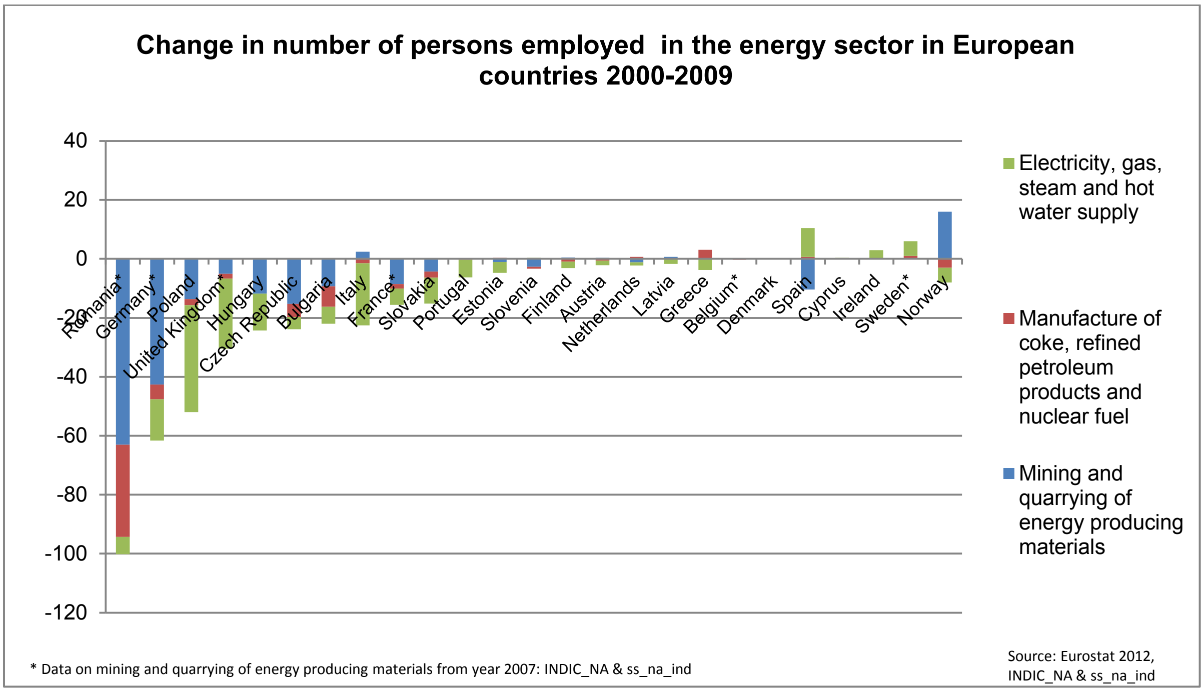
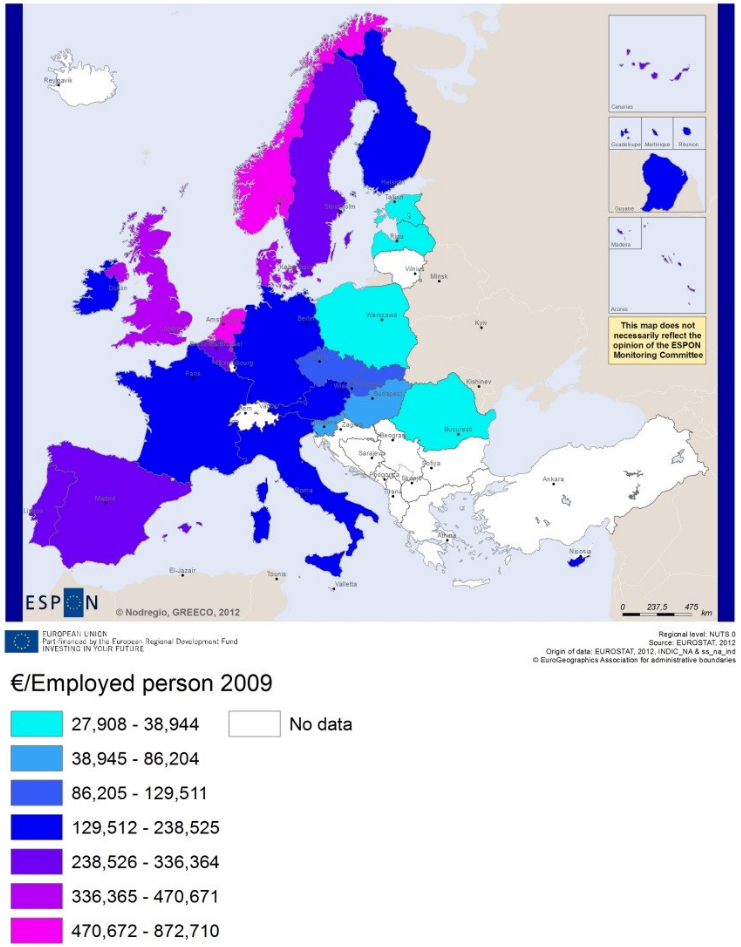


Figure 8 Change in number of persons employed in the energy sector in European countries 2002-2006

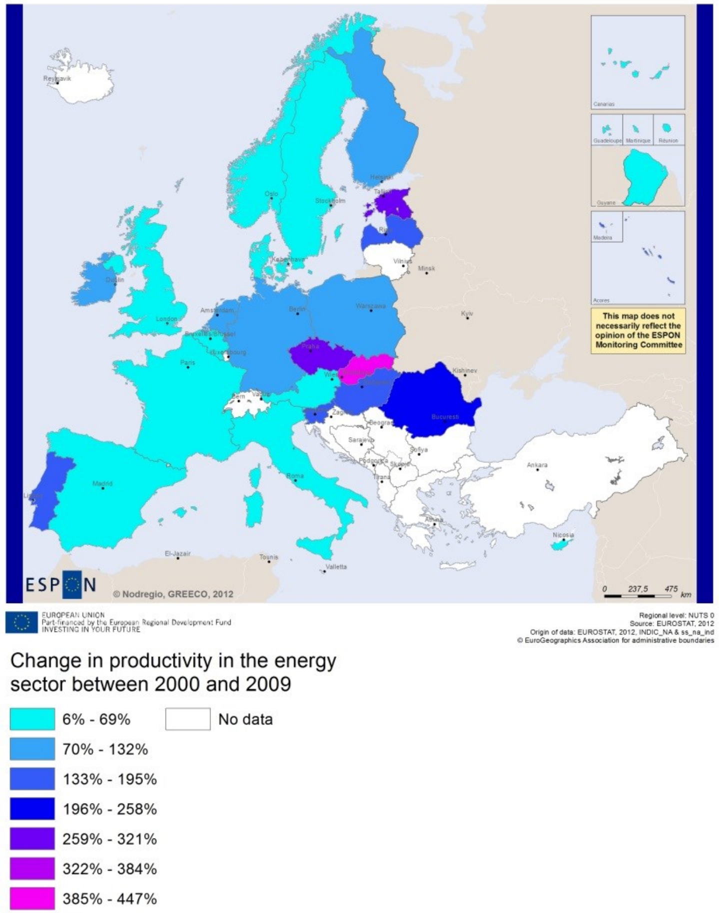
Map 1 shows that productivity in Eastern European countries is lower compared to Western European countries. The general reduction of employment accompanied by increases of GVA implies a general increase in productivity in the energy sector as illustrated by Map 2. While increases in productivity for the EU27 between 2000 and 2009 is approximately 47%, most significant increases are particularly higher in Eastern European countries including Slovakia (447%), the Czech Republic (297%), Estonia (297%) and Romania (240%) where mining activities and energy transformation and distribution have become significantly less labour intensive. Activities related to manufacture of coke and refined petroleum products seem on the contrary to decrease in their productivity.

Productivity in the energy sector



Map 1 Productivity (GVA/employed person) in the energy sector 2009

Change in productivity in the energy sector



Map 2 Change in productivity in the energy sector between 2000 am 2009

Table 2 Changes in employment in the energy sector in European Countries 2000-2009 (Eurostat, 2012).

NACE activity	Mining and quarrying of energy producing materials (sbs_na_2a_mi)				Manufacture of coke, refined petroleum products				Electricity, gas, steam and hot water supply (sbs_na_2a_el)				All Sectors			
GEO/TIME	2000	2009	Chage	Change %	2000	2009	Chage	Change %	2000	2009	Chage	Change %	2000	2009	Chage	Change %
Belgium*	0.2	0.1	-0.1	-70.0	4.6	4.5	-0.1	-2.2	20.0	20.1	0.1	0.5	24.8	24.7	-0.1	-0.6
Bulgaria	24.7	15.4	-9.3	-37.7	10.5	3.6	-6.9	-65.7	59.6	53.7	-5.9	-9.8	94.8	72.7	-22.1	-23.3
Czech Republic	55.5	40.2	-15.3	-27.6	6.3	1.9	-4.4	-69.8	37.0	32.9	-4.1	-11.1	98.8	75.0	-23.8	-24.1
Denmark	3.0	3.0	0.0	0.0	1.0	1.0	0.0	0.0	13.0	13.0	0.0	0.0	17.0	17.0	0.0	0.0
Germany*	92.7	50.1	-42.6	-46.0	34.0	29.0	-5.0	-14.7	267.0	253.0	-14.0	-5.2	393.7	332.1	-61.6	-15.6
Estonia	6.9	5.8	-1.1	-15.9	1.0	1.4	0.4	39.0	11.3	7.7	-3.6	-31.9	19.2	14.9	-4.3	-22.4
Ireland	2.1	2.1	0.0	0.0	0.3	0.5	0.2	66.7	9.5	12.3	2.8	29.5	11.9	14.9	3.0	25.2
Greece	6.2	6.2	0.0	0.0	4.2	7.3	3.1	73.8	26.4	22.6	-3.8	-14.4	36.8	36.1	-0.7	-1.9
Spain	18.4	8.0	-10.4	-56.5	8.1	8.8	0.7	8.6	43.3	53.1	9.8	22.6	69.8	69.9	0.1	0.1
France*	11.1	2.6	-8.5	-76.6	9.5	7.9	-1.6	-16.8	148.6	143.1	-5.5	-3.7	169.2	153.6	-15.6	-9.2
Italy	6.9	9.3	2.4	34.8	25.4	23.9	-1.5	-5.9	113.6	92.6	-21.0	-18.5	145.9	125.8	-20.1	-13.8
Cyprus	0.0	0.0	0.0	0.0	0.1	0.0	-0.1	-100.0	1.1	1.5	0.4	36.4	1.2	1.5	0.3	25.0
Latvia	1.6	2.3	0.7	43.8	0.1	0.0	-0.1	-100.0	15.3	13.7	-1.6	-10.5	17.0	16.0	-1.0	-5.9
Lithuania	1.7	1.9	0.2	11.8	0.0	n.a.	n.a.	n.a.	27.7	18.5	-9.2	-33.2	29.4	n.a.	n.a.	n.a.
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0	0.0	n.a.	n.a.	1.3	n.a.	n.a.	n.a.	1.3	n.a.	n.a.
Hungary	16.0	4.2	-11.8	-73.8	6.8	6.9	0.1	1.5	52.8	40.3	-12.5	-23.7	75.6	51.4	-24.2	-32.0
Malta	0.0	0.0	0.0	0.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	6.7	5.5	-1.2	-17.9	5.6	6.3	0.7	12.5	26.0	24.9	-1.1	-4.2	38.3	36.7	-1.6	-4.2
Austria	0.6	1.0	0.4	66.7	2.2	1.6	-0.6	-27.3	28.0	26.5	-1.5	-5.4	30.8	29.1	-1.7	-5.5
Poland	191.2	177.5	-13.7	-7.2	23.0	21.0	-2.0	-8.7	226.1	189.8	-36.3	-16.0	440.3	388.3	-52.0	-11.8
Portugal	0.0	0.0	0.0	0.0	2.3	2.0	-0.3	-13.0	15.8	9.8	-6.0	-38.0	18.1	11.8	-6.3	-34.8
Romania*	139.7	76.6	-63.1	-45.2	55.8	24.6	-31.2	-55.9	139.5	133.6	-5.9	-4.2	335.0	234.8	-100.2	-29.9
Slovenia	4.8	2.1	-2.7	-56.3	0.7	0.1	-0.6	-85.7	7.7	8.1	0.4	5.2	13.2	10.3	-2.9	-22.0
Slovakia	9.5	5.2	-4.3	-45.3	4.7	2.6	-2.1	-44.7	28.8	20.0	-8.8	-30.6	43.0	27.8	-15.2	-35.3
Finland	1.9	2.4	0.5	26.3	3.7	2.8	-0.9	-24.3	15.3	13.1	-2.2	-14.4	20.9	18.3	-2.6	-12.4
Sweden*	0.7	0.7	0.0	0.0	2.0	3.0	1.0	50.0	24.0	29.0	5.0	20.8	26.7	32.7	6.0	22.5
United Kingdom*	41.1	36.0	-5.1	-12.4	11.6	10.0	-1.6	-13.9	137.6	113.9	-23.7	-17.2	190.3	159.9	-30.4	-16.0
Iceland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Liechtenstein	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0.2	0.2	0.0	0.0	n.a.	n.a.	n.a.	n.a.
Norway	26.0	42.0	16.0	61.5	17.0	14.0	-3.0	-17.6	17.0	12.0	-5.0	-29.4	60.0	68.0	8.0	13.3
Switzerland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	24.4	24.3	-0.1	-0.4	n.a.	n.a.	n.a.	n.a.
Macedonia	0.2	0.1	-0.1	-50.0	n.a.	0.8	n.a.	n.a.	8.7	7.9	-0.8	-9.2	n.a.	8.8	n.a.	n.a.
European Union (27 countries)	729.8	484.8	-245.0	-33.6	188.1	160.8	-27.3	-14.5	1427.6	1316.7	-110.9	-7.8	2345.5	1962.3	-383.2	-16.3

Source: Eurostat 2012, INDIC_NA & ss_na_ind
* Data on mining and quarrying of energy producing materials from year 2007: INDIC_NA & ss_na_ind

3.1.3 The electricity, gas, steam and air conditioning supply sector

Recent national data is available for most European countries within the Electricity, gas, steam and air conditioning supply sector (NACE D35), specifically for year 2009. View from a green growth perspective this sector is the most relevant as it is where most RES activities are found. However, structural business data is not detailed enough to reveal their particular state of the art of the RES sector.

As shown in Figure 9, the supply energy sector in Europe is more pronounced in countries with large population and economies such as Germany, the UK, France, Italy and Spain. Figure 9 also shows that the electricity activities stand for the largest share of the added value of this subsector.

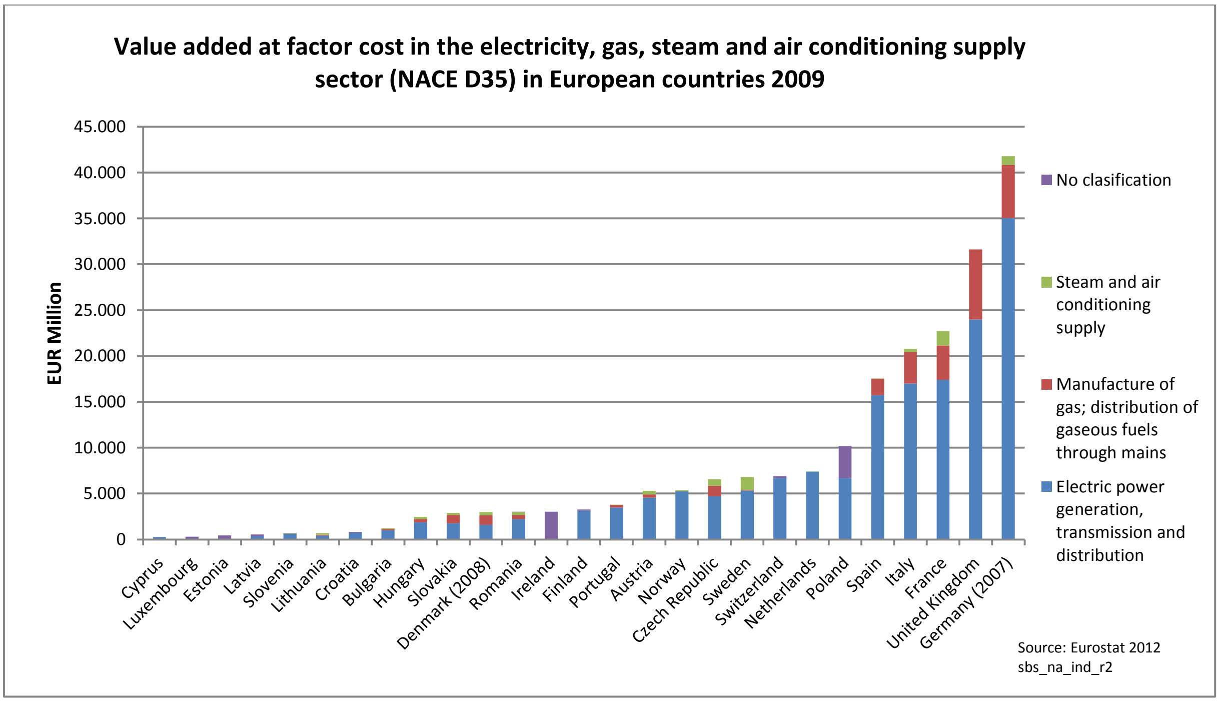


Figure 9 Value added at factor cost in the electricity, gas, steam and air conditioning supply sector in European countries 2009

When relating the sector's added value to the countries' GDP it is noticeable its large contribution to the national economies particularly in Eastern countries, among others the Czech Republic, Slovakia, Bulgaria, Poland, Estonia and Latvia, all with shares larger than 2.5%. Among western countries Sweden and Portugal the energy supply sector appears more pronounced with values above 2%.

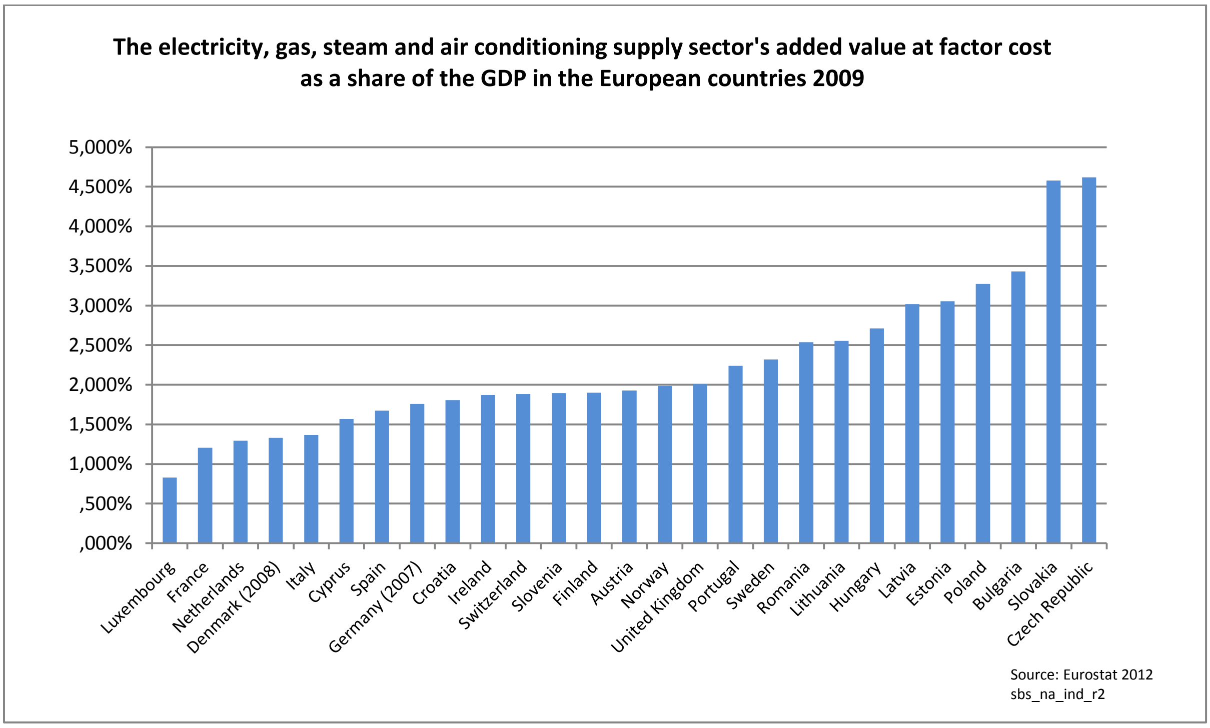


Figure 10 The electricity, gas, team and air conditioning supply sector's added value at factor cost as a share of the GDP in European countries 2009

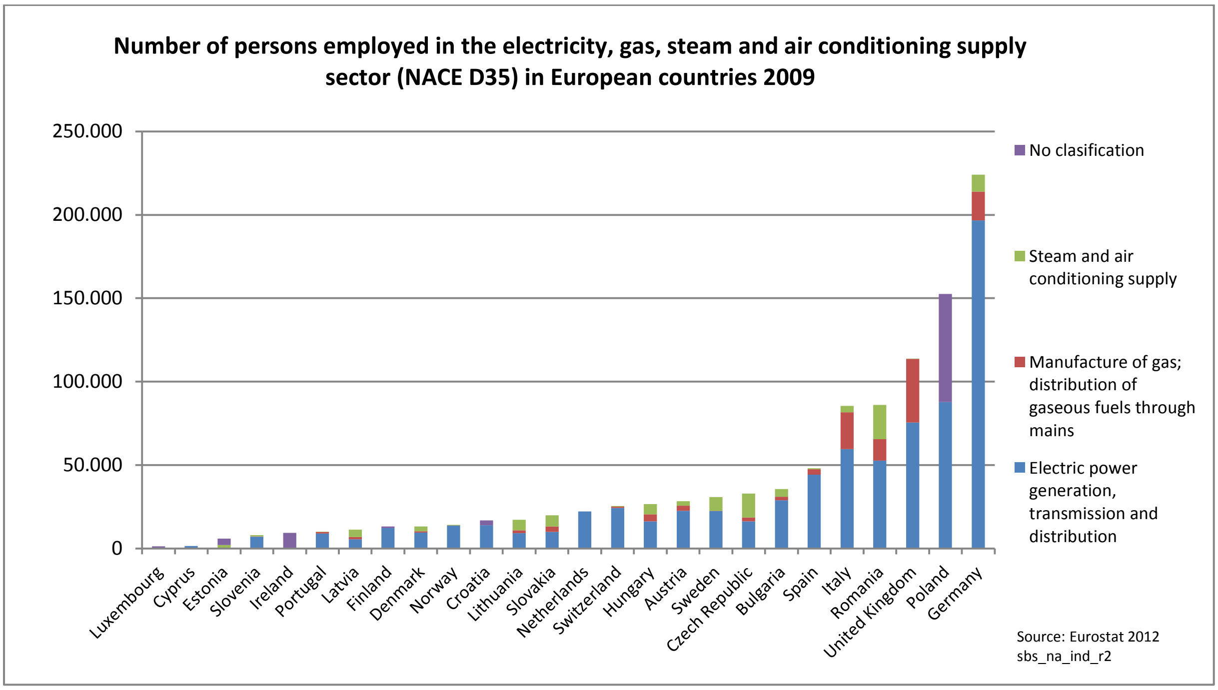


Figure 11 Number of persons employed in the electricity, gas, steam and air conditioning supply sector in European countries 2009

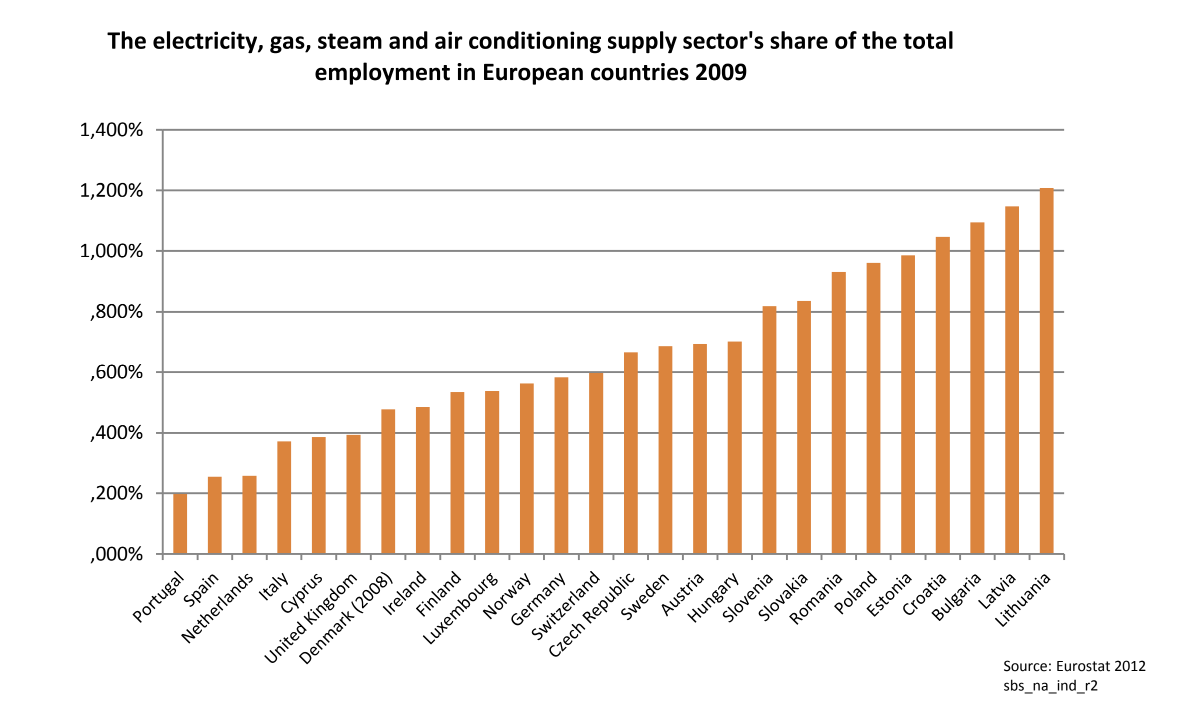


Figure 12 The electricity, gas, steam and air conditioning supply sector's share of the total employment in European countries

The distribution of employment in the energy supply sector among countries reflects partly the distribution of added value. However, Poland becomes ranked second while Rumania becomes ranked fourth among the countries presented in Figure 11. If normalized by the total number of jobs an east-west division regarding the labour intensity of this sector is visible as illustrated in Figure 12.

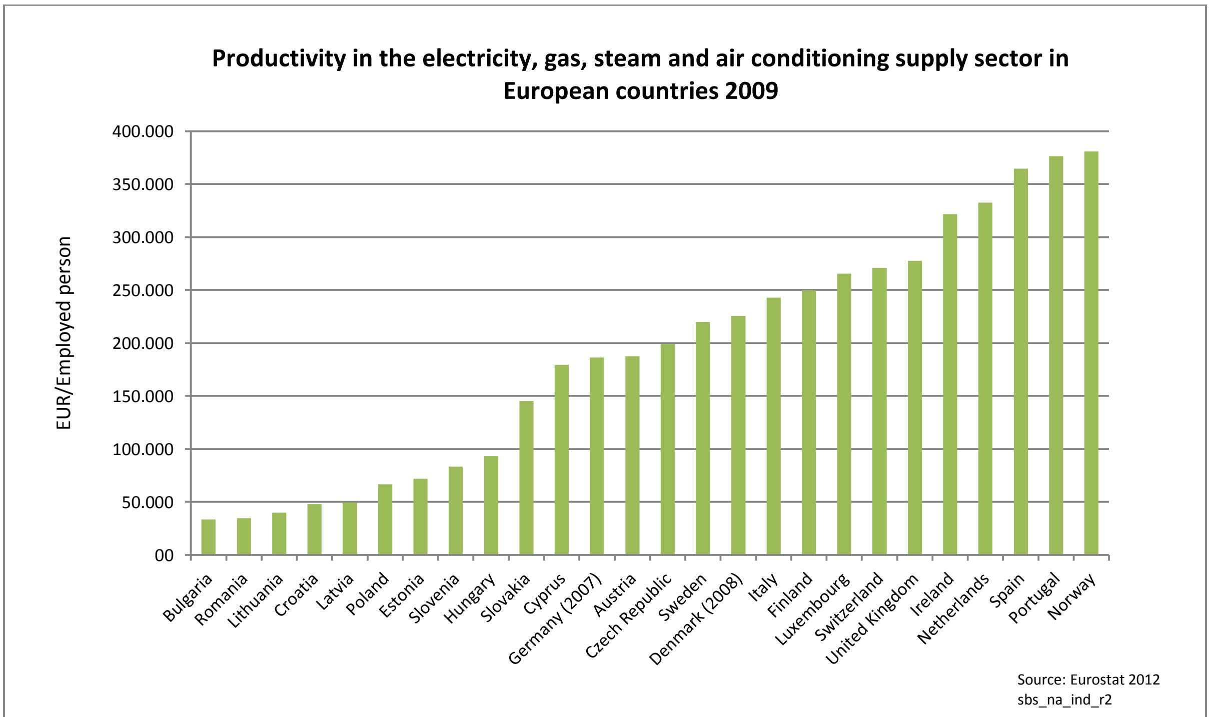
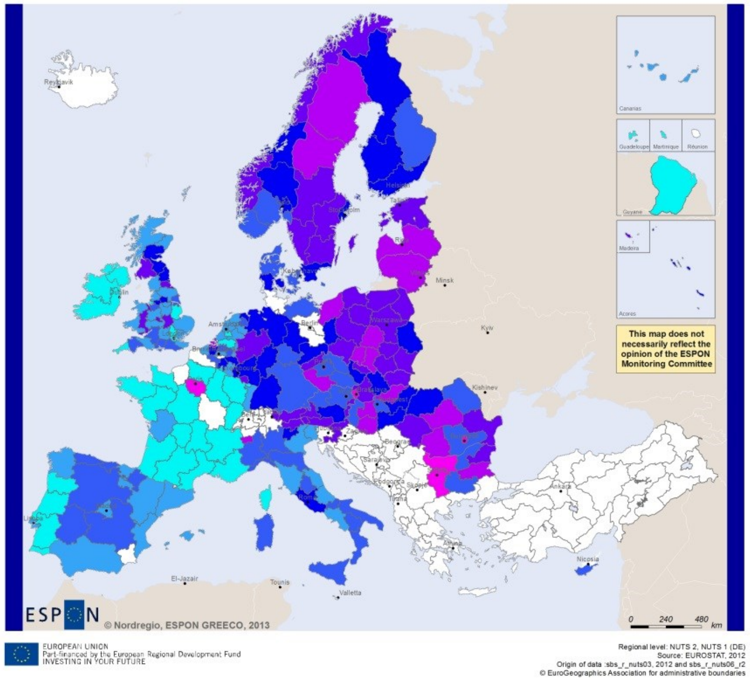


Figure 13 Productivity in the in electricity, gas, steam and air conditioning supply sector 2009

The east-west differentiation among European countries in the energy supply is explained by Figure 13 which shows the sector's productivity given by ratio between added value and the number of employment. It shows that countries such as Bulgaria, Rumania, Lithuania, Croatia and Latvia have lower productivity compared to western countries such as Norway, Portugal, Spain and the Netherlands.

A look at the share of this sector's share in the regional share of the energy supply sector in the total regional employment in Map 3 provides good insight of not only on its role in regional economies but also the level of centralization in the energy sector in individual countries. Generally speaking, the energy sector appears to be more significant in regional economies in peripheral regions particularly in Sweden, Norway and Spain while in France, Italy and the UK the energy sector has larger shares in large urban regions. In the case of France, the extreme level of centralization can be explained partly due to the dominance of nuclear energy generation which is considerably less labour intensive compared to other energy sources. The same map also reflects the east-west division in regarding employment levels at national level.

Relative regional labour importance of the electricity, gas, steam and air conditioning supply sector

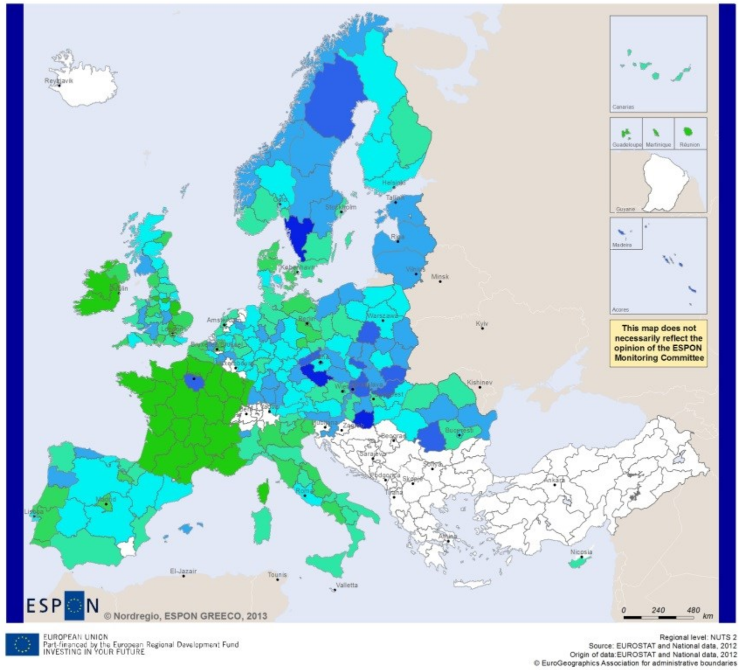


Share of employed labour force involved in Electricity, gas, steam and air conditioning supply sector 2009

- 0.01% - 0.16%
- 0.17% - 0.32%
- 0.33% - 0.48%
- 0.49% - 0.66%
- 0.67% - 0.95%
- 0.96% - 1.44%
- 1.45% - 2.84%
- No data available

Map 3 Relative regional labour importance of the electricity, gas, steam and air conditioning supply sector 2009

Share of the total regional GVA by the electricity, gas, steam and air conditioning supply sector



Share of the total regional GVA by the electricity, gas, steam and air conditioning supply sector 2009

- 0% - 0.7%
- 0.8% - 1.6%
- 1.7% - 2.3%
- 2.4% - 3.1%
- 3.2% - 4.6%
- 4.7% - 7.8%
- 7.9% - 12.8%
- No data available

Map 4 Relative importance of the electricity, gas, steam and air conditional supply sector in the regional economy 2009

3.1.4 The renewable energy sector and future macroeconomic impacts of the RES sector

According to Ragwitz, et al. (2009), the European RES industry has increased significantly since the 1990's, not only due to a fivefold increase in investment expenditure for new RES generation plants (to almost €30 billion in 2005) but also thanks to European suppliers gained considerable market shares through the booming of RES technology such as wind and photovoltaic energy. A strong cross-sectorial RES industry has emerged from this development, comprising of activities needed for planning, manufacturing and installing RES infrastructures, for operating, maintaining, supplying them as well as indirectly by industries upstream in the supply chain. As a result the total grows value added generated by the European RES industry reached in 2005 approximately €58 billion or 0.58% of the EU GDP and provided generated approximately 1.4 million jobs.

Table 3 Macroeconomic impacts of RES policies according to the EmployRES project (Ragwitz, et al., 2009)

Key figures EU27	Unit	Start of modelling	Business as usual			Accelerated deployment policies		
		2006	2010	2020	2030	2010	2020	2030
Gross value added	bln. €2000 / a *	58						
scenario moderate exports (gross effect module)	bln. €2005 / a		65	99	122	70	129	188
scenario optimistic exports (gross effect module)	bln. €2005 / a		65	101	128	70	131	197
Gross employment	mln. jobs *	1.38						
scenario moderate exports (gross effect module)	mln. jobs		1.47	2.31	2.34	1.58	2.76	3.36
scenario optimistic exports (gross effect module)	mln. jobs		1.48	2.34	2.4	1.59	2.8	3.48

The effect of further strengthened RES policies supporting the EU's 20% renewable energy targets in final energy consumption in 2020 is forecasted to generate important employment and economic growth. Specifically, this scenario may provide a net effect[3] of about 410,000 additional jobs and 0.24% additional Gross Domestic Product (GDP). According to Table 3, this implies that the RES sector would amount to €129 billion or 1.1% of the total GDP and provide approximately 2.8 million jobs by 2020, in an accelerated deployment policy scenario. Further, in a scenario with optimistic export expectation, the total gross employment in this sector could increase to 3.4 million jobs by 2030 (Ragwitz, et al., 2009).

Over 60% of the total impacts are related to biomass technologies, mainly the supply of biomass for energy use from agriculture. This mainly because increased demand of biogas, the higher labour intensity of biomass production and increased expenditures on electricity. On the contrary sectors that may experience job losses in the future are among others trade and retail and the tourism sector, but as a consequence of higher energy expenditure of households, the sectorial elasticity in response to higher goods prices drive by energy cost increases and the prevailing budget constraint of households (Ragwitz, et al., 2009).

[3] Net effect: is the sum of positive and negative effects of the deployment of renewable energy systems (Ragwitz, et al., 2009).

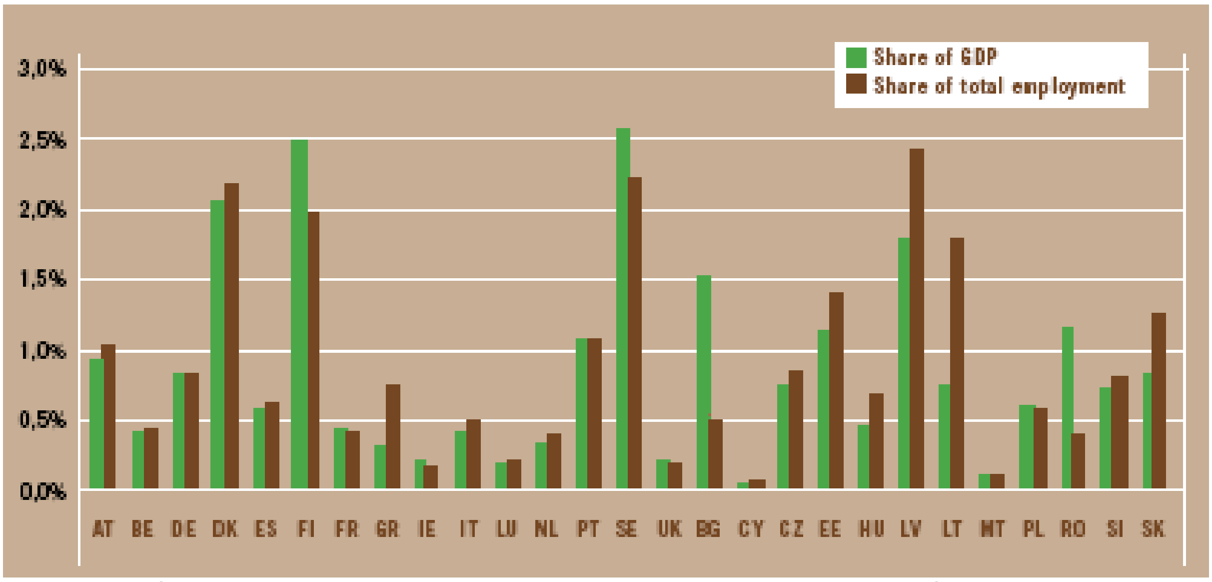


Figure 14 RES related gross economic and employment impacts in EU Member States, 2005 (Ragwitz, et al., 2009)

Figure 14 shows that the size of the RES sector for year 2005 varies among MS. The MS with largest market shares of RES industries are Sweden, Finland, Denmark and Latvia while in Cyprus and Malta this sector is very small. According to Ragwithz, et al. (2009) differences between GDP and employment shares reflect the relationships between RES-related labour productivities and average labour productivity in MS.

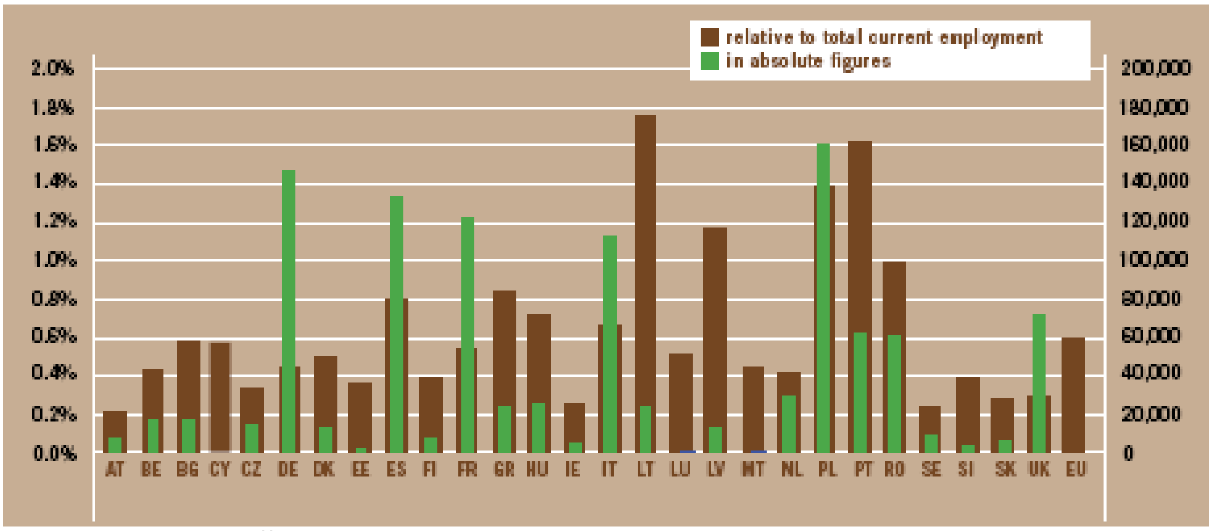


Figure 15 Absolute differences in employment between the Accelerated Deployment Policies (ADP-ME) and no-policy scenarios for 2020 in relation to total employment in 2007 (Ragwitz, et al., 2009)

Relative to current employment levels the impacts of an accelerated deployment RES policies will be particularly larger for Eastern European countries in year 2020, as illustrated in Figure 13. In absolute terms the impacts of the impacts will be larger in countries with large population such as in Germany, Poland, Spain and France.

3.2 Production and consumption of energy

3.2.1 Patterns and trends

Gross inland energy consumption in the EU-27 has since 1990 been relatively stable with an increase of approximately 6% until 2010. A dynamic trend characterized however by a shift in the structure of the primary energy consumption towards and increased use of natural gas, nuclear and renewable energies and the detriment of coal and oil has taken place. This process of substitution implied specifically that the consumption of coal and oil decreased by 38% (173,460 TOE) and 2.5% (15,840 TOE) respectively while the demand of natural gas and nuclear and RES has increased by 50%(146,890TOE), 31% (31,358TOE) and 143% (101,418TOE) respectively .

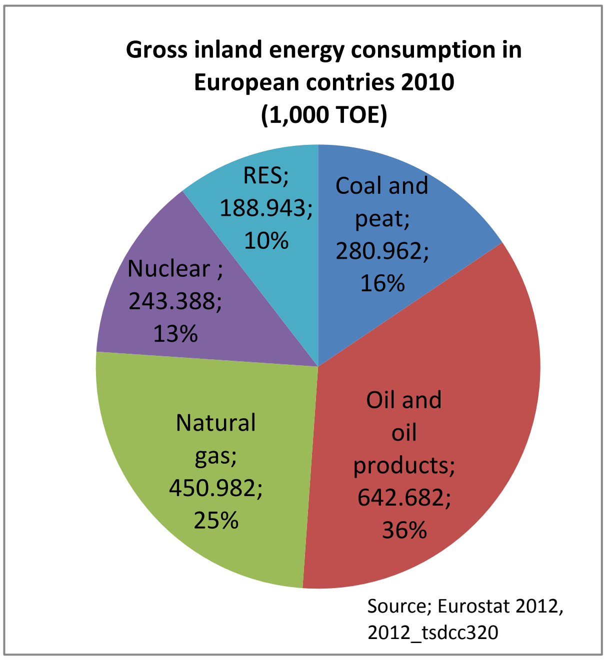


Figure 16 Gross inland energy consumption in European countries 2010

Still fossil fuels are the main source of energy in Europe because it represents approximately 76% of the gross inland energy consumption, followed by nuclear energy (13%) and RES (10%) according to Figure 16.

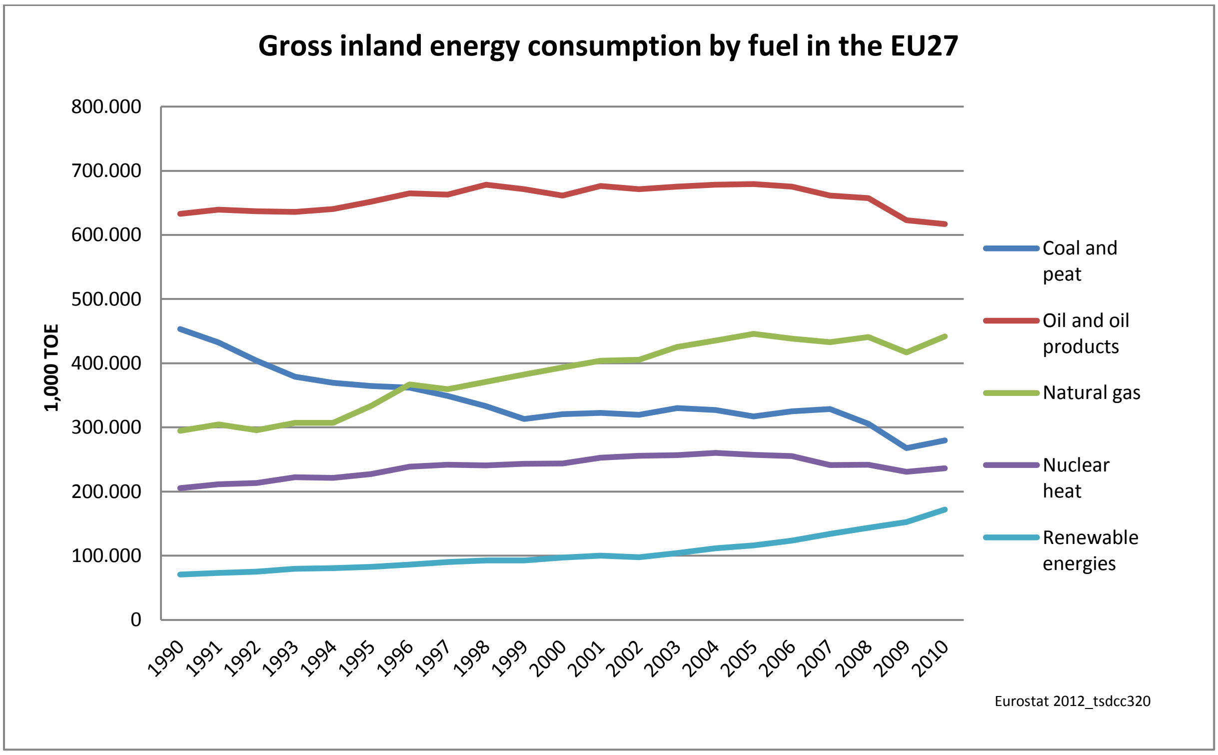


Figure 17 Gross inland energy consumption by fuel in the EU27 (1990-2010)

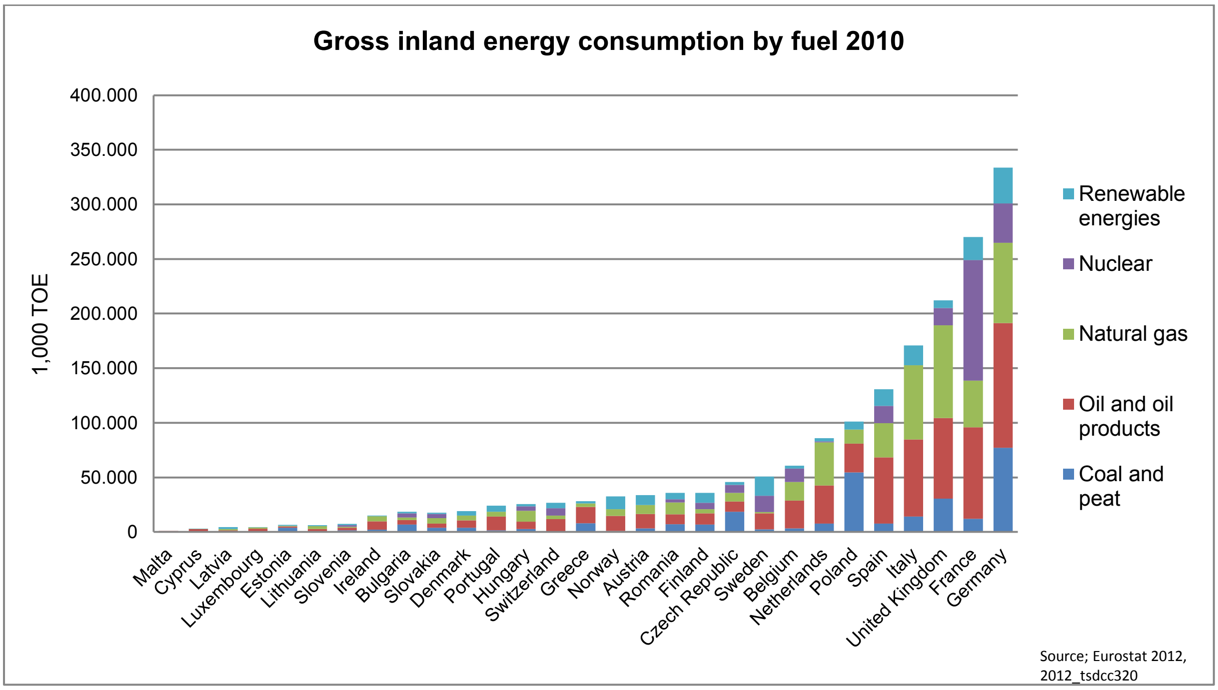


Figure 18 Gross inland energy consumption by fuel type 2010

By 2010 the European countries with highest energy demand were Germany (336,095TOE), France (268,576TOE) and the United Kingdom (212,629TOE). The energy mix in European countries varies individually depending of the availability and accessibility to local and imported energy sources, as well as policies in the energy sector. It is clear that European economies are very dependent of coal, gas and oil fuels as combined they correspond to more than 70% of the gross energy consumption for most European countries excepting in Latvia, Lithuania, Switzerland, Norway and Sweden.

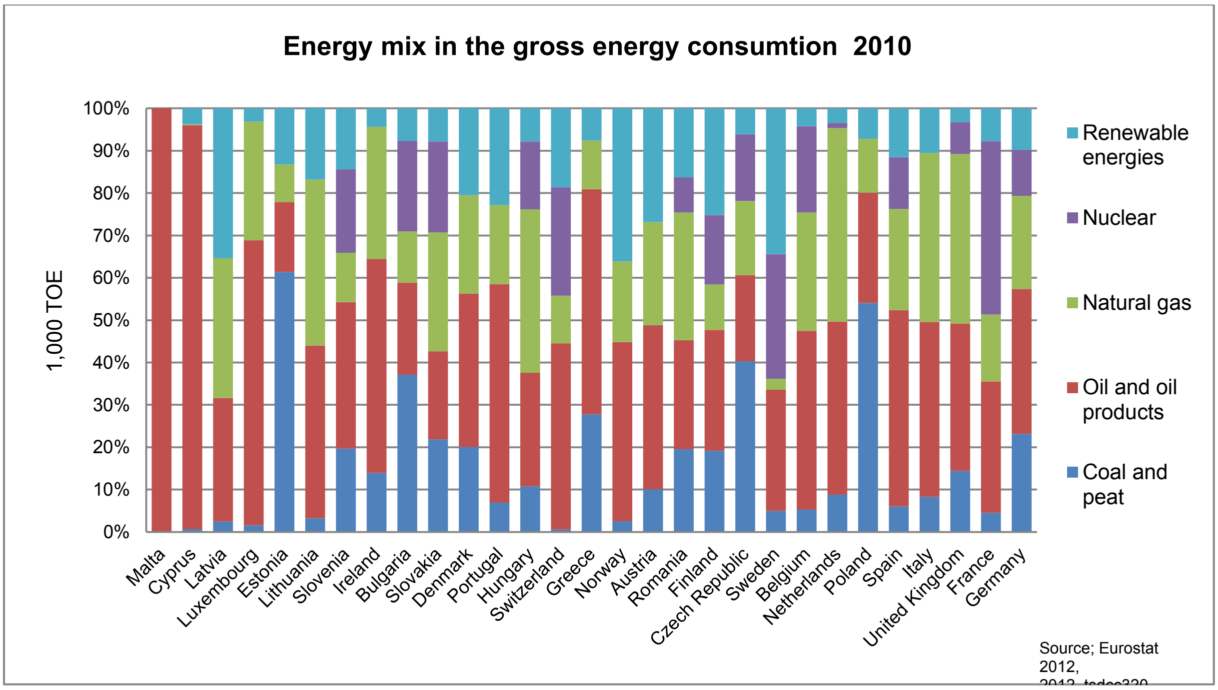
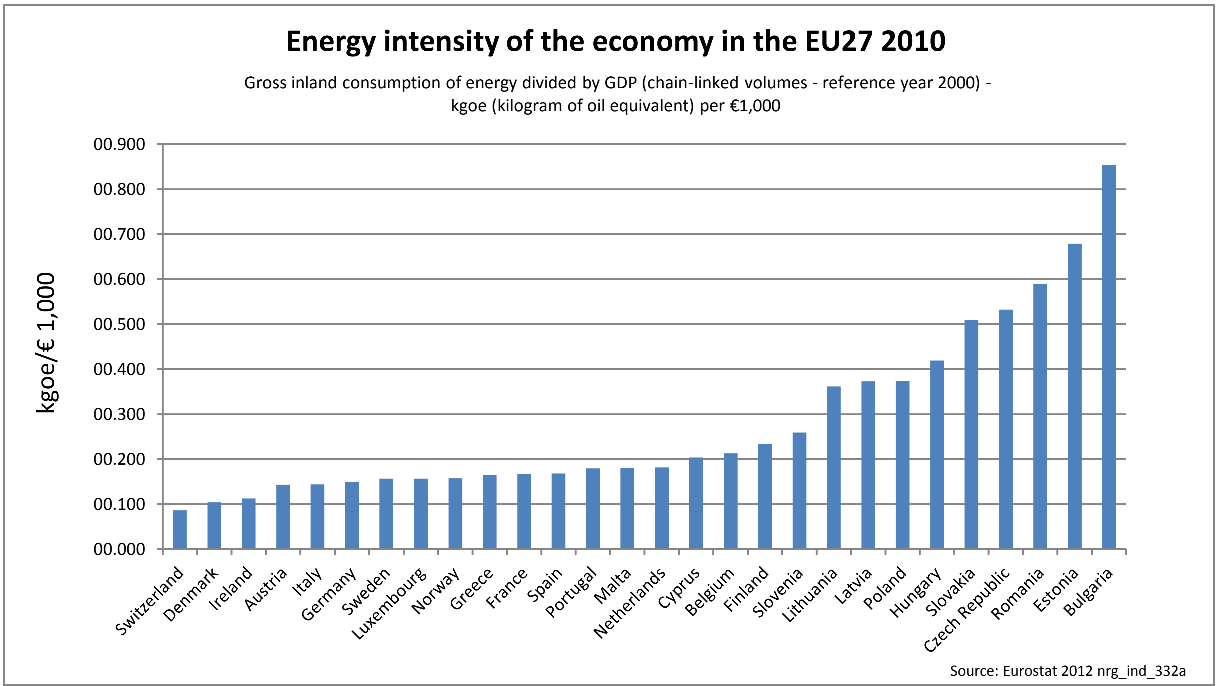


Figure 19 Energy mix in the gross energy consumption in European countries 2010

A common comparative approach on energy consumption in countries is to assess the energy intensity of the economy by dividing the gross inland consumption of energy by GDP. According to Figure 20 most energy intensive economies are found in eastern European countries among others Bulgaria, Estonia, Romania, the Czech Republic and Slovenia. Among the less energy intensive economies are Switzerland, Denmark, Ireland, Austria, Italy and Sweden. Looking at the energy intensity of the EU27 through time it is possible to observe that it has decreased by approximately 10% between year 2000 and 2010.



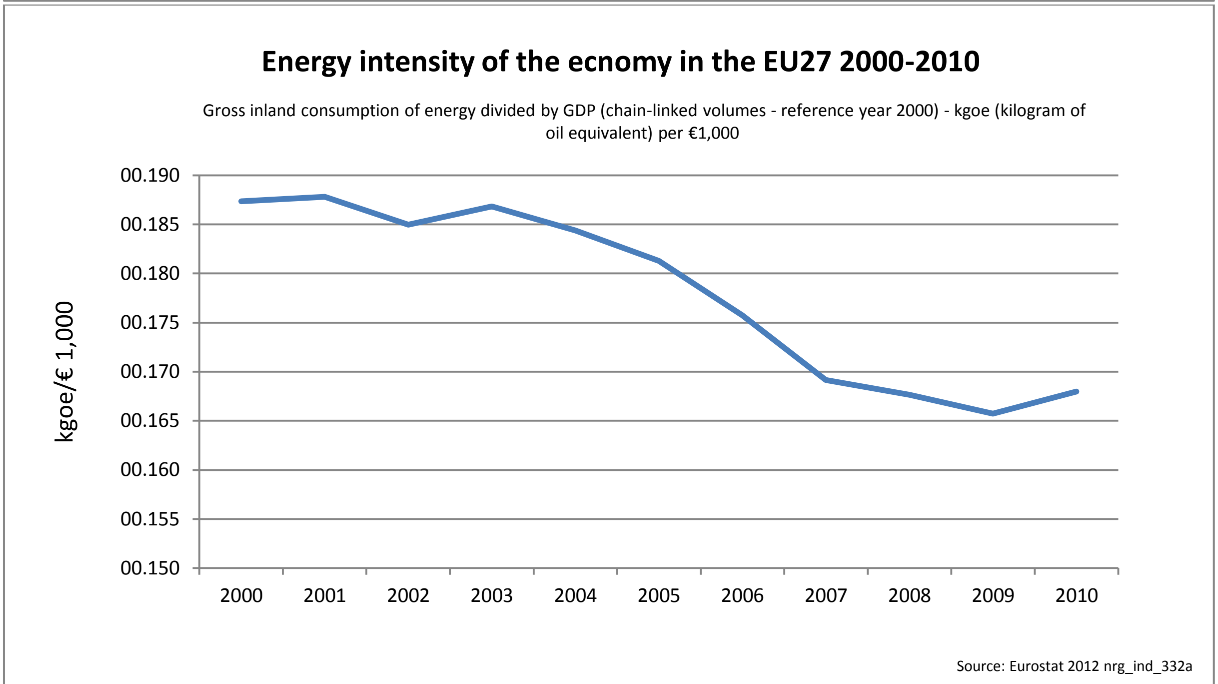
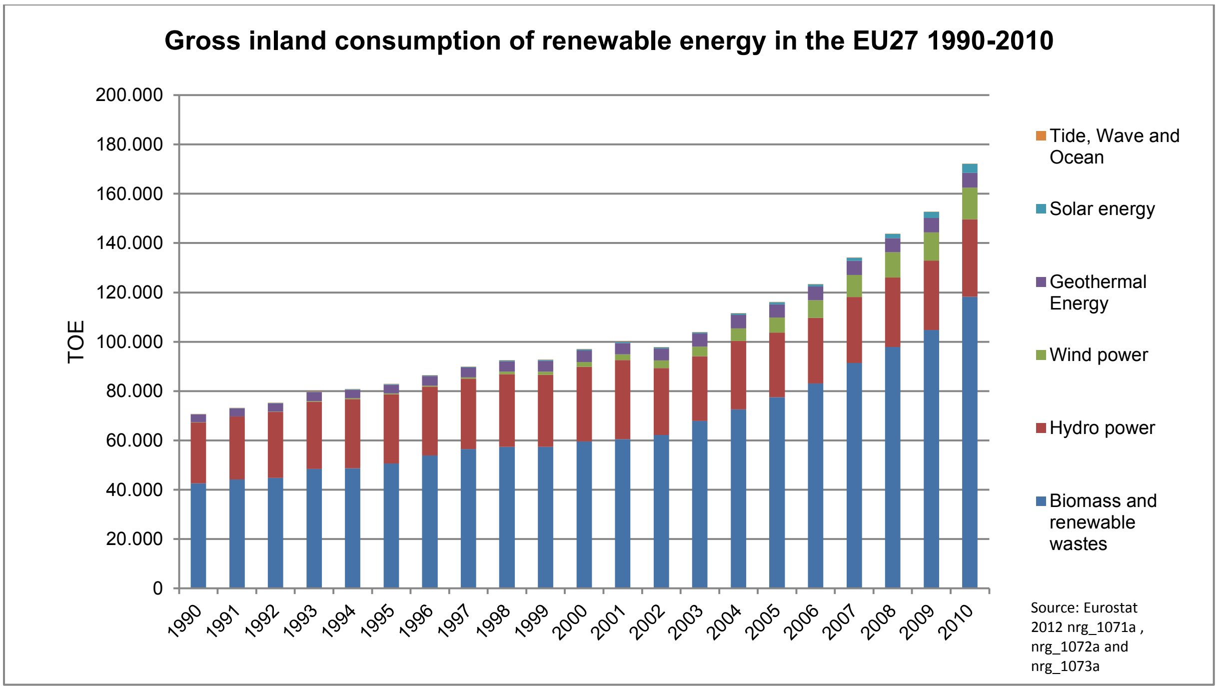


Figure 20 Energy intensity of the economy in the EU27 2010

3.2.2 Renewable energy

As previously described, the increase of renewables since year 1990 until 2010 has been the second largest among the fuels consumed in the EU27, about 101,418TOE to a total of 172,140TOE. In percentage, renewables showed the highest increase during the same period, approximately 143%.



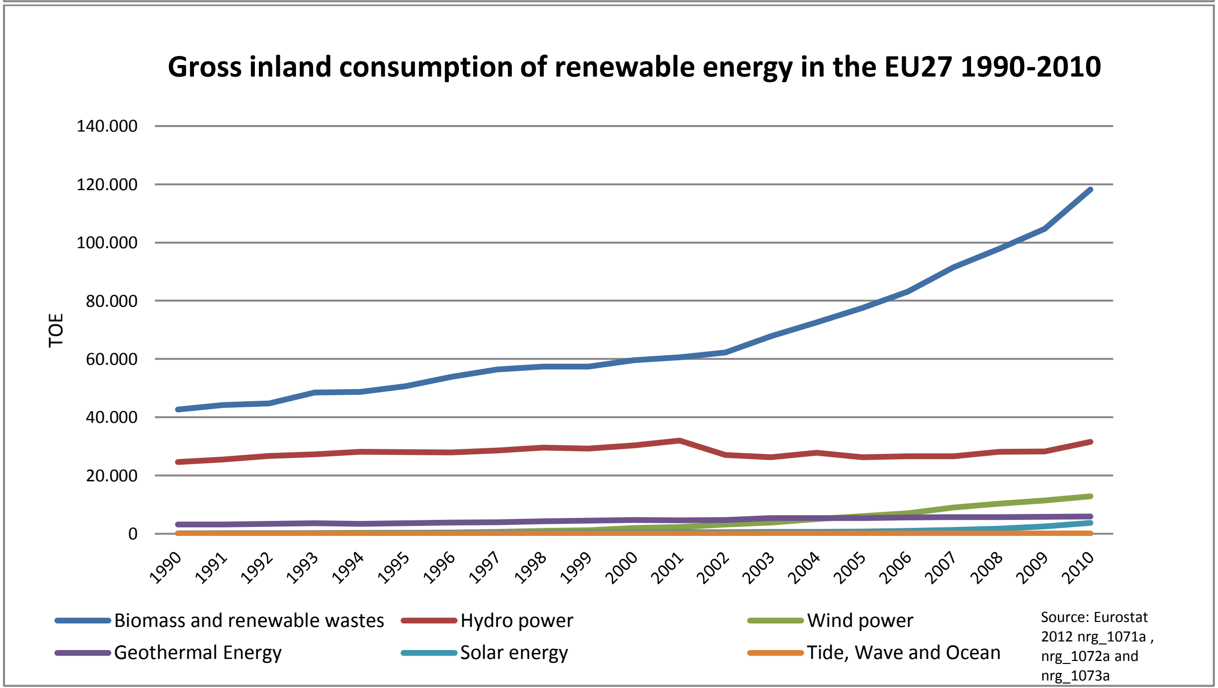


Figure 21 Gross inland consumption of renewable energy in the EU27 1990-2010

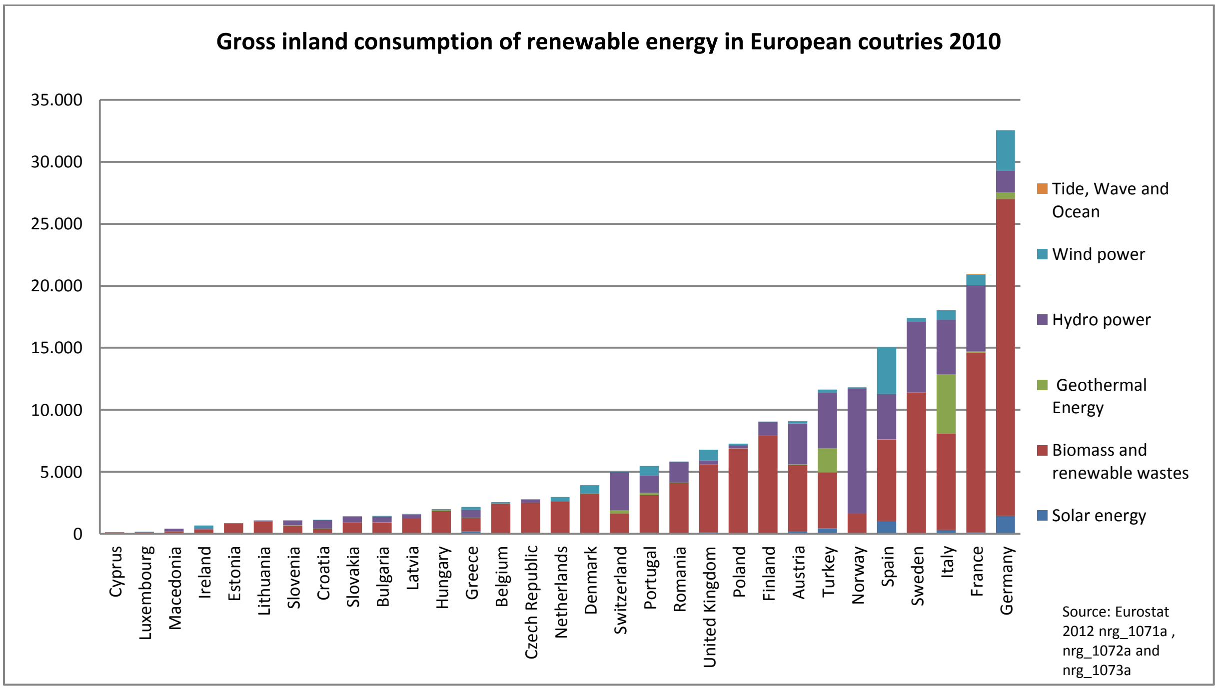
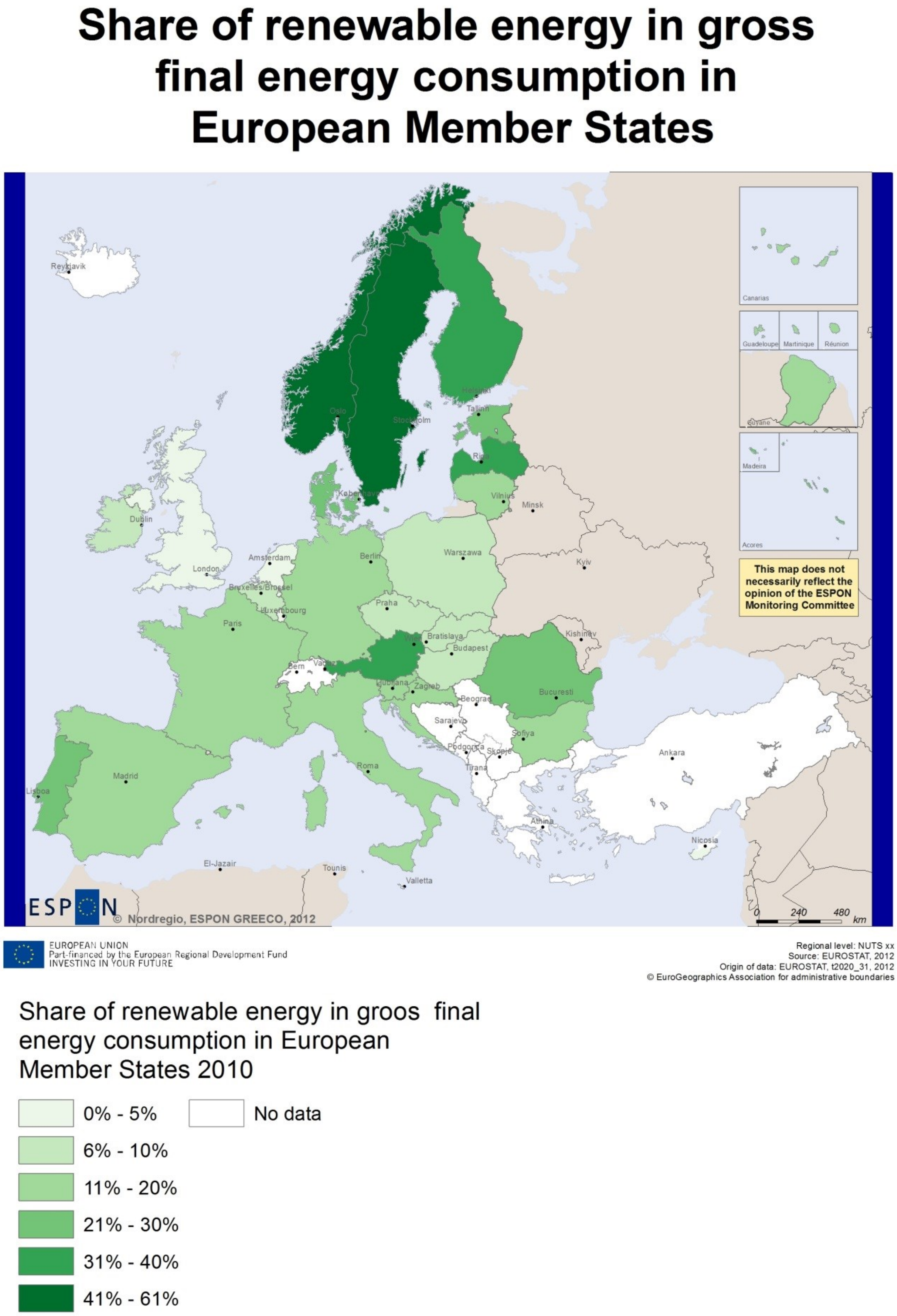


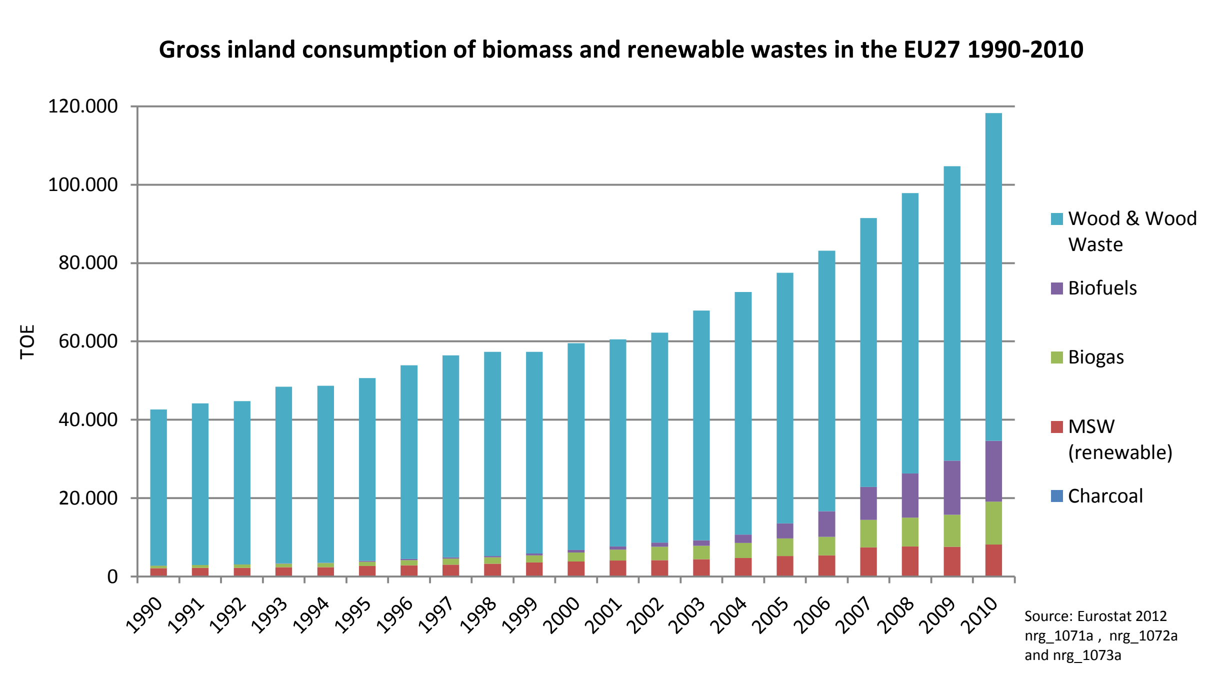
Figure 22 Gross inland consumption of renewable energy in European countries 2010

Among the different types of renewable energy sources, biomass has been the one that has increased fastest especially, approximately 177% between 1990 and 2010 to a total of 118,220TOE which corresponds to a share of 69% of all renewables in the EU27. Also the consumption of wind power has increased significantly during the same period from 67TOE to 12,800TOE becoming the third largest renewable energy source with a share of 7%. Hydropower has kept its position as the second largest by increasing about 28% or 6,880 TOE, having a total share of 18% of all renewables, approximately 31,490TOE. Also geothermal and solar energy has percent-wise increased significantly. Geothermal energy has increased by 84% or 2,690TOE to 5,880TOE while solar energy has increased approximately 3,550TOE to a total of 3,690TOE. The only RES that has shown a negative trend has been tide and wave energy from 49TOE to 45TOE.

Countries with largest gross inland consumption of RES energy are Germany, France, Italy, Sweden and Spain. However, in terms of the share of RES in the gross inland energy consumption Norway, Latvia, Sweden, Austria and Finland are at the top.



Map 5 Share of renewable energy in final energy consumption 2010 in EU MS



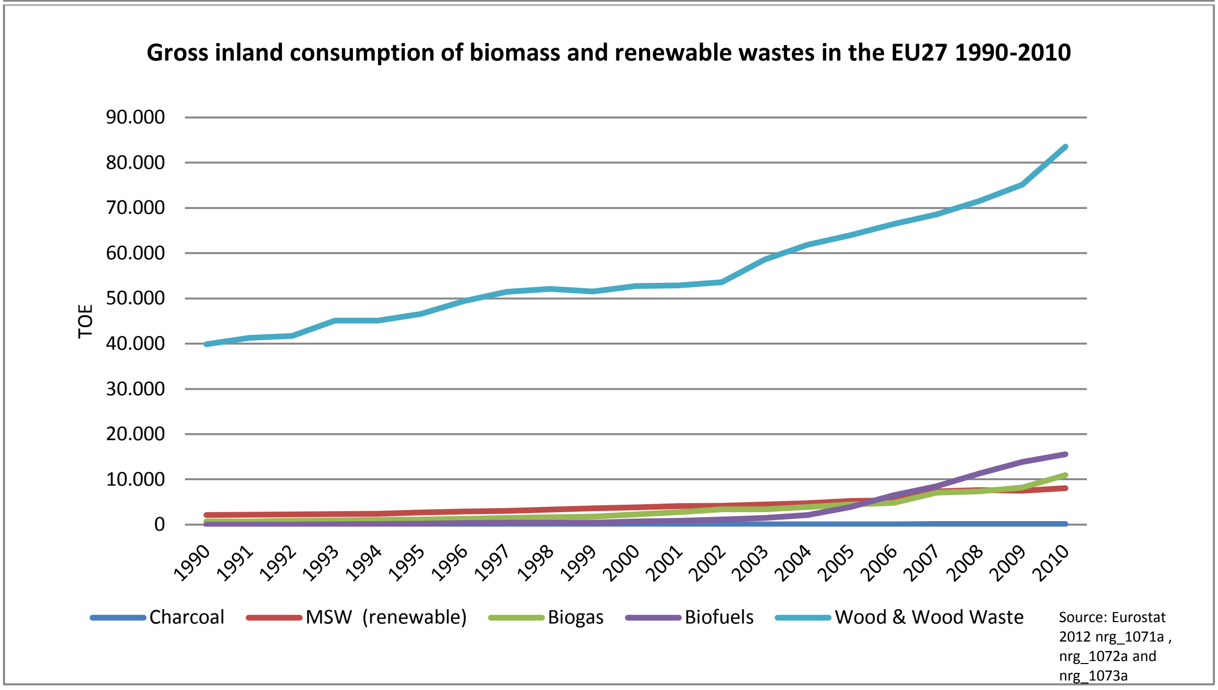


Figure 23 Gross inland consumption of biomass and renewable waste in the EU27 1990-2010

Since 1990 until 2010, generation of energy from wood and wood wastes has increased by 43,720TOE to 83,580TOE which is approximately 71% of the share of all biomass used for energy generation. Also an important increase has taken place in the consumption of biofuels for the transport sector which has increased from 6TOE in 1990 to 15,525TOE in 2010, mainly after year 2002. Consumption of biogas has also followed a similar trend as it has increased to 10,964TOE from 665TOE. To a less degree the use of renewable Municipal Solid Waste (MSW) has increased from 2,132 to 5,920 corresponding to 7% of the total biomass utilized for energy generation.

3.2.3 Achievement of policy targets

As described in section **¡Error! No se encuentra el origen de la referencia.** page **¡Error! Marcador no definido.**, in 2009 the EU set a legally binding target on 20% of RES in gross final energy consumption as well a 10% target on the share of biofuels in the transport sector. Based on the state of RES consumption in 2005, these targets are stipulated in the Directive 2009/28/EC on the promotion of energy from renewable sources, which assigns individual targets on the share of renewables for each MS as presented in Figure 24. For biofuels in the transport sector a share of 10% was stipulated for all MS.

According to Figure 24 Norway, Sweden, Latvia, Finland and Austria had the highest shares of RES among MS. By 2010 MS that were closest to achieve their RES goals were Romania (0.64%), Estonia (0.68), Sweden (1.06%) and Bulgaria (2.21%).

With regard to achievement of a 10% of biofuels in the transport sector, Slovakia (7.85%), Sweden (7.75%), France (6.1%), Poland (5.94%) and Germany (5.73%) are having highest shares of biofuels in the fuels consumption in the transport sector.

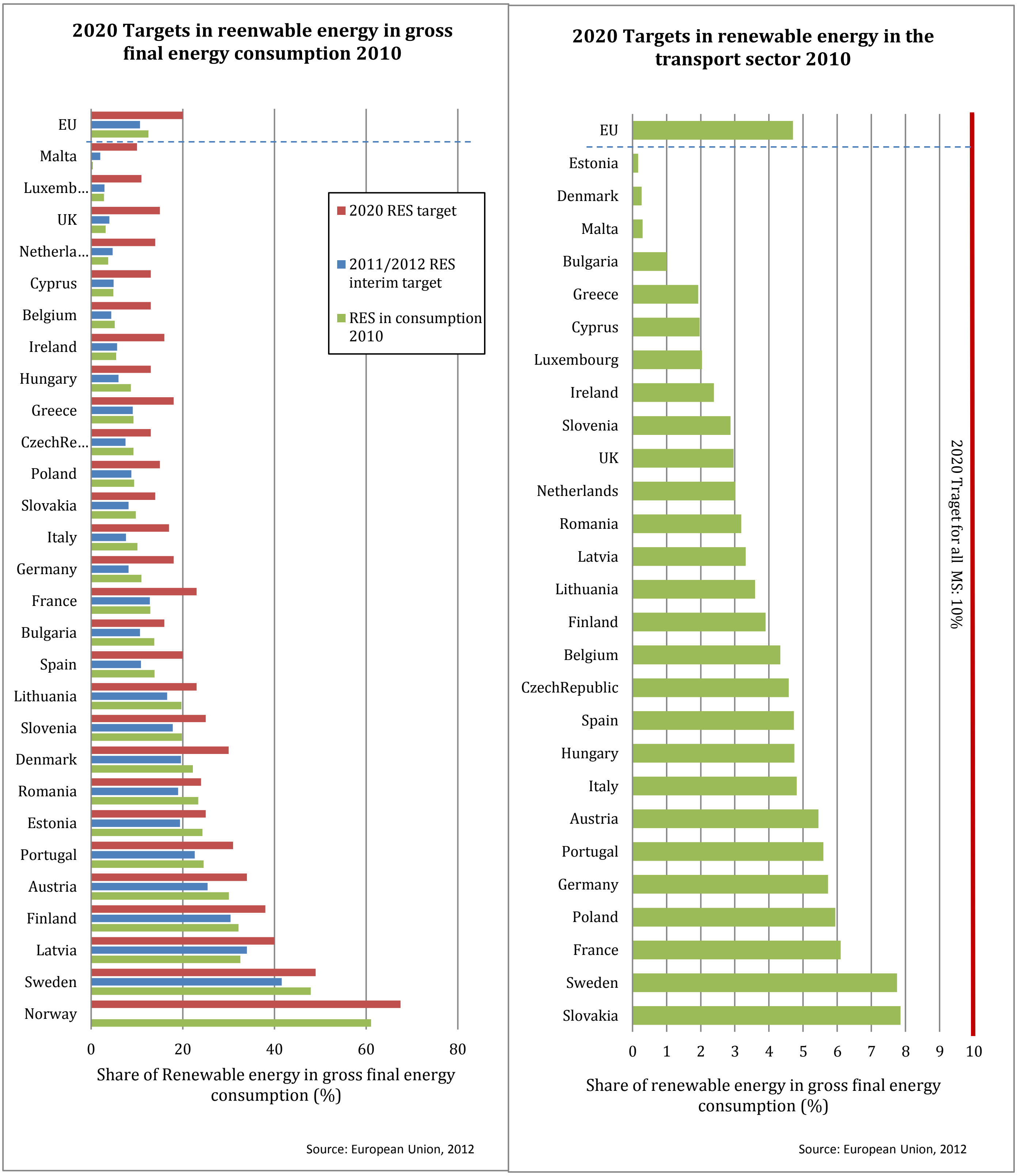


Figure 24 Achievement of renewable energy goals in the European Union year 2010 (European Union, 2012a)

Table 4 MS's progress towards 2020 targets in renewable energy (European Union, 2012a)

EU	12.5	10.7	20	4.7	10
Sweden	47.94	41.6	49	7.75	10
Latvia	32.57	34	40	3.32	10
Finland	32.17	30.4	38	3.9	10
Austria	30.05	25.4	34	5.45	10
Portugal	24.57	22.6	31	5.59	10
Estonia	24.32	19.4	25	0.17	10
Romania	23.36	19	24	3.19	10
Denmark	22.22	19.6	30	0.27	10
Slovenia	19.8	17.8	25	2.87	10
Lithuania	19.72	16.6	23	3.59	10
Spain	13.83	10.9	20	4.73	10
Bulgaria	13.79	10.7	16	1	10
France	12.93	12.8	23	6.1	10
Germany	11	8.2	18	5.73	10
Italy	10.11	7.6	17	4.81	10
Slovakia	9.76	8.2	14	7.85	10
Poland	9.41	8.8	15	5.94	10
Czech Republic	9.24	7.5	13	4.58	10
Greece	9.24	9.1	18	1.93	10
Hungary	8.68	6	13	4.74	10
Ireland	5.46	5.7	16	2.39	10
Belgium	5.16	4.4	13	4.33	10
Cyprus	4.85	4.9	13	1.97	10
Netherlands	3.76	4.7	14	3.01	10
UK	3.2	4	15	2.96	10
Luxembourg	2.83	2.9	11	2.04	10
Malta	0.36	2	10	0.3	10

Sweden, Finland, Spain and Germany predict that they will generate RES energy far beyond their EU targets. Other MS such as Italy and Luxemburg are foreseeing on the contrary a shortfall in the deployment of RES technologies and therefore not likely to achieve their goals (Environmenatal Data Services (ENDS), 2012).

According to the review of the National Renewable energy Action Plans (NREAPs) made by the Environment Data services (2012) the rate at which RES energies will grow in MS depends largely on current state of development of this sector in Member States. Member States with the lowest 2020 targets have however ambitious plans, including Poland, the Netherlands and the UK.

Member States have different strategies and levels of ambitions regarding RES deployment. Most emphasis among the NREAPS is paid on increases on wind and solar power while hydropower is foreseen to grow slowly. Wind power is expected to largely increase in Germany, Spain, the UK and Sweden. In Denmark, where wind power deployment has been taking for a long time, a transition towards off-shore wind power generation is planned. Plans on increases of solar energy are dominant in Germany, where capacity is planned to increase to 51,000MW over one decade. Solar energy increases are also foreseen in Italy, Spain and France (Environmenatal Data Services (ENDS), 2012).

Plans on increases of biomass for heating are found mainly in Sweden and Finland, which are countries with log tradition on forestry and district heating, while in other MS this energy source expected to be slower, mainly due to the lack of infrastructure (Environmenatal Data Services (ENDS), 2012).

At the sectorial level, targets on electricity generated from RES are highest while targets on renewable heat and cooling are the most divergent. Specifically, some MS already have well developed heating and cooling infrastructure while other lack these technologies completely. National targets for RES in the transport sector are low, but are most consistency among MS because it has commonly been se to 10% (Environmental Data Services (ENDS), 2012).

3.3 Greenhouse gas emissions in the energy sector

The energy sector is the largest contributor of GHG emissions in the EU27 with a share of approximately 30% or 1.43 billion tonnes CO_2 equivalents. At country level emissions from the energy sector vary considerably relative to emissions from other sectors, being Estonia, Malta, Bulgaria, Greece and Poland those countries with highest shares (Figure 27).

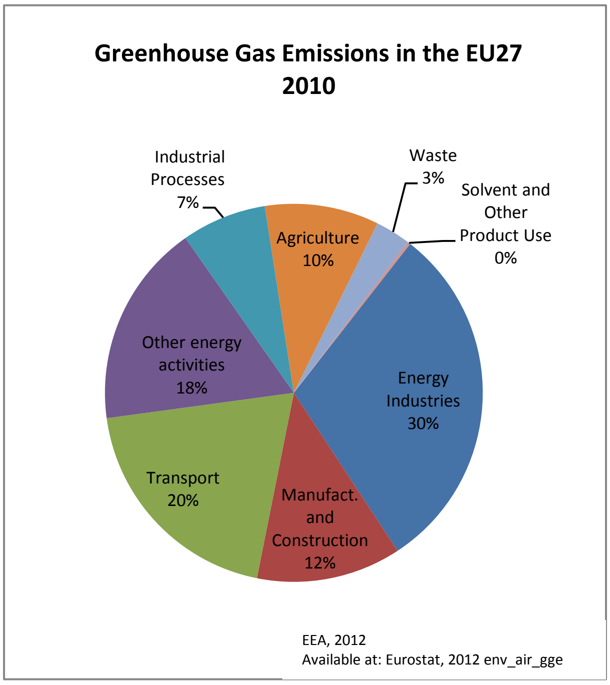


Figure 25 Greenhouse gas emissions in the EU 27 2010

GHG emission levels from the energy sector are relegated mainly to the size of the economy and dependence of fossil fuels. In absolute terms emissions from energy industries are highest in Germany, the UK, Poland and Italy with emissions above 130 million tonnes CO_2 equivalents as illustrated in Figure 26.

A way for measuring the energy sector's performance relative to GHG emissions is by relating GHG to the sectors GVA. Figure 28 on page presents the CO_2 intensity by the energy sector as CO_2 emissions normalized by the sector's GVA. However, as an indicator on how 'green' the energy sector is, the GHG intensity of the economy implies various limitations. Primarily, the share of RES in the final energy consumption is not correlated to this indicator due to several reasons, including the presence of nuclear energy in the energy minx, the energy efficiency in energy supply and important differences in the business structural characteristics among countries.

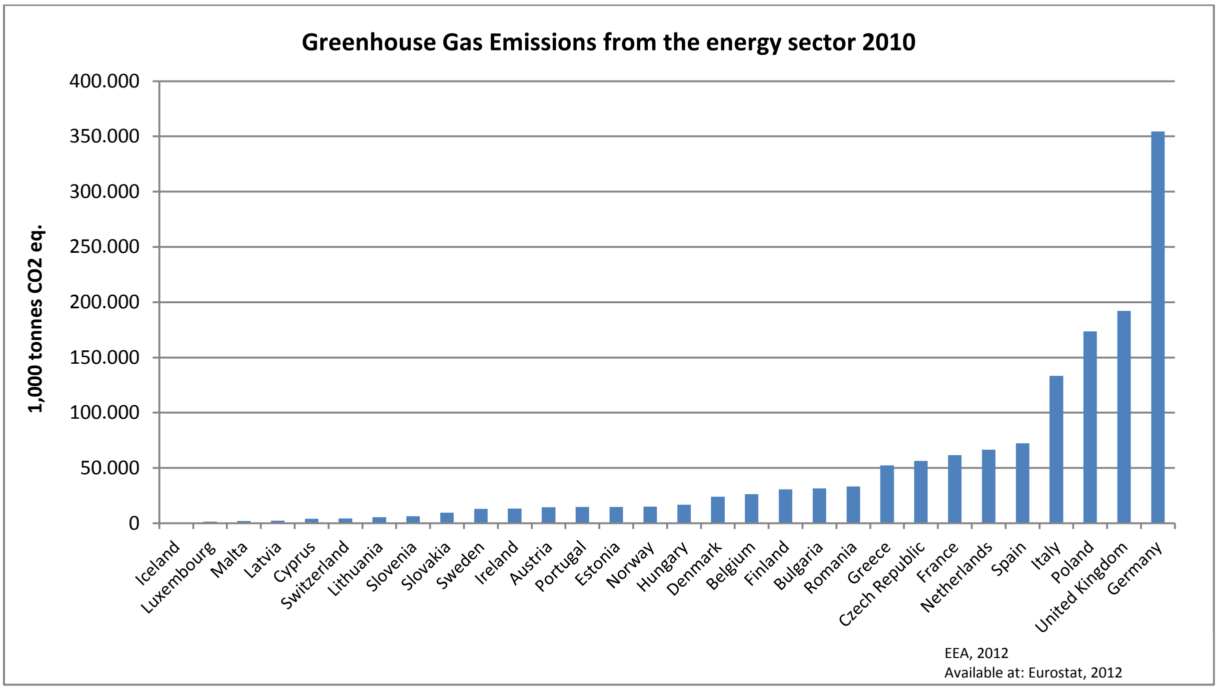


Figure 26 Greenhouse gas emissions from the energy sector 2010

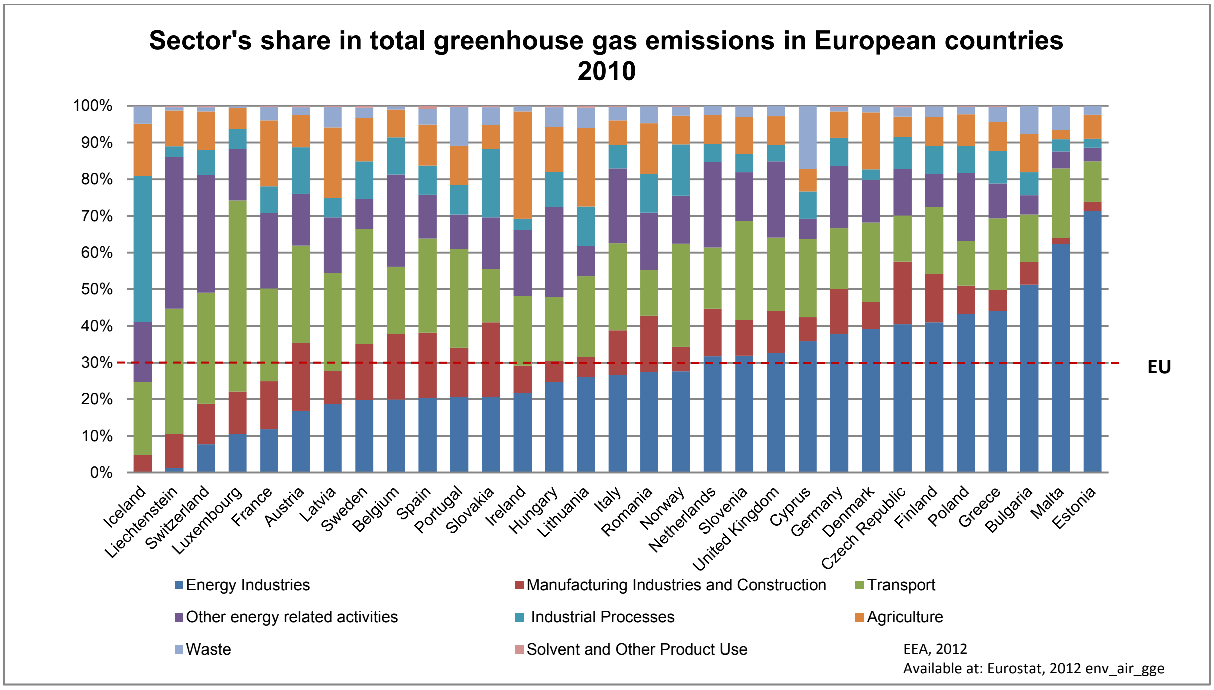


Figure 27 Sector's share in total greenhouse gas emissions in European countries 2010

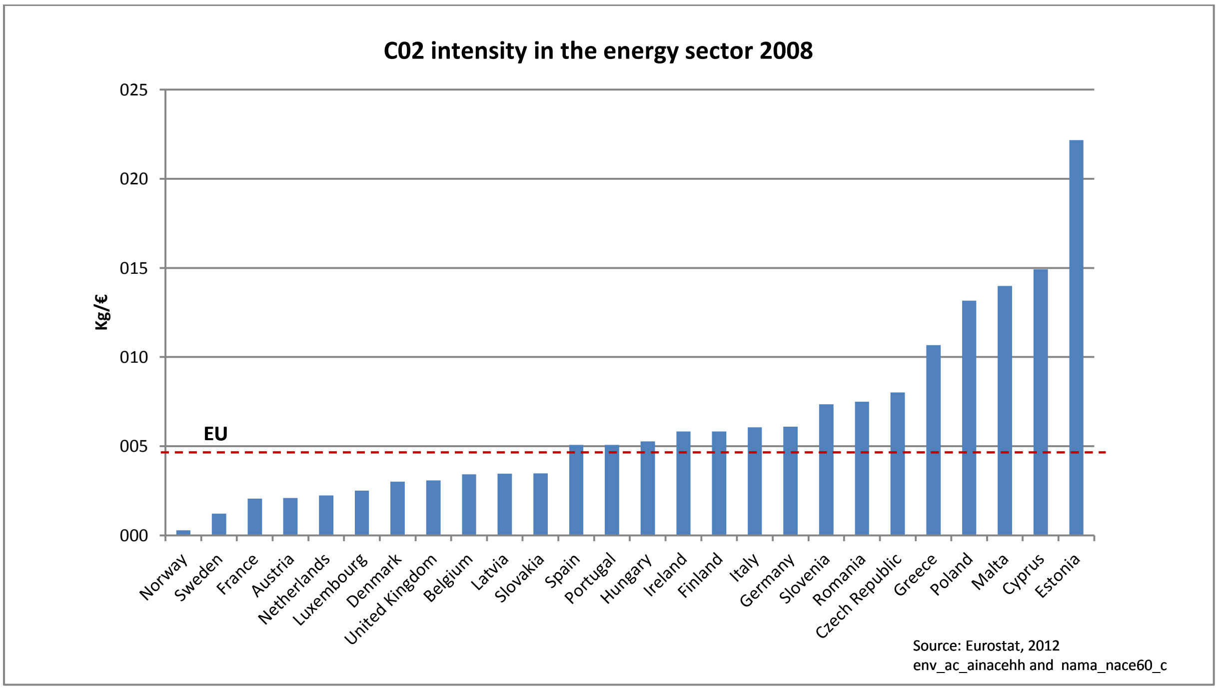


Figure 28 CO2 emissions by the energy sector 2009

4 Drivers and enablers

4.1 Drivers in energy technology deployment

According to Müller et al. (2011, p. 9) there are three principal reasons for governments to take measures to increase the deployment of RES technologies:

- To improve energy security.
- To encourage economic development, particularly associated with rural and agricultural and agricultural sectors and innovation and high-tech-manufacturing.
- To protect the climate and the environment from the impacts of fossil fuels use.

Each of these motives, defined here as pillars, embraces complex constellations of mutually dependent drivers. An important feature in this approach is therefore that the three pillars are not viewed in insolation but intimately interrelated as illustrated in Figure 29. Moreover, this model does not address any hierarchy on the level of importance of drivers, as these are assumed to build the foundations of energy development. The following section briefly introduces the most important drivers and their interrelations in the context of the three pillars.

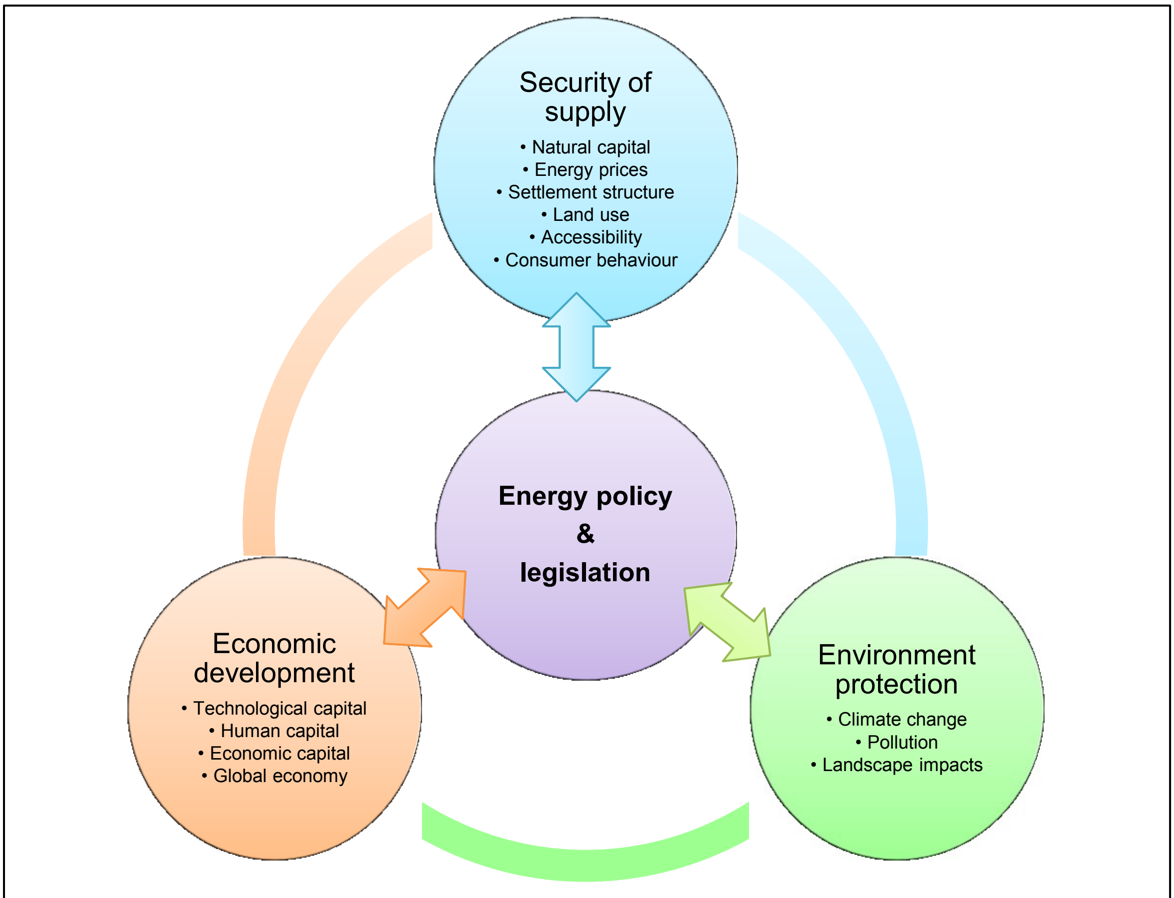


Figure 29 Drivers in energy development and their relationship to energy policy

4.1.1 Energy security

Energy security implies not only the provision of sufficient and reliable energy supplies to satisfy demand at all times and at affordable prices, but also the mitigation of environmental impacts related to the exploitation and use of energy sources. This reconciliation between availability and affordability with sustainability has evolved especially during the last two decades as the environmental impacts of fossil fuel have become a matter of great concern for nations (Müller, et al., 2011).

Natural capital (Energy availability)

Availability of energy sources is among the most central drivers in the energy sector, implying both sufficient availability of primary resources and the infrastructure needed to transform and transport these resources to final users. Natural capital is recognized here as a territorial factor of energy production that are provided by nature such as fossil fuels, sun- and wind exposed areas, agricultural and forest land. A key aspect of energy availability is its' diversity because that enables to build resilience in energy systems. In other words, a diversify energy portfolio is complementary so one energy source hedges the risk of the other (Müller, et al., 2011).

Energy sources are found everywhere but their abundance is unevenly distributed. Historically, regions have adapted to the availability of local energy resources but as energy become a tradable commodity, and technological development has enable the transmission of electricity and the transport of solid and liquid fuels, the commodity chain of energy carriers has reached global scale becoming therefore very complex (Damsgaard, 2008). This implies that the presence of primary energy resources in regions does not necessarily benefit these because trade, transformation and consumption may occur elsewhere.

Despite of energy sources have become an integral commodity in global markets, energy systems are usually designed to operate at national level. Differences in the energy mix among European countries exemplify how the presence of local energy resources has not only determined the type of energy consumed by countries but also the consumption patterns of industries and settlements. For example in Norway and Sweden hydropower have become an important source of electricity while in Poland coal is the main source of energy (Rasmussen, et al., 2010). The reason that the country level has had an unprecedented role the energy sector is twofold, namely local energy sources are usually cheaper, thus beneficial from a security of supply perspective, and power transmission grids have been designed to cover national supply (Müller, et al., 2011).

The availability of local energy sources is also a territorial aspect that shapes technological development. A good example is found Denmark, where the availability of wind resources and suitable areas has laid down the foundations for the development of a strong wind energy industry. However, the accessibility of imported energy sources such as oil and natural has clearly affect the development directions in the energy sector in most European countries (Rasmussen, et al., 2010).

Energy prices (affordability)

The price of primary energy has a fundamental impact on the entire commodity chain of energy from producers to consumers, and therefore among the most influential driver in the decision of these. It is thus not surprising that European energy policy is oriented towards preventing fluctuations in energy prices.

Energy affordability consists of two key dimensions; price volatility and price uncertainty (Müller, et al., 2011). Price volatility refers to the range in which market prices fluctuates over time while price uncertainty refers to the average price of energy. Both aspects have negative economic impacts on societies being oil prices is a good example.

Due to the vital role of energy in modern society, energy prices are a very sensitive issue in the political agenda in countries. Energy prices affect private economies of individuals and nevertheless production cost for industries. Heavy industries are often exposed to energy prices because energy is often an expensive assets needed in production. Further, this implies that increases in energy prices can lead workers to lose their jobs and in cases that the production is moved overseas (Rasmussen, et al., 2010).

Energy prices act also as a driver in the transition to new energy technologies such as the case of RES technologies (Rasmussen, et al., 2010). Today continued increasing oil prices is pushing RES into a more competitive position alongside with general recognition on their environmental benefits. This not only motivates consumers to adopt these technologies but also reduces investment risk associated to the deployment of infrastructure for large scale renewable energy production.

The characteristics of energy markets have also of great importance from a territorial perspective. A well- designed and no-discriminatory market reinforces competition and helps avoiding market distortions, by allowing the integration of larger number of suppliers and thereof promotes lower energy prices and more diversified energy supply in regions (Podralska, et al., 2011).

Land-use

Land-use practices and traditions are central territorial aspects in the energy sector. Specifically, the exploitation of energy resources and its subsequent transport, transformation and generation are land-use intensive activities. Land-use activities that relate to the exploitation of energy illustrated in the following list:

- mining activities; coal, lignite, oil and peat
- agriculture and forestry; biomass
- collection; sun energy and hydropower

These activities are very unique not only regarding how they are performed but also in terms of their environmental and social impacts, capacity to provide energy and coexist and interact with other land-use types.

According to Müller et al. (2011) the highest land-use per unit of electricity is performed by onshore wind power installations. However, since turbines occupy only 3% to 5% of the area needed for their proper operation, and their emission free character, the remaining area can be combined with other activities such as agriculture.

Large-scale solar installations such as Concentrated Solar Power (CSP) also demand significant land. However, areas suitable for these technologies are often found in deserts implying that the likelihood of land-use conflicts is low. Small scale solar installations also have advantages as they do not demand space because they can be installed in facades and roofs of buildings (Müller, et al., 2011).

With reward to hydropower plants the amount of land demanded depends of the type and the scale of these plants. Generally *speaking 'run-off-river'* hydro power plants do not require a reservoir and therefore do not occupy large amount of land. On the contrary hydropower plants with reservoir are significantly land use intensive (Müller, et al., 2011).

Among fossil fuels coal fired generation consumes significant amount of land, primarily due to the extension of mining areas needed to supply coal demand (Müller, et al., 2011).

The energy source that demands less area per GWh among all energy technologies is nuclear energy. This is because its high generation capacity and relatively small amount of raw material demanded (Müller, et al., 2011).

The territorial dimension of different energy technologies is closely related to their environmental impacts. Therefore, further insights on their landscape and environmental impacts as well as their interactions with other land-uses are further discussed later in this chapter.

Settlement structure

The size and distribution of settlements across territories have important repercussions on the nature of the energy carrier that is made available and how it is transmitted (transported) to consumers. Larger and more concentrated settlement structures are often supplied by more centralized energy systems while disperse settlement structures tend to rely on decentralized energy solutions. There are several reasons to this, among others investment and operational costs, limitations in transmission and transport and the characteristics and cost of energy resources (Rasmussen, et al., 2010).

Large central energy plants are able to serve large number of consumers suitable therefore to supply large markets. In terms of electricity the European power grid coverage is rather extensive at national level and designed to rely on large power plants. The grid coverage can however be limited in sparsely populated areas (Rasmussen, et al., 2010). As later explained European power grids are confronting with severe limitations with respect to the integration of RES energy.

District heating is more suitable for local supply of large and dense settlements. Energy losses in district heating increase significantly relative to the transmission distance, requiring therefore that a large number consumers are located in the proximity of district heating plants (Zinko, et al., 2008). In Sweden for instance large cities have several district heating plants while buildings in small settlements in sparsely populated areas rely often on boilers, stoves, electric heat and heat pumps.

Accessibility

Accessibility is defined in this study as energy producers' access to primary energy sources and markets by different transmission/transport means. Previously, it was stated that the access to primary energy resources plays a decisive role in securing energy supply in regions and countries. This implies that efficient transmission infrastructure has to connect areas where primary energy is exploited, transformed and consumed (Rasmussen, et al., 2010).

An extensive infrastructure for the transport of fossil fuels exists in Europe, comprising of maritime routes, harbours and pipelines. These infrastructures are still evolving, primarily gas pipelines such as the on-going construction of the Nord Stream and the plans on the Nabucco pipeline (International Energy Agency, 2008).

The incorporation of RES in European energy systems raises new challenges related to the transmission of energy. Starting with solid biomass, transport costs are today imposing a barrier mainly due to the lack of transport infrastructure between forest and urban areas (Galera-Lindblom, et al., 2012). Furthermore, areas with good wind and solar conditions are remote, implying that electric power needs to be transmitted through long distances. This means that losses will take place unless the current power grid is modernized (Rasmussen, et al., 2010). Lack of capacity in the European power grid to withstand fluctuating inputs from RES generation is also an obstacle, not only in the incorporation of large wind and solar installations but also households and buildings that may become energy producers through small scale renewable energy generation. In that regard smart grids are required to improve the efficiency and reliability in power distribution (Rasmussen, et al., 2010).

Energy consumption

The behaviour of energy consumers namely industries and individuals, and the scale of consumption are important territorial elements in energy development.

The scale energy consumption in industries is high which requires that energy supply needs to be stable and reliable. Therefore hydro, nuclear and thermal power is often suitable for these industries (Rasmussen, et al., 2010). Energy efficiency also becoming important for heavy industries as many of them reincorporate residual heat and materials back in their processes. Pulp and paper industries and sawmills, both in Sweden and Finland, are good examples of energy efficiency measures because they use wood residues as source of energy (Galera-Lindblom, et al., 2012). In Denmark, an example of industrial symbiosis also exists in Kalundborg where energy and manufacturing industries exchange and reincorporate residual heat and materials (Rasmussen, et al., 2010).

The role of individuals on the energy sector is complex to analyse due to cultural perceptions and values as well as socioeconomic factors.Despite factors that constrains individual's possibilities to direct take decisions upon the type of energy that is consumed, cultural views of communities and nations have had an important role due to the energy sector's dependence on political decisions. An example that illustrates cultural perceptions in energy policy is found in Sweden and Denmark where cultural ties to nature conservation have been an important driver behind increases in RES consumption. Cultural values are also boosting the deployment of small scale generation of RES especially wind and solar. Initially, the generation of electricity through these technologies was not very profitable being the individuals values an important driver. Today, these technologies have become significantly more efficient and their increasing demand has contributed in reducing their price in markets (Rasmussen, et al., 2010).

4.1.2 Economic development

From an economic perspective, energy development is a process that consists of adaptation towards changes in the availability and cost of energy and value creation through the development and commercializing new commodities such as energy carriers (hydrogen and biofuels) RES technologies (windmills, fuel cells, solar panels, etc.) (Müller, et al., 2011). An example of these processes is *'green growth'* itself, which is an adaptation process where industries conquer and take advantage of new market originated by the demand of new energy sources and resource efficient solutions. RES technologies contribute thus to economic development by enabling the exploitation of new natural capital, in this case renewable energy sources and the creation of value added from industries. Today there are example of regions such as the canton of Valais (Switzerland) and the region of Békés (Hungary) that have taken the opportunity to invest on energy projects as a way to get out of the financial crisis, leading to the diversification of energy sources and the reinforcement of regional autonomy in energy supply (Podralska, et al., 2011).

Technological capital

The access to technology is a vital element in energy development. It allows the extraction and collection of primary energy as well as their transformation into electricity and other energy carries and transmission and utilization by end users. The availability of technology can be domestic, in other words, developed locally by actors directly or indirectly involved in the energy sector, or it can be imported. The fact that technology enables the utilization of energy sources implies that the energy sector is characterized by a mutual dependency between accessibility to energy sources and technology (Galera-Lindblom, et al., 2012).

Strategically, locally developed technologies are often more advantageous than dependence of imported ones, not only because new jobs and value added are generated but also because it allows the energy sector to rapidly adapt to shifts in energy markets. However, imported technology serves in many cases as the foundation for the creation of new industries, often referred as the 'fast followers'. This was the case of the Navarra province in Spain where wind energy technology was initially imported from Denmark. Strong support from public agencies and private companies and long tradition in R&D and innovation gave the bases for the creation the Navarrese wind energy industry which currently is recognized as one of the world's leaders (Rasmussen, et al., 2010). According to Müller et al. (2011, p. 16) first-mover countries that have specialized in renewable energy technology such as Denmark and Germany are characterized by high knowledge intensity and learning potential.

Human capital: Innovation

Human capital needed in the energy sector comprises of a high diversity of labour groups. Human capital is therefore a territorial asset that not only makes the energy sector's operation possible, but most important it enables adaptation processes through innovation (Rasmussen, et al., 2010). As previously mentioned, the energy sector is dependent of the availability of technology and therefore innovation capacity of both professionals and researchers play decisive role in how efficient the operations perform and enable adaptation.

Innovation is central in energy development as it enables the energy sector to adapt to new circumstances and increase productivity and efficiency (OECD, 2011). While the correlation between green growth and regional development is strong, investments in energy development are usually higher in regions with well-developed R&D policies. Innovation capacity does not only involve the process of developing technologies for the transformation and transmission of energy but also involves other non-technical operations A good example is the case of Kalundborg in Denmark were the key aspect of success in the establishment of the so called *'industrial symbiosis'* was the creation of solutions to improve collaboration between energy producers and industries (Rasmussen, et al., 2010).

A new phenomenon in the energy sector is the incorporation of new sectors. This implies that sectors diversify their activities and open access to new markets that are economically viable in the long term (Müller, et al., 2011) (Galera-Lindblom & Rasmussen, 2008).

Economic capital

A general understanding in RES deployment is that countries that are most able to afford a package of measures necessary to promote RES are likely to be early adopters and developers of these technologies. According to Müller et al. (Müller, et al., p. 27) a correlation exists between GDP and increases in renewable energy generation. This phenomenon has been the case for the period 1990-2009 which corresponds to a time of major development in RES technologies and their introduction into markets. This has been partly the result of high level of investment and political support on the development and deployment of these technologies in several European countries.

A great challenge related to RES technologies has been the large amount of investments required for their development and introduction in markets. Moreover the lifecycle of RES projects are long implying that investors seek long-term planning regimes that can provide stability and predictability for their investments. Generally large scale RES projects are perceived by investors as risky because the technology's profitability has not been proven until demonstration is successful a situation that hinders developers to secure the necessary financing. This phenomenon commonly known as the *'valley of death'* incurs when financial means are absent before energy technologies reach commercialization (Müller, et al., 2011).

The combination of technology-push by governments and market-pulls forces from business in early stages of RES technologies plays a fundamental role on how these develop. Lack of funding often occurs when a mismatch of these two phenomena occurs. Here, governments represent the technology-push through RD&D support, grants and direct investments while business provide direct investments later in the market pull, when technologies are commercialized (Müller, et al., 2011).

Global economy

From a territorial perspective the global economy is an external driver which means that it is difficult to steer through domestic policies. Fluctuations in financial markets have a very important impact on the energy sector's development. Financial crises are characterized by the lack of investment capital for industries and governments and the reluctance of financial institutions to lean money (Galera-Lindblom, et al., 2012). Considering the amount of finance required to develop and build new energy infrastructure it is not surprising that transitions to new energy technologies such as RES is often slowed down during economic crises. In fact, instability in energy markets and the economy is one important barrier for the allocation of investments on RES projects (Podralska, et al., 2011)

Nevertheless, governments tend to cut subsidies and investments during financial crises resulting into an additional hindrance from new investments. This is has incurred in Finland where new investments on bioenergy technology has been slowed down by the ongoing financial crisis (Galera-Lindblom, et al., 2012).

4.1.3 Environment protection

Climate change

Climate change mitigation is considered the main driver for the integration of environmental policy in European energy policy since the 1990's, in particular in connection to the Rio Conference in 1992. While perceptions of security of supply and economic development vary among MS, climate change as the consequence of fossil fuel energy use is unanimously acknowledged. Moreover, all MS have committed on taking measures to reduce CO_2 emissions (Solorio Sandoval & Zapater, 2012).

RES technologies play already an important role in reducing CO_2 emissions and therefore their deployment is a central measure in climate change mitigation. In Europe only, CO_2 savings in 2008 accounted for 297 million tonnes, and globally 1,718 million tones (Müller, et al., 2011, p. 20).

Environmental and landscape impacts

As previously introduced in section the section on land-use, the exploitation of energy resources implies impacts on the environment and landscape. However, the degree of these impacts depends of several factors including the type of exploitation, the methods, the modes of transportation and the sensibility of the ecosystem and the landscape subject to exploitation.

Mining activities relate to the extraction of fossil fuels including coal, lignite and oil. The quality that characterizes all of these activities is that they provide high output of energy but involve sever negative environmental risks and consequently difficult to perform without harming the environment and other forms of land use such as settlements, agriculture, tourism, fisheries, recreation and nature conservation.

Exploitation of coal and lignite implies often that larger quantities of soil are removed, a process that alters not only the geophysical characteristics of those areas but also generates soil waste products, changes ground and surface water regimes, releases both hazardous organic compounds and heavy metals into water streams resulting in the contamination and acidification of both surface and ground water (Mamurekli, 2010).

An additional problem related coal mining is that it often demand that settlements are displaced and natural areas are destroyed. Nevertheless, the recovery of these areas after being exploited is very difficult and expensive to achieve, and in many cases irreversible, due to the presence of free forms hazardous substances and heavy metals in the soil as well as the soil becomes infertile alongside with radical changes in the landscape. Ultimately, this implies that the land become unsuitable for any other alternative use (Mamurekli, 2010).

In terms of air emission, energy generation from coal not only implies the release of greenhouse gases such as CO_2 and CH_4 but several other pollutants such as NOx, SO_2, which are responsible for water eutrophication and acid rain as well as mercury and other heavy metals, Polycyclic Aromatic Hydrocarbons (PAH), radium and uranium, which are harmful for humans and other living organisms (American Lung Association, 2011). Today, several techniques are applied to reduce air and water pollution from both in coal mining processes as well as in firing. However, the extension in the application of these techniques varies among coal producing and consuming countries (Mamurekli, 2010).

In the case of oil and gas extraction offshore drilling involves environmental risks, most notably oil spills from oil tankers or pipelines transporting oil from the platform to onshore facilities, and from leaks and accidents on platforms. Residual process water is also generated, which contain varying amounts of oil, chemicals used in or resulting from oil production and heavy metals. Being a fossil fuel emissions resulting from oil combustion contain the same type of pollutants present in coal combustion.

Production of biomass from agriculture and forestry for energy purposes has increased significantly during the last two decades showing positive results both in terms of economic performance and sustainability. From a land-use perspective both practices provide several advantages. In first place both agriculture and forestry can be performed with low impact on the productivity or the qualities of other land-uses among others residential, recreation and commercial. Nevertheless, both agriculture and forestry also give room for '*multifunctional land uses'* as they can be combined with activities such as tourism and wind power generation (Galera-Lindblom, et al., 2012).

The sustainability of biomass production for energy purposes from agriculture and forestry has however been questioned. In the case of agriculture it has been considered having negative impacts on food production while in forestry conflicts with wood dependant industries have already been experienced, for example in Sweden and Finland. Due to those reasons biomass from agriculture and forestry is becoming oriented towards harvesting residues, especially in the case of forestry (Galera-Lindblom, et al., 2012)

Even if biomass production is entirely based on residues it still implies environmental risks if proper measures are not taken. Both in the case of agriculture and forestry residues help to preserve the soil structure and nutrient balance. Moreover, dead wood in forest serves as habitat for different organisms including insects, fungi and plants. This means that limitations regarding the amount of residues that may be removed have to be considered. Cultivation of monocultures both in agriculture and forestry can also have negative impacts on biodiversity the cultural landscape (Galera-Lindblom, et al., 2012).

In terms of emissions energy generation from biomass consumption is less convenient compared to other renewable energy sources. This is because biomass combustion can result in relatively high levels of SO_2 and NO_2. However, emission levels are strongly dependent on the composition of the biomass and on harvesting conditions, transport and conversion processes (Müller, et al., 2011).

4.1.4 Policies

As such, policies are defined as enablers as they are tools created to steer the development of sectors in desirable direction. This implies among others that policies are deliberately designed to overcome barriers in the process of achieving certain policy goals (Müller, et al., 2011). Policies are moreover set in specific legal frameworks embedding rules and norms that not only develop policies but also have an important impact in the relationships among actors involved in policy making and makes certain kind of policy more feasible than others (Wallace, 1996).

The objectives European energy policies are to maintain the energy sector's competitiveness and achieve a secure and sustainable energy supply. As explained in next chapter the territorial dimension of European energy policy is rather complex and lacks direct relation to regional policy. While goals in the energy sector require international cooperation, particularly in setting goals on GHG emissions and market conditions, energy policies are traditionally of national concern, which is clearly reflected the current evolution of this policy area (OECD, 2011). Due to the challenge related to energy supply, climate change mitigation and the increasing role of RES, energy policy is becoming a central policy area in regions. According to a survey conducted by the Assembly of European Regions (Podralska, et al., 2011) 82% of the 27 regions investigated have established regional energy strategies during the past 10 years.

When reviewing the drivers in this section it becomes evident that moving towards greener models for the energy sector requires restructuring in regions, especially if the goal is to increase competitiveness. The challenge in this process is not only the uneven distribution of natural, economic and social capital but also the large diversity in planning culture and governance in regions.

5 Legal and policy framework for energy supply in the EU

5.1 Introduction to EU policy

As a key field with the overall EU policy discourse, EU energy policy is a diverse collection of more specific themes. As such, it isn't possible to capture the essence of EU energy policy within the analysis of a single document or strategy. But from a general perspective, and with the aspect of the green economy in mind, there are two headline policies that characterise the sector: Energy 2020 (meant as a translation of Europe 2020 in terms of energy) and the *'Climate and energy package,'* which was agreed by the European Parliament and Council in December 2008. Today, these policy goals are accompanied by the 20-20-20 targets; namely 20% of final energy consumption from RES, 20% reduction on GHG emissions and 20% reduction in primary energy consumption by 2020.

Since the White Paper of 1997 European Energy Policy has evolved towards today's pillars in European energy policy (as expressed in the Lisbon Treaty), namely to ensure the functioning of the energy market, security of energy supply, promote energy efficiency and energy saving and the development of new and renewable forms of energy, and not least, to promote the interconnection of energy networks (Art. 194.1, TFEU). Upon this basis the EU has further arranged the policy goals in energy policy;

- Increasing security of supply
- Ensuring competitiveness
- Promoting sustainability and combating climate change.

While energy policies are traditionally of national concern, both the global impact of energy issues and the need for place-based energy solutions as the regional, local and even building scale has meant that energy policy has become a central policy area both at the European level, but also at the regional scale. According to a survey conducted by the Assembly of European Regions (Podralska, et al., 2011) 82% of the 27 regions investigated have established regional energy strategies during the past 10 years. This alone indicates an increase in the territorial perspective within Energy policy for Europe. Therefore, while lacking a direct relation to regional policy, energy issues can often be a key component of regional development strategies. Not least, European **regional** policy supports energy sector development through the Europe 2020 strategy, particularly concerning the structural and cohesion funds.

The Lisbon reform in 2009 removed formal barriers in the Treaty on the Functioning of the European Union (TFEU). This established shared competences between the EU and its Member States in energy policy, particularly related to development of and common and internal energy market (IEM), improved environmental performance and transport policy (Solorio Sandoval & Zapater, 2012).

Despite these important changes in European energy policy Member States are ultimately responsible for their national energy mix and exploitation of indigenous energy resources. This implies that the EU has no power over MS' energy mix, depletion policy or taxation (Solorio Sandoval & Morata, 2012).

A review of the EC's energy strategy website (http://ec.europa.eu/energy/index_en.htm) divides information into the following factors, each containing their own package of policy documents.

- Renewable energy
- Energy efficiency
- Technology & innovation
- Oil
- Coal
- Single market for gas & electricity
- Nuclear energy
- Energy from abroad
- European Council
- Energy infrastructure

The focus of the tables below is on how those factors relating most directly to development of the green economy are developed with the Energy 2020 policy profile. We have chosen to narrow our focus to Renewable energy, Energy efficiency, Energy Infrastructure and a single market for gas and electricity. Therefore, the first two tables introduce the overarching energy policy discourse for Europe – Energy 2020 and the Energy Roadmap 2050. From here, we also subjectively focus on the most important policy documents, directives and regulations concerning the green development of the energy sector. This focuses on the aforementioned issues of Renewable energy, Energy efficiency, Energy Infrastructure and a single market for gas and electricity. To do this, one policy is selected for each theme, but introduction of policies documents supporting them could be introduced within the tables themselves.

Roadmaps	• 'Energy Roadmap 2050' [COM(2011)0885]
Thematic strategies and other thematic communications	• 'Energy 2020 A Strategy for competitive, sustainable and secure energy' [COM(2010) 639] • Renewable energy progress report COM(2013) 175 final • Energy Efficiency Plan 2011COM(2011) 109 final
EU Directives	• Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. • Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC [OJ L315 p.1]
EU regulations	• Regulation (EU) No 347/2013 of the European Parliament and the Council on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009

5.1.1 EU policy tables for the energy sector

Table 5 Policy analysis table for the Energy Roadmap 2050

Type of policy and hierarchy	Roadmap
Name	Energy Roadmap 2050 [COM (2011)885]

<table>
<tr><td>Description</td><td colspan="2">On 15 December 2011, the European Commission adopted the Communication ‘Energy Roadmap 2050’. In the context of the EU is committed to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 the Commission explores through the Energy Roadmap 2050 the challenges posed by delivering the EU's objectives on decarbonisation, ensuring security of energy supply and competitiveness. The Energy Roadmap 2050 is the basis for developing a long-term European framework together with all stakeholders (European Biofuels Technology Platform, 2012). Here the commission outlines ten conditions to be met in order to reach Europe energy targets:
An immediate fully implementation of the EU’s Energy 2020 strategy.
A dramatically more efficient energy system and society.
Particular attention to be given to the development of renewable energies.
Higher public and private investments in R&D and technological innovation.
Well-designed market structure instruments and new ways of cooperation needed for achieving a fully integrated market by 2014.
Energy prices need to better reflect costs.
A new sense of urgency and collective responsibility to bear on the development of new energy infrastructure and storage capacities across Europe and with neighbours.
Continuity in strengthening the safety and security frameworks and international leadership in the energy field.
A broader and more coordinated EU approach to international energy relations.
The creation of concrete milestones for Member States and investors.</td></tr>
<tr><td>Targets</td><td colspan="2">Reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050</td></tr>
<tr><td rowspan="2">Territorial implication</td><td>Characterisation</td><td>Average</td></tr>
<tr><td>Description</td><td>Average is seen here as something between weak and strong.

Weak reflects the fact that this is a general roadmap and does not include any direct discussion of implementation of place-based approaches at the regional or local level.
At the same time, the notion that emissions should be cut by the extent suggested means that policy actions will have to be executed at all governing scales, from the EU to the local. For instance, public procurement at all scales will have to be greened substantially in the coming 10 years in order support more widespread take-up of green technologies and behaviours.

Strong reflects the fact that in order to achieve the goals that underpin the roadmap planning, development and management of local energy systems (both in terms of supply via renewables and demand-side improvements) will have to increasingly take place at the local and regional level. This is the primary reason why green energy issues are an important element of EU regional development funds, and many local/regional stakeholder networks for these issues are supported by the EU.</td></tr>
<tr><td>Indicators</td><td colspan="2">N/A because the Roadmap discusses many factors, where each would have their own respective indicator (i.e. emissions, renewables, efficiency, international connections for infrastructure, etc.</td></tr>
<tr><td>Distance to target (Graph</td><td colspan="2">N/A. See above.</td></tr>
</table>

or map should be provided in support of the distance to target analysis)		
Policy effectiveness	**Characterisation**	*Unknown*
	Description	
Transformative character of policy	**Characterisation**	***Radical***
	Description	The Roadmap does not necessarily reflect a paradigm shift (although it might), but its targets of an almost a complete reduction (80-95%) of CO2 emissions suggests that energy issues will involve a major shift in the way we think about environmental issues (not just socially, but also in terms of the way energy market acknowledges environmental protection).
Green economy implication	**Characterisation**	***Unknown***
	Description	• It is completely impossible to suggest the implications of a policy package that is so broad in scope and duration. • There are obvious positive implications in terms of the environment as the goals of the roadmap fundamentally suggest. • There are obvious positive implications in terms of territory because to achieve these goals increased local regional actions are needed in terms of planning and managing energy services. Not least, this includes the local, place-based nature of renewable energy, as well as community energy systems. • However, there are potential negative impacts in terms of society. The ESPON project ReRisk suggests that energy poverty is not only a concern in Europe, but is also a reality. As such, development of more sustainable energy solutions across all sectors will have to mitigate the reality that energy is already a burdening expense for some people in many, if not all, member States. • Ideally, achieving the goals of the roadmap will imply that technologies are developed in Europe that can be exported globally. This would imply an economic gain and a clear contribution to the green economy. However, the reality is that countries like China are developing these technologies faster and cheaper than in Europe, thus implying that some policies supporting the this roadmap will result in export leakage (requiring investment in foreign technologies) and may not generate direct economic gains.

Table 6 Policy analysis table for Energy 2020

Type of policy and hierarchy	**Thematic Strategy**
Name	**'Energy 2020: A Strategy for competitive, sustainable and secure energy' [COM(2010) 639]**
Description	The objectives of from this strategy are part of the European Union's 2020 Strategy and the Resource Efficient Europe Initiative and are built on the so far achievements in

	European energy policy in order to make far-reaching changes to Europe's energy production and consumption patterns (European Union, 2012b). This strategy focuses on five priority areas: • Achieving an energy efficient Europe: The Commission proposes to mainstream energy efficiency into all relevant policy (sector) areas and concentrate efforts on the whole energy chain from production to final consumption (European Commission, 2012b). • Building a truly pan-European integrated energy market: measures oriented towards the implementation of legislation on the internal energy market, including the establishment of a blueprint of the European infrastructure for 2020-2030 concerning the development of the European Network of Transmission System • Empowering consumers and achieving the highest level of safety and security: This priority consist of two actions; making energy policy more consumer-friendly and continued improvement in safety and security • Extending Europe's leadership in energy technology and innovation (making a technological shift) • Strengthening the external dimension of the EU energy market (Strong international partnership, notably with our neighbours. This priority seeks the integration of energy market and regulatory frameworks with Europe's neighbours, promoting the global role of the EU for a future of low-carbon energy and legally binding nuclear-safety, security and non-proliferation standards.	
Targets	The 20/20/20 target: 20% RES consumption, 20% reduction on GHG and 20% reduction in primary energy.	
Territorial implication	**Characterisation**	***Average***
	Description	Average is seen here as something between weak and strong. Weak reflects the fact that this is a general strategy and does not include any direct discussion of implementation of place-based approaches at the regional or local level. At the same time, the notion that emissions should be cut via new energy sources and improved efficiency means that policy actions will have to be executed at all governing scales, from the EU to the local.
Indicators	N/A because the strategy discusses many factors, where each would have their own respective indicator (i.e. emissions, renewables, efficiency, international connections for infrastructure, etc.)	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	N/A. See above.	
Policy effectiveness	**Characterisation**	
	Description	
Transformative character of policy	**Characterisation**	***Incremental/radical***
	Description	Incremental in terms of the fact that the targets underlying the policy are not binding, but are only guidelines and recommendations. Radical from the perspective that if the targets are achieved there will undoubtedly be a radically transformed market for green energy technologies that will drive research and eco-

		innovation.
Green economy implication	**Characterisation**	***Unknown***
	Description	It is completely impossible to suggest the implications of a policy package that is so broad in scope and duration. There are obvious positive implications in terms of the environment as the goals of the policy fundamentally suggest. Positive implications in terms of territory relate to the need for increased local regional planning and management of energy services. Not least, this includes the local, place-based nature of renewable energy, as well as community energy systems. However, there are potential negative impacts in terms of society. The ESPON project ReRisk suggests that energy poverty is not only a concern in Europe, but is also a reality. As such, development of more sustainable energy solutions across all sectors will have to mitigate the reality that energy is already a burdening expense for some people in many, if not all, member States. Ideally, achieving the 20/20/20 goals will imply that technologies will continue to be developed in Europe that can be exported globally. This would imply an economic gain and a clear contribution to the green economy. However, the reality is that countries like China are developing these technologies faster and cheaper than in Europe, thus implying that some policies supporting the this roadmap will result in export leakage (requiring investment in foreign technologies) and may not generate direct economic gains.

Table 7 Policy analysis table for Directive 2009/28/EC on the promotion of the use of energy from renewables

Type of policy and hierarchy	**Directive and accompanying strategy and progress reporting**
Name	**Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.**
Description	As a policy basis to reach the goals of the 20/20/20 targets (thereby more than doubling the renewable energy production compared to the 2006 level of 9.2%) the EU adopted the 2009 Renewable Energy Directive. The directive provides each MS with a differentiated legally binding national target to reach the overall 20%, together with a requirement to put in place national policies in order to achieve that national target. This includes that each MS should establish *National Renewable Energy Action Plans* (NREAP) which set the share of RES consumed in transport, in the generation of electricity and heat for 2020 and take into account the effects of other energy efficiency measures on final energy consumption (European Union, 2012b). Setup of joint projects between MS concerning the production of electricity and heating from renewable sources are allowed by the Directive, as well as the establishment of cooperation with third countries as far the electricity generated is consumed in the Community. MS are also required to guarantee the origin of electricity, heating and cooling produced from RES. In order to provide consumers with information on the composition of different electricity sources (European Union, 2012b). The Directive also requires MS to build the necessary infrastructure for transmissions of RES, and to provide priority access for this type of energy. It addresses the removal of major non-economic barriers and provides measures to streamline procedures and grid

	access. With regard to biofuels and bio-liquids the directive stipulates sustainability criteria. It implies that emission savings of bio-liquids shall be at least 35% in order to be taken into account. Their share in emission savings should be further increased to 50% by 1 January 2017. It is also stipulated that biofuels and bio-liquids shall not be made from raw material obtained from land with high biodiversity value including primary forest, nature protected areas, highly bio diverse grassland, wetlands or continuously forested areas.	
Targets	National targets that amount to an increase to 20% of final energy consumption in Europe coming from renewables and a 10% share of energy from renewables in transport by 2020.	
Territorial implication	**Characterisation**	***Average***
	Description	Average is seen here as something between weak and strong. Weak reflects the fact that this is a general strategy and does not include any direct discussion of implementation of place-based approaches at the regional or local level. At the same time, the notion that emissions should be cut via new energy sources and improved efficiency means that policy actions will have to be executed at all governing scales, from the EU to the local.
Indicators	Share of Renewable Energy to Final Energy Consumption with normalised hydro and wind in EEA countries.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)		

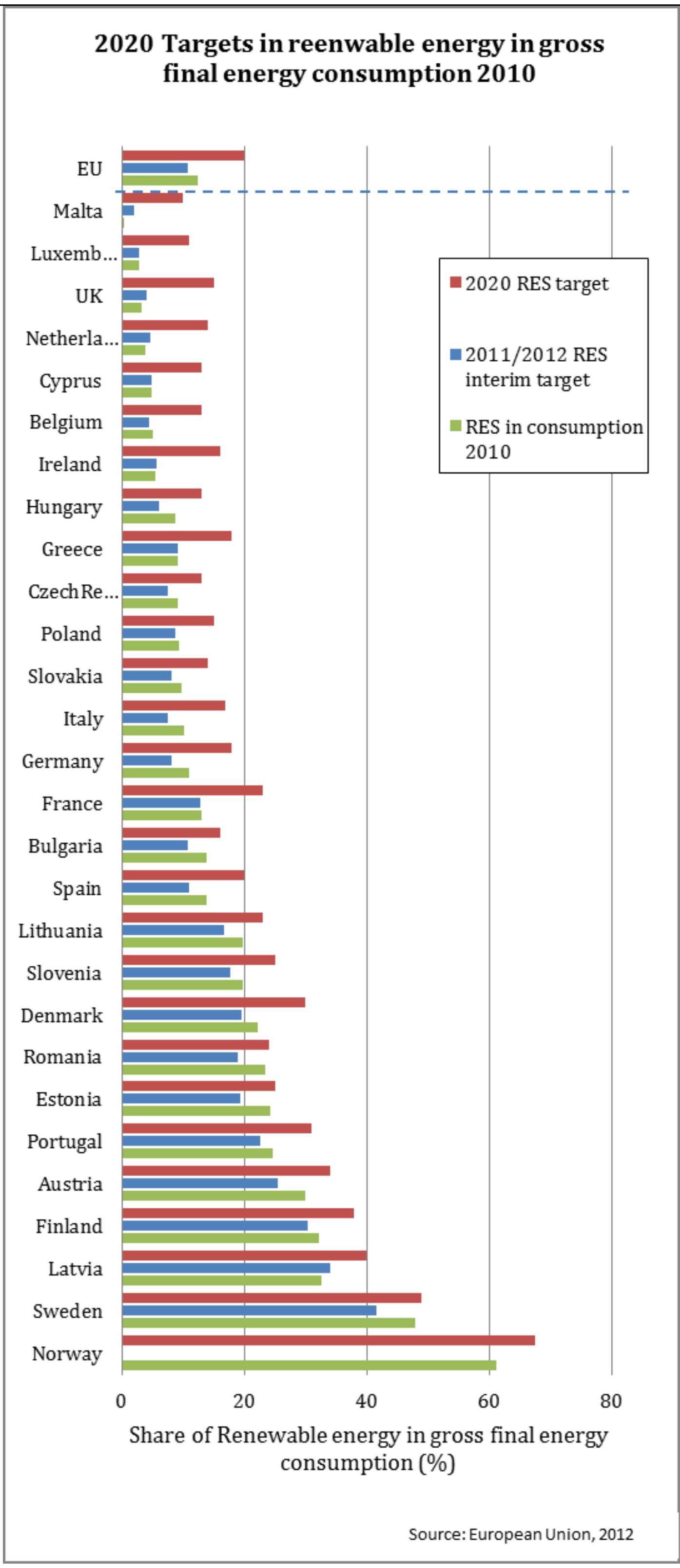
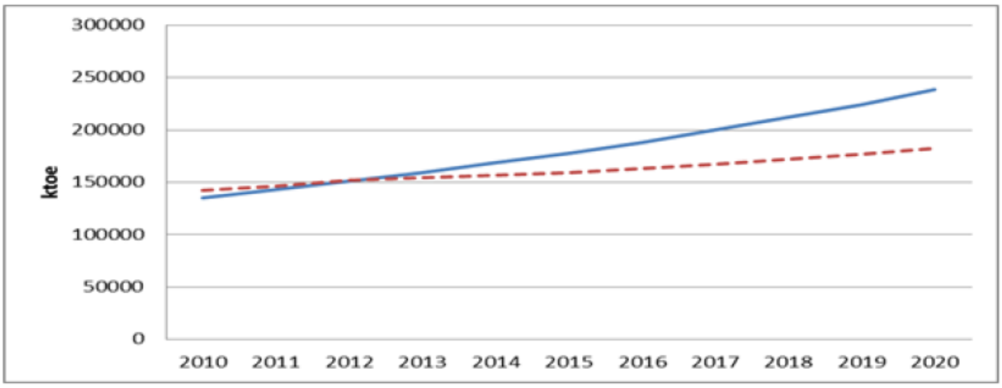


Figure 30 Share of Renewable Energy to Final Energy Consumption, compared to both the 2011/2012 interim target and the 2020 RES target for each MS.

	 **Figure 31 Planned (blue) versus estimated (red/dotted) trend in EU renewable energy production (published Renewable energy progress report COM(2013) 175 final).**	
Policy effectiveness	**Characterisation**	*Average*
	Description	The information in the previous graph provides some indication of the progress towards the 2020 targets – showing countries such as Sweden, Estonia and Romania as seeming to be close to their targets while other countries have a long way to go. However, this very overarching view can be misleading. The recently published **Renewable energy progress report COM(2013) 175 final** is a key component of Energy 2020 and the RES directive as it serves to benchmark progress as the MS level. It mentions that the 2010 renewable energy shares of 20 Member States and the EU as a whole were **at the level of or above** 2010 commitments set out in their national plans and above the first interim target for 2011/2012. This is shown in Figure 30 above. However, further EC funded analysis reveals that the cumulative 2020 target may not be reached. The analysis limits estimates to growth based on current policies that are in place, effects of the economic crisis, ongoing administrative and infrastructure barriers and disruptions of existing policies and support schemes. Figure 31 therefore shows that even though progress was above planned levels through to 2012, trends suggest that, due to stalling support for development, the EU will collectively fall well short of its target for 2020. The report then provides five additional graphs for onshore wind, offshore wind, biomass, biofuels and solar PV – each showing a shortfall to their specific 2020 target. Estimates for solar PV come closest to its target while the greatest shortfall appears to be in terms of off-shore wind. The report makes a particular emphasis on troubles in the wind sector as being due to reduced national efforts (policy support) and

		infrastructure difficulties. In terms of the latter, this was a key reason for the recent release of **Regulation (EU) No 347/2013 of the European Parliament and the Council on guidelines for trans-European energy infrastructure.** This document points out that additional infrastructure investments are needed in order for the EU to reach its 2020 goals. The report specifically focuses on: connections across borders (part of creating a common market and balancing RES with traditional sources in space and time), refurbishment of existing infrastructure, and further development of smart grids in order to support decentralised (renewable) energy production.
Transformative character of policy	**Characterisation**	***Incremental***
	Description	This is difficult to characterise, but one could say that renewable energy policy in Europe has an incremental transformative character because it only attempts to reach a level of 20% of final energy consumption coming from renewables. As such, its target acknowledges that the switch to RES is a long, incremental process that must take place within the confines of existing market conditions – both in terms of supply cost and energy affordability. Furthermore, considering that key funding policies such as feed-in tariffs will continue to be key drivers of the sector, it is also assumed that renewables will not have a clear competitive advantage over traditional sources by 2020.
Green economy implication	**Characterisation**	***Positive Average (++ or +++)***
	Description	It is undoubted that the EU's RES strategy has positive implications on the environment – not lease due to the reduction of carbon intensive energy sources and the mandated sustainable uptake of renewable sources (that acknowledges environmental consequences of RES development. It also certainly has a positive impact on territory, particularly in terms of its importance on regional knowledge and strategies for place-based development of renewables. This is part and parcel with the nature of RES as part of decentralised energy strategies, and RES development has been a core rationale of the Intelligent Energy Europe Programme and the associated establishment of Regional Energy Agencies throughout Europe. It is perhaps too early to suggest the economic implication of RES development. On one hand it, RES technology for domestic development and export is an important contribution of generating a low-carbon economy, but only time will tell if this

		type of economic strategy will help keep Europe as a world economic leader. On the other hand, countries such as China are rapidly moving on their competitive advantage in the development of renewable energy technologies and this could have major consequences for the economic benefits that EU countries may have related to RES development. It is also difficult to determine the implications on the social sphere. On one hand, an improved environment means improved social welfare, but it is crucial that RES development takes place in a way that allows for all MS to adapt to new a new energy paradigm. Without such coordination, varying impacts will cause winners and losers, and through increased energy poverty will likely go against the goals of social cohesion in Europe.

Table 8 Policy analysis table for Directive 2012/27/EU on energy efficiency

Type of policy and hierarchy	**Directive and accompanying strategy and progress reporting**
Name	**Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC [OJ L315 p.1]**
Description	As the EU's main directive concerning energy efficiency, it has a host of policies and thematic strategies underneath it. Perhaps most notably, this includes the 2011 adopted strategy **Energy Efficiency Plan 2011 (EEP 2011)**, which sets out a strategy for MS to implement the details of the directive. However, the EU's most comprehensive policy strategy affecting the market conditions of any sector is – the EU Emissions Trading Scheme (Directive 2003/87/EC) (EU-ETS). This aims to set a common market for emissions from 'energy intensive' industries – the revenues of which can be reinvested in energy efficiency measures or RES development. Yet, as such a decisive policy programme for the EU, it is surprising that the ETS is not closer aligned with goals of energy efficiency in the EU. For instance, this 2012 Directive on energy agency only acknowledges the role of the ETS once – in saying that in order to implement the 20% energy efficiency target, the Commission will have to ensure that incentives within the ETS continue to reward low carbon investments. The primary reason for releasing the 2012 EE directive is the indication that the EU will fall woefully short of its 20% target for increased efficiency. As shown by Figure 32, the most recent projection indicates that we will only achieve a 9% savings; less than half of what was expected.

<table>
<tr><td></td><td colspan="2">

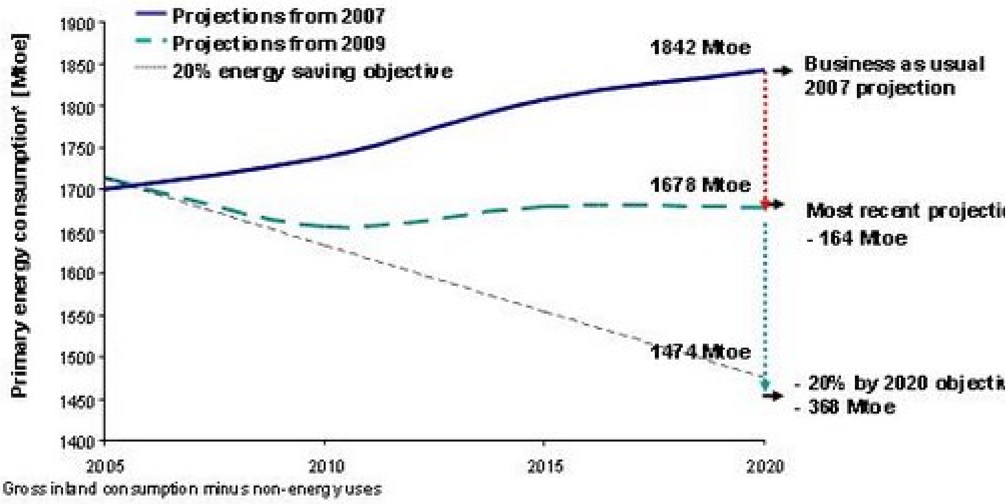


Figure 32 Projection of primary energy use for the EU by 2020 (MEMO/11/440 of the EC)

As a result, the directive proposes a number of new or revised measures. Highlights include:

- Legal obligation to establish energy saving schemes
- energy distributors or retail energy sales companies will be obliged to save every year 1,5 % of their energy sales
- Public sector to lead by example: for instance, every year they are required renovation works covering at least 3% of their total floor area
- To motivate MS to improve investment in energy infrastructure.

In addition, the Commission proposes that:
(1) Member States set themselves **non-binding national energy efficiency target**
(2) The Commission will propose binding national targets if in 2014 we come to the conclusion that the EU is not likely to achieve the 20 percent target.

What is notable through the Directive is that while the theme energy efficiency has an overarching perspective it is very much elaborated in terms of a) the EU ETS for energy intensive sectors and b) through sector specific interventions for auxiliary sectors. For example, this relates to the building and construction sector (cf. Directive 2010/31/EU on the energy performance of buildings) and the transport sector (cf. White Paper on Transport, adopted 28 March 2011). As such, much of the actual policy discussion on energy efficiency is rooted within the individual sector reports.
As a part of this Directive, all MS are responsible for developing and implementing national energy efficiency action plans.
</td></tr>
<tr><td>Targets</td><td colspan="2">20% increase in energy efficiency compared to business as usual. See Figure 32.</td></tr>
<tr><td rowspan="2">Territorial implication</td><td>Characterisation</td><td>Strong</td></tr>
<tr><td>Description</td><td>The directive and its supporting documentation has a very string territorial implication. First and foremost, its decisive focus on leading by example through public sector investment means that local and regional governments (owners of public buildings and infrastructure) are essential to the process of achieving the EU's energy efficiency</td></tr>
</table>

		goals. As such, the directive points out a number of governance networks, policies and funding sources directed towards local and regional authorities. This includes: • The EU Covenant of Mayors – especially in terms of developing integrated approaches to energy savings, complete with action plans. • Managenergy – energy efficiency and renewables at the local and regional level. • The Intelligent Energy Europe programme – for instance through the establishment of regional energy agencies. • JESSICA funds in support of urban projects targeting efficiency. • The ERDF and Cohesion fund will both extend their focus on energy efficiency issues in the 2014-2020 period.
Indicators	While Figure 32 provides an EU level appraisal of the progress towards the 20% reduction in energy efficiency – no breakdown at the national level has thus far been found.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	N.A.	
Policy effectiveness	**Characterisation**	*Weak-Average*
	Description	As shown in Figure 32, current forecasts suggest that the EU will not even achieve half of its goal towards energy efficiency. As such, the main reason for this directive in the first place is due to the overall lack of progress towards the 2020 target. Here, emphasis is placed on the incredible variation towards improvement among member states, the lack of direct public investment compared to what is needed and the need for additional financial measures supporting energy efficiency improvements (cf. Financial support for energy efficiency in buildings COM(2013) 225 final).
Transformative character of policy	**Characterisation**	***Radical***
	Description	The goals of the directive require parallel development of new markets for energy efficiency goods and services, as well as behavioural changes in the ways of thinking about energy consumption. This requires that we move from a condition now where energy is very much considered as a residual cost of a transaction towards energy issues being considered at the forefront of investment decisions. This policy also has a radical transformative

		character because of its crucial importance for achieving the EU's climate change goals, as well as improving security of supply and reduced dependency on energy imports.
Green economy implication	**Characterisation**	***Positive Strong (++++)***
	Description	All four spheres of the green economy would benefit under a condition where a 20% improvement in energy efficiency takes place. First, the environmental importance goes without saying – energy efficiency is absolutely essential to EU meeting its short, medium and long term climate change goals. Socially, we are more resilient to fluctuating energy prices, just as we are less dependent on foreign energy sources. Urban systems are likely put in focus for their energy efficiency benefits and these are marketed on their parallel benefits for social well-being. No least, this includes good access to public transit and high quality leisure space. Economically, we are investing in green technologies that are not only energy efficient for us at home, but we are able to export these goods and services at the global scale. Territorially, achieving the EU's energy efficiency goals requires increased action at the local and regional level. These actions not only consider that important of local context in the development of policy (e.g. via the development of regional energy agencies for example), but improvements to Europe's building stock (the main consumer of energy in the EU) and urban mobility require participation from knowledgeable local and regional authorities.

5.2 Cross-sectorial policies

5.2.1 The Lisbon Strategy

The general goal of the Lisbon Strategy (2000) was that Europe shall become the most competitive, knowledge-based economy in the world while preserving or improving social cohesion and maintain environmental sustainability (Johansson, et al., 2007). The Strategy sets also a framework for national and regional policies aimed to achieve these goals. Emphasis on energy policy in the Lisbon Strategy was made mainly within the second cycle (2005-2008) presented through the Communication '*The renewed Lisbon strategy for growth and jobs*' [COM(2007)803][4]. This Communication highlighted the importance of four priority areas: investing in knowledge and innovation, unlocking business potential, modernizing labour markets and developing an energy-efficient low-carbon economy. Within this last priority The Commission proposed that the EU should:

[4] Communication from the Commission to the Council of 11 December 2007, 'Strategic report on the renewed Lisbon strategy for growth and jobs: launching the new cycle' (2008-2010) Part I [COM(2007) 803]

- seek to reduce greenhouse gas emissions by at least 20% and achieve a renewable energy share of 20% by 2020;
- promote an industrial policy geared towards more sustainable production and consumption, focusing on renewable energies and low-carbon and resource-efficient products, services and technologies;
- review the taxation of energy in the light of EU's energy and environmental objectives;
- strengthen the requirements regarding the energy performance of buildings.

Hence, it is clear from the Lisbon priorities that, EU builds its future policy development around the notion of competitiveness and places the knowledge and innovation together with entrepreneurship, security of supply, energy efficiency and climate change mitigation as indispensable tools at the heart of its regional development objectives (Rasmussen, et al., 2010).

5.2.2 Europe 2020 a strategy for European Union growth COM(2010) 2020

The Europe 2020 strategy[¡Error! Marcador no definido.] replaces the Lisbon Agenda, adopted in 2000, which aims at enabling the European Union (EU) to achieve growth that is:

- *Smart*: through the development of knowledge and innovation;
- *Sustainable*: based on a greener, more resource efficient and more competitive economy;
- *Inclusive*: aimed at strengthening employment, and social and territorial cohesion.

In addition, the Commission proposes a series of targets to be achieved by 2020:

- increasing the employment rate of the population aged 20-64 to 75 %;
- investing 3 % of gross domestic product (GDP) in research and development;
- reducing carbon emissions by 20 % (and by 30 % if conditions permit), increasing the share of renewable energies by 20 % and increasing energy efficiency by 20 %;
- reducing the school dropout rate to less than 10 % and increasing the proportion of tertiary degrees to 40 %;
- reducing the number of people threatened by poverty by 20 million.

Thus, this strategy has a clear integrative approach as it fully incorporates the energy sector by reflecting the goals set in the 20-20-20 strategy. The energy sector is addressed in the *'the resource-efficient Europe'* initiative which aims to support the sustainable management of resources and the reduction of carbon emissions, while maintaining the competitiveness of the European economy and its energy supply.

5.2.3 Implementation of EU incentives at regional level

A study survey carried out by the Assembly of European Regions in 2011 (Podralska, et al., 2011) provides a good overview of which European incentives are applied on 27 member regions and how these are applied. According to this survey at least 82% (7% has did not responded) ofCF the regions have adopted at least one energy strategy during the last 10 years.

The Structural and Cohesion Funds (SCF) are the European Union's main instruments for supporting social and economic restructuring across the EU. They account for over one third of the European Union budget and are used to tackle regional disparities and support regional development. The Structural and Cohesion Funds budget for 2007-2013 is EUR 347 billion of which a greater proportion of the overall budget is allocated to the poorest regions where the Gross Domestic Product (GDP) per capita is lower than the EU average. Three objectives determine the eligibility of the region to use these funds, namely the 'convergence' objective, the 'regional competitiveness and employment' objective and the 'European territorial cooperation' objective.

Table 9 Priorities concerning energy supply and efficiency in EU Structural and Cohesion Funds (Energy cities, 2007)

European Regional Development Fund	– Improving security of supply, integrating environmental considerations. – Development of Public-Private-Partnerships. – Climate change mitigation. – Clean transport – Improvement of energy efficiency and development of renewable energies
European Social Fund	– Exchange of experiences and dissemination of good practice. – Mechanisms to improve good policy and programme design. – Support for interdepartmental coordination and dialogue between relevant private and public bodies. – Capacity building in delivery of policies and programmes.
Cohesion Fund	– Trans-European transport networks – Environment – Sustainable development: renewable energies, energy efficiency and clean urban and public transport.
European Regional Development Fund	– Stimulation of renewable energy production and energy efficiency – Development of efficient energy management systems. – Promoting clean and sustainable transport in urban areas.
European Social Fund	– Exchange of experiences and dissemination of good practice. – Mechanisms to improve good policy and programme design. – Support for interdepartmental coordination and dialogue between relevant private and public bodies. – Capacity building in delivery of policies and programmes.
European Regional Development Fund	– Networking, exchange of experience, transfer and dissemination of the best practice case studies on sustainable urban development (cross-border, trans-national and inter regional cooperation). – Cross-border environmental joint strategies. – Improved access to transport and cross-border energy management systems.

The EU Structural and Cohesion Funds for 2007-2013 are divided into three separate funds, the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund. Table 9 presents the priorities concerning energy supply and efficiency for each of the programmes (Energy cities, 2007).

For the programming period of 2014-2020 the European commission has proposed to almost double the proportion of the Cohesion policy budget to climate and sustainable energy expenditure to 5% or EUR 17 billion of a total budget of EUR 347 billion. Three priorities relate to investments in sustainable energy, namely research and innovation, competitiveness of Small and Medium-sized Enterprises (SMEs) and shift towards a low-carbon economy (Skäringer, 2012).

Intelligent Energy for Europe Programme

The Intelligent Energy for Europe programme was originally launched in 2003 to support projects aiming at introducing RES technology, informing and implement policies across the EU and monitoring and stimulating markets (International

Energy Agency, 2008). As a measure to support the European Union's 20-20-20 objectives the Intelligent Energy Europe II Programme (IEE II) was launched for the period 2007-2013. IEE II forms part of the Competitiveness and Innovation Framework Programme (CIP), which aims at achieving the EU energy objectives and to implement the Lisbon Agenda. The total budget allocated to the IEE II program for 2007-2013 is EUR727.3 million.

The programmes specific objectives are (Intelligent Energy Europe, 2012):

- to foster energy efficiency and the rational use of energy resources;
- to promote new and renewable energy sources and support energy diversification;
- to promote energy efficiency and the use of new and renewable energy sources in transport.

Two kind of actions have been supported with grants a, namely Promotion and Dissemination Projects and Project Development Assistance Facilities (ELENA), introduced in 2009, managed by international financial institutions.

Projects are categorized in four families (Intelligent Energy Europe, 2012):

- Energy efficiency and rational use of energy (SAVE): support projects that aim to tap the large potential for energy savings by improving energy efficiency and the rational use of energy sources, in particular buildings, products and the industry.
- New and renewable energy resources (ALTERNER): focuses on non-technological actions that contribute to the implementation of the RES Directive and on accelerating the growth of renewable energy markets to meet the EU 2020 target.
- Energy in transport (STEER): aims at promoting energy efficient modes and more rational use of energy in transport as well as stimulating the demand for alternative fuels and clean and energy- efficient vehicles.
- Integrated initiatives: are funding priorities covering more than one specific filed.

By the end of 2011 IEE has supported more than 300 promotion and dissemination projects representing more than EUR300 million. On average public bodies represented 34% of the beneficiaries while private organizations and SMEs were 21% and 45% respectively (Intelligent Energy Europe, 2012).

Projects within ALTERNER comprise non-technological actions that enhance the growth of renewable energy markets covering four key actions (Intelligent Energy Europe, 2012):

- Electricity from renewable energy sources (RES-E): aims at supporting the implementation of RES, infrastructure and sector specific actions to remove market barriers (Budget: EUR 30.8).
- Heating and cooling from RES: consists of key actions aiming at accelerating the large-scale use of renewable energy for heating and cooling in new and existing buildings, and in commerce and industry either from renewable energy systems or district heating and cooling (DHC) systems (Total budget 16.3 million).
- Small-scale applications: consists of actions aiming at accelerating the deployment of biomass, geothermal, and /or solar (thermal or PV) systems for heating, cooling and electricity in energy efficient buildings mainly by supporting policy implementation (Total budget EUR 14.8).
- Bioenergy: covers the following aspects of the bioenergy sector (Total budget: 36.1 million).

5.3 National support mechanisms for renewable energy development

Discussion on both the RES and energy efficiency directives mentioned the importance of national governments supporting development via financial mechanisms, national targets and place-based action plans. For both renewable energy and energy efficiency key financial support mechanisms are typically rooted in national schemes. For instance, from a European scale each country has adopted individual sets of support mechanisms and adapted these to its specific socio-economic, technical and geophysical context. This does not only imply that MS have their own mix of support mechanisms but also that the level of support and rules of these vary in individually.

According to the results obtained from the RE-SHAPING project, most common support instruments in the renewable energy sector are feed-in tariffs, feed-in premiums, quota obligation systems and combinations of these. In 20 MS feed-in tariffs are the main support scheme applied on RES whereas an increasing trend towards feed-in premiums is also noticeable. Quota obligation systems with tradable green certificates (TGC) have been implemented in Belgium, Italy, Sweden the UK, Poland and Romania. In Belgium, Italy and the UK quota obligations are combined with feed-in tariffs for small-scale projects or specific technologies. The implementation of tender schemes has on the contrary become rare excepting in few cases for supporting specific projects or technologies such as in the case of wind offshore installations in Denmark (Ragwitz, et al., 2012).

Quota obligations supporting onshore wind power plants in Sweden, Belgium, the UK and Italy have become an effective scheme. Compared to feed-in tariffs, quota obligations still generates considerably higher profits for onshore wind electricity that involve higher risk premiums and windfall profits for investors. However, feed-in schemes still appear to be more effective than quota obligations, despite of improvement of quota in the support of low-cost technologies such as onshore wind and biomass. Technology uniform quota obligations are effective in stimulating more mature technologies such as onshore wind or biomass-based renewable power plants than in promoting less mature technologies such as offshore wind or solar PV (Ragwitz, et al., 2012).

The remuneration granted under FIT system tends to be lower for lower-cost technologies than under quota obligation schemes. On the contrary, quota obligations provide low levels of remuneration when applied on cost intensive technologies such as solar PV (Ragwitz, et al., 2012).

Countries using feed-in systems such as Portugal, Ireland, Spain, Hungary and Germany have achieved higher policy effectiveness at reasonable profits in 2009 (Ragwitz, et al., 2012). However, Price-based policy instruments such as feed-in tariffs or feed-in premiums can imply considerable policy cost for consumers if technology prices decline faster than expected, in the case support levels for new projects are not adjusted in response to deployment volumes. This happened with the development of solar PV in Spain and the Czech Republic in 2008-2009, Germany in 2010-2011, and in the UK in 2011. In quota systems this risk also exists but to a lesser extent, mainly with technology-specific banding or minimum prices (Ragwitz, et al., 2012).

Table 10 Support schemes on renewable energy in Member States (RESLEGAL, 2012)

Austria	x	x		
Belgium			x	x

Bulgaria		x					
Cyprus		x	x				
Czech Republic	x	x	x		x	x	
Denmark	x					x	x
Finland			x				
France		x			x	x	
Estonia						x	
Germany		x				x	
Greece		x					
Ireland		x					
Italy		x		x	x	x	x
Latvia		x					
Lithuania		x	x		x		
Luxemburg		x	x		x		
Malta		x	x				
The Netherlands		x			x		
Poland	x			x	x		
Portugal		x			x		
Slovakia		x	x		x		
Slovenia	x	x	x			x	
Spain		x			x	x	
Sweden			x	x	x		
The UK		x		x	x		
Romania			x	x			

High support levels do not in all cases lead to substantial growth in RES deployment. Flaws in the support instruments, high risk premiums or non-economic barriers hamper the effectiveness of support schemes. Further, the effectiveness of support schemes decrease as RES become well established in markets due to saturation effect (Ragwitz, et al., 2012).

Comparisons made between support schemes on renewable heat and renewable electricity technologies show that support on renewable heat generally appears to provide less profit than those for renewable electricity, despite of low generation cost related to many renewable heat technologies. This is because long reinvestment cycles limit the diffusion rate for the integration of renewable heating systems in buildings. Further, the dependence of financial incentives, predominantly investments grants, gives rise to greater uncertainty for investors in renewable heating than in renewable electricity (Ragwitz, et al., 2012).

5.4 Legal and policy framework for Carbon Capture and Storage

A new dimension in European energy policy is the introduction of CCS which not only is expected to help in reducing CO_2 emissions but also may offer a high degree of energy security in European countries with high availability of coal and lignite (Fischer, 2012).

Being a technology initially applied in upstream oil and gas production activities, Norway started promoting CCS in the first place. CCS entered high-level political discussion in the EU for the first time in 2005 during negotiations about the second phase of the European Climate Change Programme (ECCPII). CCS was later presented in the Green Paper '*A European strategy for sustainable competitive and secure energy*' [COM (2006) 105] **¡Error! Marcador no definido.** as strategic solution for future exploitation of coal and lignite for energy generation. Moreover, the Commission stressed the need of investments in CCS technology and proposed several support mechanisms for its development. In the EU Energy

Action Plan (2007-2009)[5] the European Council followed the Commission's recommendations in the Green Paper. It identified the development of CCS as a main challenge in the SET-Plan. Heads of state and governments asked the Commission to improve knowledge about CCS, to promote the deployment of 12 demonstrations plants until 2015 and to develop the technology towards full and cost effective market integration in 2020 (Fischer, 2012).

In 2007 the Commission started to prepare legislation on CCS, focusing on two aspects, the regulation of local and global risks related to the use of CCS and the establishment of investment security and favourable conditions for integrating CCS into the European energy markets. In 2008[6] the European Commission pinpointed challenges that needed to be addressed in connection to CCS, namely the regulation of potentially negative impacts from the application of an unknown technology while offering incentives to invest in large-scale demonstration projects (Fischer, 2012).

As part of the 'climate and energy Package' published on 23 January 2008, the Commission proposed a directive to enable environmentally safe capture and geological storage of carbon dioxide in the EU, giving then foundations for a legal framework to promote the development and safe use of CCS. The Commission decided to consider three questions in the context of the Climate and Energy Package; how far the CCS should be regulated at the EU level, whether there should be one comprehensive legal framework for the three steps involved in CCS (capture, transport and storage), and whether support schemes for CCS should be established at the national or EU level.

5.4.1 The CCS Directive 2009/31/EC

The EU Directive on the geological storage of carbon dioxide**¡Error! Marcador no definido.** was adopted by the Council of Ministers on 6 April 2009 and entered into force on 25 June 2009 as part of the Climate and Energy Package. The Directive establishes a comprehensive regulatory framework for geological storage (both on- and offshore) and associated capture and transport activities. The Directive is often described as '*enabling*' legislation to provide the necessary regulatory framework upon which CCS deployment could move forward (Centre for Law and the Environment, 2012).

The aim of the Directive is the '*environmentally safe*' storage of CO_2, meaning its permanent containment as to prevent and eliminate as far as possible negative effects and any risk to the environment and human health (Centre for Law and the Environment, 2012). The three steps in the CCS chain are addressed in the Directive stipulate rules concerning planning and operational procedures for the capture, transport and storage of CO_2. However, the Directive sets mainly rules on storage of emission while capture and transport are regulated primarily by national and EU legislations. The Directive provide rules on storage of CO_2 concerning procedures in the site selection and exploitation, storage permits, operation, monitoring, closure and post-closure and transfer of liability (Fischer, 2012).

The capture process is primarily regulated through the EU's Integrated Pollution Prevention and Control (IPPC) Directive[7]. The CCS Directive also lies down, through an amendment to the Large Combustion Plant (LCP) Directive[8], a

[5] European Council (2007) *European Council Presidency Conclusion's, 8/9 March 2007.* 7224/1/07 REV1, Brussels, 2 May.
[6] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions of 23 January 2008. Supporting early demonstration of sustainable power generation from fossil fuels [COM(2008)13].
[7] Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control.
[8] Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants.

Carbon Capture Readiness (CCR) requirement meaning that new combustion plats with an output of 300MW or more should be capable of being fitted with capture technology (Centre for Law and the Environment, 2012).

In terms of transport of CO_2 the Directive addresses few provisions, relying principally on national pipeline regulations, and property planning laws, together with existing European legislation including the regulation on conditions for access to natural gas transmission networks (2005/1775/EC)[9]. The Directive deals however with third-party access to both transport networks and storage facilities; implying that MS must ensure that potential users can obtain fair and open access to transport and storage facilities (Centre for Law and the Environment, 2012).

5.4.2 Incentive for investing in CCS installations

According to Severin Fischer (2012, p. 90) the cost of building CCS installation currently outweighs the cost of preventing GHG emission because the ETS only covers parts of the European economy. Furthermore, export potentials on CCS technology and its positive externalities for global climate policy are not fully understood and therefore not obvious in the present status of technology development. Lastly, CCS is also an energy demanding process which implies a drop in energy efficiency of more than 10%. In order to overcome these barriers the European Commission has perceived several measures as being applicable:

- Exclusion of CCS from emission trading
- Mandatory use of CCS in new installations
- Direct public financial support to private investments

Article 10(a) 8 of the revised Emissions Trading Directive 2009/29/EC**¡Error! Marcador no definido.** contains the provision to set aside 300 million allowances (rights to emit one tonne of carbon dioxide) in the New Entrants' Reserve of the European Emissions Trading Scheme for not only subsidising installations of innovative RES technology but also up to 12 commercial demonstration projects on CCS (NER300.com, 2011).

Through the Regulation 663/2009/EC[10] the European Council and Parliament on the allocation of EUR 1.05 billion to seven CCS projects in a geographically and technologically balanced way. This Regulation not only demands competition among companies to installation start operating in the next years but also is considered to initiating a race among governments to create investment friendly environment and set up legal frameworks to provide investment security necessary to attract more investments (Fischer, 2012).

As previously outlined the Strategic Energy Technology Plan (SET-Plan)**¡Error! Marcador no definido.** reviewed at the end of 2009 includes an initiative for support and investments on the promotion and market introduction of CCS technologies. The European CO_2 Capture, Transport and Storage Initiative aims to demonstrate and develop CCS technologies in power generation and in other intensive industries that use fossil fuels, mainly coal and gas. Ultimately this initiative should achieve commercial viability of CCS under the Emission Trading Scheme by 2020. Accordingly, CCS projects would receive the largest amount of all the budget items were the SET-Plan to be accepted by the European institutions, EUR 13 billion by 2020 (European Union, 2010).

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[9] Regulation (EC) No 1775/2005 of the European Parliament and of the Council of 28 September 2005 on conditions for access to the natural gas transmission networks.

[10] Regulation (EC) No 663/2009 of the European Parliament and of the Council establishing a program to aid economic recovery by granting Community financial assistance to projects in the field of energy.

The first research initiative on CCS can be found as far back as the EU's Third Framework Programme (FP3), 1990-1994. Subsequent programmes, which in 2006 became seven-year programmes, have given increasing weight to CCS-related projects (European Technology Platform for Zero Emission Fossil Fuel Power Plants, 2012).

CCS Research is also supported by the FP7 specifically within energy theme in the Cooperation Specific Programme, which aims to support the creation and establishment of sustainable energy technologies (European Commission, 2007).

5.5 Actions and initiatives supporting sustainable energy

Today the European energy sector dealing with sustainable energy supply consists of a large number of initiatives and networks of different kinds. These can be public, private or partnerships of either supported or independent from the EU. Bellow some of the most important initiatives and actions quoted by the European Commission's webpage are briefly introduced.

5.5.1 The Energy Community

The Energy Community (also referred in the past as Energy Community of South East Europe (ECSEE) and European Energy Community (EEC)) is a community established between the European Union and a number of third countries. The treaty establishing the Energy Community was signed in Athens, Greece, on 25 October 2005, and entered into force on 1 July 2006. The Community aims to extend the EU internal energy market to Southeast Europe and beyond as Parties commit themselves to implement the relevant EU acquis communautaire, to develop an adequate regulatory framework and to liberalise their energy markets in line with the acquis under the Treaty (Energy Community, 2012).

Box 1: European Renewable Energy Associations

- EFOA: the European Fuel Oxygenates Association
- EWEA: European Wind Energy Association
- European Association for Battery, Hybrid and Fuell Cell Electric Vehicles
- European Biomass Association
- European Biomass Industry Association
- European Biodiesel Board
- European Photovoltaic Industry Association
- European Solar Thermal Industry Federation
- European Small Hydropower Association
- European Renewable Energy Research Centres Agency
- European Renewable Energy Council
- European Association for Renewable Energies
- EnR : European Energy Network
- EUFORES : European Forum for Renewable energy Sources
- Comité de Liaison Énergies Renouvelables(CLER)
- Nordic Folkecenter for Renewable Energy
- Fuel Cell Europe
- European Wave Energy Thematic Network
- International Geothermal Association
- Bioenergy
- European Bioenergy Networks
- European Biomass Association
- European Biomass Industry Association
- IEA Bioenergy
- European Biodiesel Board
- ITEBE - Bois-énergie
- Wind energy
- IEA Research and Development of Wind Turbine Systems
- EWEA: European Wind energy Association
- Concerted Action on Offshore Wind energy in Europe
- IEA Research and Development of Wind Turbine Systems
- EWEA: European Wind Energy Association
- Concerted Action on Offshore Wind Energy in Europe

Souce: (European Commission, 2012h)

5.5.2 EurObserv'ER

The EurObserv'ER barometer is an initiative established in 1998 which measures the progress made by renewable energies in each sector and in each Member State. EurObserv'ER produces a series of figure-backed indicators covering energy, technological and economic aspects. The aim is to (EurObserv'ER, 2012):

- Monitor and analyse the development of renewable energy sectors in the European Union.
- Evaluate this progression in comparison of the White Paper objectives for 2010.
- Disseminate the results of the investigation to European journalists and energy actors.
- Enable all webvisitors to download the barometer.

EurObserv'ER is supported by Intelligent Energy Europe and the French Environment and Energy Management Agency (EurObserv'ER, 2012).

5.5.3 The Covenant of Mayors

The Covenant of Mayors is a voluntary commitment by signatory towns and cities to go beyond the objectives of EU energy policy in terms of reduction in CO_2 emissions through enhanced energy efficiency and cleaner energy production and use. The Covenant of Mayors has been regarded as model of multi-level governance (Covenant of Mayors, 2012).

5.5.4 Cities demonstrating energy and climate change policy solutions (CONCERTO)

CONCERTO supports local communities, in developing and demonstrating concrete strategies and actions that are both sustainable and highly energy efficient. Consisting of 18 projects the focus is primarily on demonstrating the environmental, economic and social benefits of integrating renewable energy sources together with energy efficiency techniques through a sustainable energy-management system operated on a community level. The CONCERTO initiative provides also a platform for the exchange of ideas and experiences between the 45 demonstration communities, and other cities that are committed to introducing similar strategies (CONCERTO, 2012).

5.5.5 Energy efficiency and renewable energies at local and regional level (ManagEnergy)

The ManagEnergy initiative was launched in 2002 to support the work of actors on energy efficiency and renewable energies at the local and regional level. ManagEnergy provides specifically training, workshops and online events targeting energy professionals and managers of energy agencies (European Commission, 2012f).

5.5.6 CIP eco-innovation call for market replication projects

Within the framework of the EU's Competitiveness and Innovation Framework Programme (CIP), the CIP Eco-innovation initiative, supports companies that develop innovative products, services and technologies enabling better use of natural resources and reduce Europe's ecological footprint. This initiative supports also the market entry and further market uptake of these technologies. Nearly EUR200 million will be available between 2008 and 2013 to co-fund eco-innovation projects across Europe and thus contribute to the implementation of the Environmental Technologies Action Plan (ETAP) (Eco-Innovation, 2012).

6 Potentials

GREECO project has made an attempt to characterise territorial potentials for RES generation linked to the following sources:

- Wind
- Photo Voltaic
- Biomass from forest, agriculture and manure residues

Such characterisation is based on a comprehensive assessment of technical and economic generartion potentials that are included within **Vol 2** of the Final Report of GREECO project.

7 Conclusions

In reviewing the contents of the above report it is clear the energy sector in EU MS is facing a transition towards new 'greener' models for the exploitation, transformation and trade of energy. Climate change mitigation and economic challenges have triggered this adaptation process which is reconciling environmental protection and economic growth, through value added and job creation from the substitution of oil and coal, recycle of residual energy and materials and efficiency in transformation, transmission and consumption of energy.

The on-going economic restructuring process that the European energy sector is witnessing implies increasing productivity. In this context an east-west division exists because productivity is greater in Western European countries. However, Eastern European countries are experiencing faster increase of productivity which suggests that major structural changes are expected to take place in these countries. These dynamics are not necessarily regarded to job reductions in the coal mining industries but to activities related to generation and supply of electricity, gas and steam. Therefore, reductions in coal consumption may not necessarily be direct reason of these developments but more likely the result of retrofitting and modernizing energy industries. Current studies on the macroeconomic impacts of European RES policies indicate moreover that Eastern MS will witness major increases on RES employment relative to current levels. Considering these factors, RES deployment may play an important role in revitalizing not only the energy sector but also the economy as a whole in the near future. It is therefore central that energy policies are adapted to structural, socioeconomic and geophysical characteristics of regions in order to enable favourable conditions for deployment and development of RES technologies and the creation of new jobs. This entails furthermore that energy policy should be based on a clear understanding of national and regional priorities and this sector's interrelations with other sectors.

Despite of improvements in energy efficiency and increased demand on RES, MS still are heavily dependent on fossil fuels which constitute approximately 76% of the energy mix for the EU27. RES development in the European energy mix is taking place in parallel to increases in energy generation from nuclear plants and natural gas. European energy policy will certainly boost further deployment of RES technologies and energy generation from these resources. However, renewable energy will continue being exposed to hard competition with nuclear energy and natural gas, and possibly with energy generation from coal plants with CCS technologies. Therefore, it is central that future energy policies are developed so that they reflect not only the complexity in future energy markets but also the externalities of the utilization of different energy sources, both in terms of social and environmental costs. Here, it will nevertheless be central to phase out subsidies and support mechanisms on environmentally harmful fossil fuel technologies.

This study also raised the question of which indicator may be the best suitable for measuring the energy sector's 'green' performance. The share of RES in the final energy demand was significantly versatile to apply due to its simplicity. However, regional data on RES consumption has not been available during the project's course hindering an assessment of the energy sector's green performance at regional level. The observation indicates that regional data on energy supply, demand, intensity and efficiency as well as structural business characteristics is needed, not only for research purposes but mainly as a tool for helping policymakers to understand the territorial dimension of RES and other energy sources. Therefore, European energy policy should emphasise on the creation of a common long-term monitoring mechanisms that enable the evaluation of the state and development of the energy sector at regional level. This should imply the creation of common assessment methodologies and definitions as well as improvements in data quality.

The territorial dimension of in RES deployment is given by the driving factors and enabling conditions which are embedded within a political and legal context. Here, three overall drivers were identified namely security of supply, economic development and environmental protection. Within these drivers a series of other drivers were identified, each inducing territorial dynamics in ways energy sources are exploited, transformed, transmitted and consumed. What, where and how energy sources are exploited, transformed, transmitted and consumed are key questions that directly relate to security of supply alongside with price volatility and affordability of energy. Economic development in the energy sector inherits aspects relating a territory's accessibility to human, technological and economic capital and capacity to adapt and take advantage of changes in order to create progress and quality of life. The literature emphasises on the long-term character of energy development which suggests that policy frameworks for the energy sector should become more coherent, robust and predominantly stable so that long term investment conditions are guaranteed. This approach applies particularly on regulatory frameworks that foster innovation.

Increased cooperation between actors involved in the energy sector is required at all governance levels for accelerating a transition towards green economies. This not only implies the creation of new means of communication but most important new and effective means for coordination between both public authorities and the private sector. This is particularly important considering the complexity of energy markets, the large number of actors involved and the critical function that energy has in economies and society. Further liberalization of energy markets in MS will also be necessary in order to enable new regional actors to enter energy markets.

Climate change mitigation has clearly played a key role in European energy development since the 1990's and will maintain it is position in the European territorial agenda. Land and natural resources are continuously depleted nevertheless by unsustainable energy exploitation activities such as coal mining, which implies that other serious environmental challenges remain to overcome alongside with climate change mitigation. Therefore, it is important that energy related activities shall not only secure that natural resources are not depleted but also that these are carried out without undermining other key land-use functions for economies and society. This last assumption is particularly central in future RES deployment considering prevailing conflict of interest regarding the localization of wind power stations and harvesting of biomass from agriculture and forestry.

Considering that common legal competencies regarding energy policy did not exist between the EU and its MS until the Lisbon reform in 2009, the progress made so far on energy policy in Europe is impressive. European energy policy has today not only crystalized into directives enacted under the 'Climate and energy package' but more important it is an integral part of the Europe 2020 strategy. In this way the EU does not only pursue security of supply and environmental protection in energy policy but also economic growth through value added and job creation in the field of energy. However, European energy policy does not have an explicit regional dimension as it exclusively refers to EU's and MS's targets for the energy sector. It is instead the Europe 2020 strategy that brings energy and regional policy into a common policy context. However, the local and regional implications of energy policies and their increasing strategic importance at these levels suggest that European energy policy should incorporate a regional dimension.

At European level the RES deployment is supported mainly by the RES Directive and the European Emission Trading Scheme. RES are also supported by several EU funding programmes, including Structural and Cohesion funds, the FP7 and the Intelligent Energy Europe programme among others. The Structural and Cohesion funds are however the European policy instrument that explicitly targets regions in the area of sustainable energies. Considering the importance of the energy sector and its potentials, EU funds targeting regional and local energy agencies should not only continue but also increase in absolute terms. This means net increases of funds as well as the creation of institutional capacity to support larger number of regional and local actors. Funding programmes in the field of energy should also target poor regions with large RES potentials in order to both unleash these potentials but also create value added and employment.

At national level MS have implemented individual sets of support mechanisms aiming not only to overcome economic barriers related to RES deployment and increase their competitiveness but also overcome non-economic barriers including administrative hurdles, grid access, market design, social acceptance, etc. Within this context, the literature reviewed in this study pointed out the importance of maintaining a balance between government's push and market's pulls, necessary for RES technologies to reach maturity in markets. These forces must nevertheless be maintained through long-term policies in order to increase more predictable investment conditions for both small and large investors. Also a diversification and further penetration of support schemes at regional level may be required, including investments on R&D, grants and operational support mechanisms such as feed-in tariffs.

A 1 Territorial dimension of the Energy sector - a snapshot

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***	***What is the present situation?*** – *Urban areas are energy consumers mainly. This means that large scale energy production in urban areas is generally limited due to the lack of suitable land.* – *Some fuel refining activities can be found in urban areas dominated by industrial activities.* – *District heating is found in urban areas because it requires that heat generation is located close to consumers in order to prevent losses.* – *Small scale renewable energy technologies such as photovoltaic cells are still seldom present in urban areas.* – *Energy companies are concentrated in urban areas. This implies that revenues from their activities in rural areas are retained in urban areas.* ***What may be enhanced with a greening sector?*** – *Generation of electricity from photovoltaic panels may increase significantly as this technology becomes cheaper and well known.* – *An increase in the installation and use of small scale generation of renewable will created new jobs as specialized service business may appear.* – *Collection of organic residues for biogas production may increase.*
ii. Rural areas	***y***	***What is the present situation?*** – *Rural areas in the proximity of urban areas are common sites for electricity generation.* – *Large fuel refining and natural gas processing activities are often fund in semi-rural areas.* – *Most revenues from large scale electricity generation are often not retained in rural regions.* – *Rural regions were unsustainable energy production and exploitation of fossil fuels takes place are exposed to negative environmental impacts, including air, water and soil pollution.*

		– *Generation and refining of renewable energy is often found in rural areas. This is the case of biomass production from agriculture and forestry as well as generation of wind power and large scale thermal solar power.* – *Geophysical conditions, the nature of the technology applied, the type of production and planning policies and tradition, structure of the economy and policy orientations are important factors in the establishment of renewable energy generation in rural areas.* ***What may be enhanced with a greening sector?*** – *Increase production of renewable energy in rural areas will generate new jobs and value added. Biomass production may create most jobs.* – *Skilled work force may be attracted to rural areas due to emerging job opportunities generated by the green sector.* – *Revenues from renewable energy production may be reinvested locally through the participation of small energy producers.* – *Reductions of coal use in power generation will improve the environmental quality for some regions.*
iii. Urban-rural interactions	***y***	***What is the present situation?*** – *As previously explained rural and semi-rural areas are producers of energy which is consumed by urban areas. Due to the dominance of large companies the interactions between these areas regarding energy are very limited.* ***What may be enhanced with a greening sector?*** – *In a green economy rural areas will continue to act as main suppliers of energy carriers such as electricity and biomass for urban areas.* – *Interactions between urban and rural areas will increase due to increases in the number of actors required in the production of renewable energies.* – *Increased interactions may also occur because organic waste materials are transported to semi-rural or rural areas for biogas production.*
2. Land and land-based resources	***y/n***	***Why? Why Not?***
i. Land consumption or dependence	***y***	***What is the present situation?*** – *Land-use practices and traditions are central territorial aspects in energy sector. Specifically, the exploitation of energy resources and its subsequent transport, transformation and generation are land-use intensive activities. Land-use activities that*

		relate to the exploitation of energy are: • *mining activities; coal, lignite, oil and peat* • *agriculture and forestry; biomass* • *collection; sun energy and hydropower* – *The availability of land is vital for the production of renewable energy. In this context the suitability of land for energy production varies considerably due to the nature of primary energy exploitation and transformation.* – *According to Müller et al. (2011) the highest land-use per unit of electricity is performed by onshore wind power installations. However, since turbines occupy only 3% to 5% of the area needed for their proper operation, and their emission free character, the remaining area can be combined with other activities such as agriculture.* – *Large-scale solar installations such as Concentrated Solar Power (CSP) also demand significant land. However, areas suitable for these technologies are often found in deserts implying that the likelihood of land-use conflicts is low. Small scale solar installations also have advantages as they do not demand space because they can be installed in facades and roofs of buildings.* – *With reward to hydropower plants the amount of land demanded depends of the type and the scale of these plants. Generally speaking 'run-off-river' hydro power plants do not require a reservoir and therefore do not occupy large amount of land. On the contrary hydropower plants with reservoir are significantly land use intensive.* – *Among fossil fuels coal fired generation consumes significant amount of land, primarily due to the extension of mining areas needed to supply the demand of coal.* – *The energy source that demands less area per GWh among all energy technologies is nuclear energy. This is because its high generation capacity and relatively small amount of raw material demanded.* ***What may be enhanced with a greening sector?*** – *Increased renewable energy production may allow a diversification of land use practices.* – *Renewable electricity production may be combined with other activities such as agriculture.* – *Coal rich areas may be subject to more sustainable land-uses such as agriculture and renewable energy production.* – *The quality of the environment will be improved due to decreasing coal mining and refining activities as well as use of coal in power generation.*

ii. Material Consumption or dependence	***y***	***What is the present situation?*** – *Fossil fuels are the main energy source of energy in the EU27 corresponding to approximately 76% of the total gross energy consumption.* – *Consumption of coal (mainly) and oil is slowing down* – *The consumption of natural gas, nuclear energy and renewables is increasing.* – *High demand of materials such as wood fibers implies that energy generation from these materials enters in conflict with other uses such as paper production. This is also the case between food production and bioenergy production from agricultural products.* ***What may be enhanced with a greening sector?*** – *Energy prices may become more stable* – *High increase of renewable energy consumption* – *Reduced dependence of imported energy, primarily oil.* – *More balanced energy mix between nuclear energy, natural gas, renewables and oil.* – CO_2 *emissions will be reduced* – *Organic residual materials can be recycled for energy generation* – *Waste generation will be reduced*
iii. Energy consumption or dependence on specific energy types or systems	***Y***	***What is the present situation?*** – *Past dependency in the energy sector is a very important barrier when deploying renewable energy technologies. This aspect has several dimensions namely, availability of infrastructure, policy orientations, institutions and cultural perceptions.* – *The cost of new infrastructures for energy generation and distribution are very high which means that adaptations to renewable energy installations such as wind power stations imply high level of investments apart from wind turbines. Transitions from centralized to decentralized energy systems as required in the deployment of renewable energy technologies requires also new policies and institutional settings.* – *From a territorial perspective the energy sector has traditionally been dominated by national public organizations and large private enterprises.* – *Cultural perspectives of communities and nations on specific types of energy have an important role on what type of energy carrier is consumed and political decisions regarding the energy sector. Due to the dominance of fossil fuels in energy systems and the limited availability of alternatives fossil fuels are still perceived as reliable while renewable energy sources are often viewed with skepticism.* ***What may be enhanced with a greening sector?***

		– *Due to a diversification of energy sources, increases in energy production from renewable energy sources may increase security of supply and reduce energy system's vulnerabilities to changes in energy prices and operative problems.* – *Energy systems may incorporate a significant larger number of suppliers which may lead to increasing competition in the energy sector.* – *Due to the diversification of energy sources and producers, more regional organizations will be active in operations and monitoring of energy systems.*
iv. Management of ecosystem services (types of ecosystems/landscapes; spatial characteristics of ecosystems; options for maintaining and developing these services)	***y***	***What is the present situation?*** – *The exploitation of energy resources implies impacts on the environment and landscape. However, the degree of these impacts depends of several factors including the type of exploitation, the methods, the modes of transmission and the sensibility of the ecosystem and the landscape subject to exploitation.* – *Mining activities relate to the extraction of fossil fuels including coal, lignite and oil. The quality that characterizes all of these activities is that they provide high output of energy but involve sever negative environmental risks and consequently difficult to perform without harming the environment and other forms of activities such as settlements, agriculture, tourism, fisheries, recreation and nature conservation.* – *Exploitation of coal and lignite implies often that larger quantities of soil are removed, a process that alters not only the geophysical characteristics of those areas but also generates soil waste products, changes ground and surface water regimes, releases both hazardous organic compounds and heavy metals into water streams resulting in the contamination and acidification of both surface and ground water. The recovery of areas after being exploited is very difficult and expensive to achieve, and in many cases irreversible. Ultimately, this implies that the land become unsuitable for any other alternative use.* – *The sustainability of biomass production for energy purposes from agriculture and forestry has been questioned. In the case of agriculture it has been considered having negative impacts on food production while in forestry conflicts with wood dependant industries have already been experienced, for example in Sweden and Finland. Due to those reasons biomass from agriculture and forestry is becoming oriented towards harvesting residues, especially in the case of forestry.* ***What may be enhanced with a greener sector?***

		– ***A green*** *perspective on energy production recognizes that energy activities have an impacts ecosystem services and more importantly that the production of green energy is dependant of these services.* – *Greener exploitation methods of energy production may not take place in expense of other land use functions, such the case of ecosystem services. Unlike fossil fuel exploitation, which often implies land and nature depletion, renewable energy production can be performed not only without major environmental impacts but also alongside with other land-use functions such as agriculture. However, the deployment of renewable energy installations may imply some degree of landscape impacts such as the case of wind power. This may result in not only sustainable and efficient production models for energy production but also the diversification of economic activities in rural areas.*
3. ***Market relations (Production; consumption; export, import) and innovation***	***y/n***	***Why? Why Not?***
i. Local/regional markets	***y***	***What is the present situation?*** – *Energy market sizes relates directly to the type of energy carried that is traded. A good example of local energy markets is district heating as the market size of the heat produced relate only to nearby consumers, because heat losses increases in proportion to the distance it is transported.* – *Local or regional energy markets are in general terms few as been dominated by larger companies and authorities that act at national level.* – *Regional energy markets are relatively more diverse depending of both the nature of the energy carried but also how the energy system is spatially designed and governed as well as the availability of resources within a region.* ***What may be enhanced with a greener sector?*** – *The decentralized character of renewable energy production may increase and diversify local and regional energy markets. Also the larger number of actors required for production of renewable energy may stimulate the formation of these markets.*
ii. National markets		***What is the present situation?*** – *National energy markets are most common as the energy sector in countries have been initially governed and designed for supply energy at national level.* – *The power transmission grid has originally developed with a national focus.* – *Energy systems are dominated by few large energy companies and therefore markets are*

		still subject to limited competition. – *Biomass is also an energy carrier that often is traded at national level such as in the case of Sweden.* ***What may be enhanced with a greener sector?*** – *National markets may continue playing a central role in energy systems.* – *Major energy consumption may be concentrated in urban areas.* – *The number of actors in national energy markets may increase significantly, not only small producers but also the involvement of companies from other sectors such as forestry and agriculture.*
iii. EU markets		***What is the present situation?*** – *Internal energy transmission and trade within the EU27 is considerable, in particular of electricity, but also natural gas and oil.* – *Netherlands and Demark are the Member States in the EU27 that are net exporters of natural gas.* – *The European electricity market is divided into eight "regional" markets consisting of groups of neighboring countries: the Northern, Central-West, Central-South, South-West, Baltic, France-UK-Ireland and the South East Market.* – *The basic element in the European electricity market is the day-ahead market, which means that price is set-day ahead at the point where supply meets demand.* – *The customary method for buying and selling natural gas in Europe is based on long-term take-or-pay contracts that guarantee minimum purchases of gas indexed to oil prices.* – *Cross border Interconnection between countries exist but are insufficient to enable market integration at European scale.* – *Certain transmission corridors have emerged out of the liberalization process solving some bottlenecks.* – *The liberalization of markets has changed flows according to more integrated dispatch based on purely economic criteria across larger regions.* – *Whole sales of electricity across national borders are increasing.* – *Market rules are not currently designed to facilitate the integration of renewable energies.* – *Interconnections between countries are insufficient hampering competitiveness in electricity markets.*

		What may be enhanced with a greener sector? – *A common market for electricity may consolidate as a consequence of further liberalization of the sector as well as increasing cross-border interconnections enabling trade of electricity at pan-European scale.* – *Trade on natural gas may increase. Prices on natural gas may continue to increase as still being indexed to oil prices.* – *Trade on biomass within the EU may increase.*
iv. Global markets	***y***	***What is the present situation?*** – *Global markets are dominated by trade of oil and coal. Oil prices are characterized by having high degree of volatility while being central in national economies. This implies that oil prices have great repercussion on energy prices in nations. Oil prices have also great influence on natural gas prices.* – *Oil prices are very volatile.* – *Refined biomass such as wood pellets and bioethanol are renewable energies traded globally.* – *An important global asset in the energy sector is innovation, which is transferred through measures on higher education, adoption of new technologies and establishment of new enterprises.* ***What may be enhanced with a greener sector?*** – *The amount of refined solid and liquid biofuels may significantly increase in global markets. This may stimulate formation of large companies specialized in production and trade of biofuels.* – *Trade on natural gas may increase globally due further deployment of cross-border pipelines as well as higher demand.* – *The amount of oil traded at global scale may decrease both due to shortage on oil supply and rising oil prices.*
4. ***Inter- and intra-territorial relations***	***y/n***	***Why? Why Not?***
i. Within territories (place based; local cultures; relating to territorial/national policies)	***y***	***What is the present situation?*** – *As previously explained, cultural perceptions have an important repercussion on which energy carriers are used. These perceptions are often shared within communities and their*

		governments. Local cultural perceptions hinder often the introduction of alternative energy sources in energy systems. This implies in most cases that individuals tend to rely on fossil fuel because they perceive them more reliable despite of alternatives. – *Many renewable energy technologies have however been developed locally, involving in many cases local industries and authorities as in the case of Kalundborg where industrial symbiosis has been implemented. These types of communities have often a positive attitude to alternative source of energies, and act as important promoters in the deployment of new technologies in other locations.* – *Cultural ties to nature conservation have been an important driver behind increases in RES consumption. Cultural values are also boosting the deployment of small scale generation of renewable energy especially wind and solar.* – *A general problem in the implementation of national energy policies is that local perceptions and the context of regions are not adapted to these policies, resulting in reluctance towards their adoption.* ***What may be enhanced with a greener sector?*** – *An increase in the availability and affordability of small scale installation of renewable energies as well as renewable energy electricity and biomass, may lead to their adoption in communities. This however may require informative measure aiming at increasing awareness in the advantages regarded to these technologies.* – *Communities may become aware of their own energy consumption as they become energy producers.* – *Innovations in renewable energy production may appear in new regions as they gain experience in this field.*
ii. Between territories (networks; competition)	***y***	***What is the present situation?*** – *The European energy sector today is characterized by having a relatively small number of producers that act mainly at national level.* – *Small energy producer's access to transmission grids is still restricted in most European countries.* – Lack of capacity in the European power grid to withstand fluctuating inputs from renewable energy generation is also an obstacle, not only in the incorporation of large wind and solar installations but also households and buildings that may become energy producers through small scale generation. – *The dominance by large companies at national level implies that the numbers of networks*

		in the sector are limited. ***What may be enhanced with a greener sector?*** – *Competition in the energy sector may increase considerably due to a large number of small producers required in deployment and operation of renewable energy technologies.* – *The energy sector may be further liberalized allowing the access of small producers to transmission grids.* – *Networking and cooperation between regions may increase as trade of renewable electricity and biomass increase.*
iii. Across territories (cross-border supply and demand)	***y***	***What is the present situation?*** – *Cross-border trade in the energy sector is dominated primary by source of energy such as oil, gas and coal. Also electricity is a commodity that is traded mainly across neighboring nations.* ***What may be enhanced with a greener sector?*** – *The development of green economies may require increasing interconnection between and across regions and nations in order to fully take advantage of electricity generated from wind and solar energy installations.*
5. ***Place-based factors***	***y/n***	***Why? Why Not?***
i. Competitiveness through strong local economies	***y***	***What is the present situation?*** – *As already explained the energy sector is characterized by been steered at national level by large companies and governments. Moreover, energy systems are primary centralized and therefore involving relatively low levels of employment relative to revenues generated by this sector. This has result in low competition in national energy markets and the absence of regional actors in the energy sector.* ***What may be enhanced with a greener sector?*** – *The increase and diversification of renewable energy sources may lead to competition in the energy sector (Read above).* – *Revenues from energy generation may be reinvested and retained in regions strengthening therefore local economies.* – *Increasing demand of skilled labor force may stimulate regional economies and competitiveness.*
ii. Multi-functionality	***y***	***What is the present situation?*** – *As described above the scale and the negative environmental impacts of energy*

		production and exploitation of fossil fuels harm other important economic activities and land-use functions. ***What may be enhanced with a greener sector?*** – *Multi-functionality may be at the center of land-use planning. This development may be induced by increased demand of land as well as new production models that takes mutual advantages from neighboring activities.*
iii. Tacit/experiential knowledge ?????	***y***	***What is the present situation?*** – *Traditions in energy planning are often based on centralized energy models. Specifically, energy companies, authorities and actors involved in energy planning, production and supply have long experience in developing centralized energy systems dependent on large scale energy generation from thermoelectric, nuclear and hydro power stations. On the contrary experience in planning decentralized energy systems has been generally more limited.* – *Practices in energy production activities lack often long-term sustainability criteria.* – *The lack of alternative source of energy made available for individuals.* – *Knowledge regarding the benefits from the utilization of renewable energy sources is limited to few regions.* – *The above mentioned circumstances are currently evolving towards more sustainable approaches in energy planning and energy production and supply.* ***What may be enhanced with a greener sector?*** – *The adoption of greener policies and approaches in the energy sector may in one hand diversify approaches in energy planning towards more decentralized and complex models, and in the other hand change decision makers view in energy production and transmission.* – *The increasing presence of larger number of small producers in the energy sector resulting from further liberalization of the energy sector and intensification of input from renewable energy sources may demand the incorporation of decentralized approaches.*
iv. PROXIMITY	***y***	***What is the present situation?*** – *The size and distribution of settlements across territories have important repercussions on the nature of the energy carrier that is made available and how it is transmitted to consumers. Larger and more concentrated settlement structures are often supplied by more centralized energy systems while disperse settlement structures tend to rely on*

		decentralized energy solutions. There are several reasons to this, among others investment and operational costs, limitations in transmission and transport and the characteristics and cost of energy carriers. – *Large central energy plants are able to serve large number of consumers suitable therefore to supply large markets. In terms of electricity the European power grid coverage is rather extensive at national level and designed to rely on large power plants. The grid coverage can however be limited in sparsely populated areas.* – *District heating is more suitable for local supply in large and dense settlements. Energy losses in district heating increase relative to the transmission distance, requiring therefore that large number consumers are located in the proximity of district heating plants. In Sweden for instance large cities have several district heating plants while buildings in small settlements in sparsely populated areas rely often on boilers, stoves, electric heat and heat pumps.* ***What may be enhanced with a greener sector?*** – *Small scale production of renewable energy may play an increasing role in local transmission networks.* – *Large wind and solar farms may be interconnected across regional and national borders by high efficient transmission power grids.* – *National and international trade of biofuels will intensify inducing therefore to the construction and modernization of roads and railways interconnecting rural and urban areas.*
6. ***Consumer relations***	***y/n***	***Why? Why Not?***
i. Are development and innovation consumer-demand driven?	***y***	***What is the present situation?*** – *Innovation in the energy sector has been producer driven mainly (Read below)* ***What may be enhanced with a greener sector?*** – *Read below*
ii. Are development and innovation producer driven?	***y***	***What is the present situation?*** – *Due to the demand of large investments and the critical importance of energy supply, development and innovation in the energy sector has mainly been producer driven.* – *Innovation in the area of renewable energy and energy efficiency has progressively become more consumers driven.*

		What may be enhanced with a greener sector? – *Small scale technologies for renewable energy generation may enable consumers to access alternative source of energy and become energy producers. This development may enhance consumers' role on innovation.*
iii. Are development and innovation based on well-defined territorial conditions or on open access?	***y***	***What is the present situation?*** – *Regardless the spatial scale, innovation in the energy system has been both the result of territorial characteristics, including natural capital, human capital, political systems, etc., as well as access to knowledge and technologies.* – *The energy mix of within European countries clearly reflects the historical availability of both domestic and imported energy sources.* – *Major technological developments in the energy sector tend to be found in countries and regions having high degree of innovation capacity.* – *Strategically, locally developed technologies/innovation are often more advantageous than dependence of imported ones, not only because new jobs and value added are generated but also because it allows the energy sector to rapidly adapt to shifts in energy markets.* – *First-mover countries that have specialized in renewable energy technology such as Denmark and Germany are characterized by high knowledge intensity and learning capacity.* – *Imported technology serves in many cases as the foundation for the creation of new industries, often referred as the 'fast followers'.* ***What may be enhanced with a greener sector?*** – *The increasing role of renewable energy sources in national and regional energy systems will foment innovation in new locations as previously outlined.*
7. ***Accessibility and mobility***	***y/n***	***Why? Why Not?***
i. Transport connections (transport of materials; transport of labor)	***y***	***What is the present situation?*** – *Today's power transmission grid in Europe requires modernization in order to interconnect national energy grids, increase competition in the energy market, enable the connection of large wind and solar farms as well as the small scale power generation, and enable transmission of electricity through long distances.* – *Smart grids are required to improve the efficiency and reliability in power distribution*

		from renewable electricity. – *Areas with good wind and solar conditions are remote, implying that electric power needs to be transmitted through long distances.* – *An extensive infrastructure for the transport of fossil fuels exists in Europe, comprising of maritime routes, harbours and pipelines. These infrastructures for energy distribution are still evolving, primarily gas pipelines such as the on-going construction of the Nord Stream and the plans on the Nabucco pipeline.* – *The presence of roads and railways in northern peripheral regions in Europe are limited. Therefore, transport costs are today imposing a barrier in trade of biofuels mainly due to the lack of infrastructure between rural and urban areas.* ***What may be enhanced with a greener sector?*** – *A green development in the energy sector may stimulate investments on efficient transmission power grids that fulfill the demands required for the creation of an internal energy market and the integration and distribution of electricity generated from renewable energy sources.* – *A more extensive road and railway network in northern peripheral areas may develop allowing the exploitation, distribution and trade of biomass for energy purposes.*
ii. Regional Accessibility (access to markets; access to supply of materials; access to public services)	***y***	***What is the present situation?*** – *The coverage of power transmission grids in Europe is extensive but generally designed to only give access to large energy producers as previously explained.* – *The access to transmission grids for small producers is very constrained.* ***What may be enhanced with a greener sector?*** – *Regional accessibility to national and international energy markets for small and large producers may be the norm in the energy sector.*
iii. Information connections (use of communication and information services; need of interaction; questions of consumer and producer cultures)	***y***	***What is the present situation?*** – *Information connections in European Member States are today very extensive thanks to the widespread of ICT and internet connections.* – *A large number of networks, platforms, forums, associations, etc. already exist in the field of energy both representing consumers and producers.* – *The energy sector is lacking coordination between energy companies, public regional and national agencies, researchers and the public. This limits the access to information and put barriers for the development and deployment of alternative source of energy.* ***What may be enhanced with a greener sector?***

		– *Regional and local energy agencies may be the norm in the energy sector, being responsible for coordination between consumers and producers and setting strategies for their territories. National energy agencies may be responsible for coordination with regional agencies, neighboring countries and the EU.* – *Associations within several fields of the energy sector may grow in terms of actors involved and may serve as a common platform for negotiation between public and private interests.*
8. ***Policy and governance by territorial level***	***y/n***	***Why? Why Not?***
i. Scale of sector-based policy support	***y***	***What is the present situation?*** – *As being an exclusive competence for Member States until 2009, when the Lisbon reform was introduced, the national level has been the primary level for energy policy.* – Member States are responsible for their national energy mix and exploitation of indigenous energy resources. This implies that the EU has no power over Member States' energy mix, depletion policy or taxation – Governance in European energy policy relies mainly on the cooperation between the EU and its Member States in mainly the areas of the internal energy market, renewable energy, energy efficiency and carbon emissions. – *Current European energy policy does not have an explicit regional dimension.* – *An increasing number of European regions are setting up energy strategies and plans.* ***What may be enhanced with a greener sector?*** – *European energy policy may incorporate an explicit regional perspective.* – *All regions European may have competences on energy policy.*
• From the EU Level	***y***	***What is the present situation?*** – *Legally binding targets on renewable energy, emissions and energy efficiency for Member States aiming at reaching the targets set in the Climate and Energy Package.* – *Requirements on Member States to establish National Renewable Energy Plans (NREAP)* – *Requirements on building infrastructure for transmission and distribution of renewable energy.* – *The European Emission Trading Scheme (ETS) is the main instrument for achieving the goals set in the Climate and Energy Package though the allocation of tradable emission rights.*

		– *The Strategic Energy Technology Plan (SET-Plan) COM(2007) 72326 supports energy research and demonstration of low-carbon energy technologies through direct investment initiatives in several strategic energy fields.* – *The NER300 is a financial instrument managed jointly by the European Commission, the European Investment Bank and Member States. Through the Entrants' Reserve of the European Emissions Trading Scheme 300 million allowances sets aside (rights to emit one tonne of carbon dioxide) for subsidizing installations of innovative RES technology that are not commercially available. The allowances will be sold on the carbon market and the money rose - which could be EUR 2.4 billion if each allowance is sold for 8 EUR - will be made available to projects as they operate.* – The Structural and Cohesion Funds support regional investments in several strategic fields including sustainable energies. The operational programmes for Cohesion policy for the period 2000-2013 increased investments on energy related projects to 2.6% of the total budget or EUR 9 billion for energy related projects. EUR 4.8 billion has been allocated for RES and EUR 4.2 billion for energy efficiency and energy management measures. – The Intelligent Energy for Europe programme supports projects aiming at introducing renewable energy technology, informing and implement policies across the EU and monitoring and stimulating markets. The total budget allocated to the IEE programme for 2007-2013 is EUR727.3 million. – The Seventh Framework Programme (FP7) is EU's main instruments for funding research and demonstration activities. EUR 2,350 million has been allocated to the energy theme which corresponds to 7.2% of the Cooperation Programme and 4.8% of the FP7. ***What may be enhanced with a greener sector?*** – *EU funds financing sustainable energy projects may initially increase mainly on renewable energies. In the long term, support on renewable energy may decline as these become competitive, and therefore less dependent of financial aid for research, development and deployment.*
• From the national level		***What is the present situation?*** – Member States have individual policies, legislations and instruments. – Each Member State has adopted individual sets of support mechanisms and adapted these according to its specific socio-economic, political and geophysical contexts. This means also that the level of support and rules vary individually among Member States.

		– Most common support instruments in the renewable energy sector are feed-in tariffs, feed-in premiums, quota obligation systems and combinations of these two. – High support levels do not lead in all cases to substantial growth in renewable energy deployment. Flaws in the support instruments, high risk premiums or non-economic barriers hamper the effectiveness of support schemes. Further, the effectiveness of support schemes decrease as renewable energy technologies become well established in markets due to saturation effect. ***What may be enhanced with a greener sector?*** – *National governments may continue having a central role in energy policy.* – *National support mechanism will continue to diversify.* – *National governments may intensify coordination with regional and local actors.*
• From the regional/local level		***What is the present situation?*** *According to the Assembly of European regions most common support mechanisms in regional energy strategies and actions plans are:* – *Promotion/awareness rising measures* – *Grants to private households and enterprises* – *Public infrastructure* – *Legislative acts* – *European funds* – *Green procurement* ***What may be enhanced with a greener sector?*** – *An increased regional/local perspective required by further incorporation of renewable energy in energy systems will intensify the implementation of support schemes by regional/local authorities.*
ii. Role of other EU policies with territorial dimension		***What is the present situation?*** *Explained above.* ***What may be enhanced with a greener sector?*** *Explained above.*
iii. Private versus public sector – led development. Are consumer organizations advocating for developing the green economy. At what political scale are they located?		***What is the present situation?*** – *Public-private relations in the energy sector have traditionally been at the executive level, including national authorities, energy companies and large energy intensive industries.* – *Different forms consumer organizations have been active in political discourses in the field of energy policy.*

		What may be enhanced with a greener sector? – *Consumer organization may increase their "power" partly due to the presence of larger number of energy producers but also due to rising energy prices.*

Territorial outcomes of greening the sector:	
Inter- and intra-territorial relations	***The growing presence of renewable energy sources in the European energy mix may increase both relations between public and private actors within and between regions. Also relations between national and regional actors will intensify as coordination between these levels may be required due to large number of actors involved in energy generation.***
Settlement types	***Settlement structures may not be directly affected by changes related to green models in energy production or distribution. It may instead be the energy sector that becomes better adapted to prevailing spatial, structural and social characteristics of settlements. Economic prosperity generated by the generation of new source of employment and value added in regions may stimulate demographic growth in some rural settlements.***
Land and land based resources	***Due to increasing importance of renewable energy sources, sectorial competition on land will not only intensify but new approaches on multifunctional land uses will evolve. Green approaches on land exploitation will furthermore place sustainability and the preservation of ecological services at the center of energy related activities.***
Market relations (Production; consumption; export, import) and innovation	***As the internal energy market integrates thanks to increasing interconnection between nations by power grids and the construction of new roads and railways, competition will increase and the availability of energy resources will diversify. This development may be accompanied by the diversification of global energy markets. Thanks to increasing competition energy prices may stabilize while consumers may gain more power.***
Place-based factors	***Geophysical conditions such as the availability of natural resources and the geography may have less impact on energy consumers as energy resources may be more accessible, thanks to small scale energy producing solutions and modernized transmission grids.*** ***The population, industries and politicians in nations and regions may have better understanding and acceptance towards renewable energy sources.*** ***Knowledge regarding new energy technologies and management may spread through regions strengthening new regional economies in rural***

	areas thanks to innovation.
Accessibility and mobility	***A green development in the energy sector may result in the modernization and expansion of transmission grids which may allow the integration of power generated from wind and solar generators within and outside Europe. Energy consumers may benefit from better accessibility to wider options regarding the choice of energy consumed and suppliers, while being able to sell surplus electricity from small scale photovoltaic and wind power generation.***
Policy and governance by territorial level	***The diversification of energy sources and their availability as well as the incorporation of large number of small producers may require that competences in energy policy are transferred to regions and municipalities. All regions may be responsible for their own local energy plans and for the coordination between public and private actors in energy planning.***

A2 Sector non-policy factors - a snapshot

Natural capital

Description	Energy security implies not only the provision of sufficient and reliable energy supplies to satisfy demand at all times and at affordable prices, but also the mitigation of environmental impacts related to the exploitation and use of energy sources. This reconciliation between availability and affordability with sustainability has evolved especially during the last two decades as the environmental impacts of fossil fuel have become a matter of great concern for nations (Müller, et al., 2011). The main factors are thus: **Natural capital (Energy availability)** Availability of energy sources is among the most central drivers in the energy sector, implying both sufficient availability of primary resources and the infrastructure needed to transform and transport these resources to final users. Natural capital is recognized here as a territorial factor of energy production that are provided by nature such as fossil fuels, sun- and wind exposed areas, agricultural and forest land. **Energy prices (affordability)** The price of primary energy has a fundamental impact on the entire commodity chain of energy from producers to consumers, and therefore among the most influential driver in the decision of these. Energy affordability consists of two key dimensions; price volatility and price uncertainty (Müller, et al., 2011). Price volatility refers to the range in which market prices fluctuates over time while price uncertainty refers to the average price of energy. Both aspects have negative economic impacts on societies being oil prices is a good example.
Specificity for the green economy	Very specific
Provable impact on the green economy spheres	High impact
Trade-offs: mixed +/- impacts on green economic spheres?	
Externalities: impact on other sectors / case studies	

Interactions with other factors	
Causal level of operation (proximate/direct versus underlying/indirect factors)	Proximate driver
Spatial level of operation (internal versus external factors)	
Type of market force involved	Demand force
Policy recommendations: making the link between policy and non-policy factors	•
Possible indicators	Energy prices

Territorial factors

Description	**Land-use** Land-use practices and traditions are central territorial aspects in the energy sector. Specifically, the exploitation of energy resources and its subsequent transport, transformation and generation are land-use intensive activities. Land-use activities that relate to the exploitation of energy illustrated in the following list: • mining activities; coal, lignite, oil and peat • agriculture and forestry; biomass • collection; sun energy and hydropower **Settlement structure** The size and distribution of settlements across territories have important repercussions on the nature of the energy carrier that is made available and how it is transmitted (transported) to consumers. Larger and more concentrated settlement structures are often supplied by more centralized energy systems while disperse settlement structures tend to rely on decentralized energy solutions. **Accessibility** The access to primary energy resources plays a decisive role in securing energy supply in regions and countries. This implies that efficient transmission infrastructure has to connect areas where primary energy is exploited, transformed and consumed (Rasmussen, et al., 2010).
Specificity for the green economy	
Provable impact on the green economy spheres	
Trade-offs: mixed +/- impacts on green economic spheres?	
Externalities: impact on other sectors / case studies	
Interactions with other factors	

Causal level of operation (proximate/direct versus underlying/indirect factors)	
Spatial level of operation (internal versus external factors)	
Type of market force involved	
Policy recommendations: making the link between policy and non-policy factors	•
Possible indicators	

Consumer behaviour

Description	The behaviour of energy consumers namely industries and individuals, and the scale of consumption are important territorial elements in energy development. The role of individuals on the energy sector is complex to analyse due to cultural perceptions and values as well as socioeconomic factors. Despite factors that constrains individual's possibilities to direct take decisions upon the type of energy that is consumed, cultural views of communities and nations have had an important role due to the energy sector's dependence on political decisions. An example that illustrates cultural perceptions in energy policy is found in Sweden and Denmark where cultural ties to nature conservation have been an important driver behind increases in RES consumption. Cultural values are also boosting the deployment of small scale generation of RES especially wind and solar. Initially, the generation of electricity through these technologies was not very profitable being the individuals values an important driver. Today, these technologies have become significantly more efficient and their increasing demand has contributed in reducing their price in markets (Rasmussen, et al., 2010).
Specificity for the green economy	
Provable impact on the green economy spheres	
Trade-offs: mixed +/- impacts on green economic spheres?	

Externalities: impact on other sectors / case studies	The scale energy consumption in industries is high which requires that energy supply needs to be stable and reliable. Therefore hydro, nuclear and thermal power is often suitable for these industries (Rasmussen, et al., 2010). Energy efficiency also becoming important for heavy industries as many of them reincorporate residual heat and materials back in their processes. Pulp and paper industries and sawmills, both in Sweden and Finland, are good examples of energy efficiency measures because they use wood residues as source of energy (Galera-Lindblom, et al., 2012). In Denmark, an example of industrial symbiosis also exists in Kalundborg where energy and manufacturing industries exchange and reincorporate residual heat and materials (Rasmussen, et al., 2010).
Interactions with other factors	
Causal level of operation (proximate/direct versus underlying/indirect factors)	
Spatial level of operation (internal versus external factors)	
Type of market force involved	
Policy recommendations: making the link between policy and non-policy factors	•
Possible indicators	

Technological capital

Description	The access to technology is a vital element in energy development. It allows the extraction and collection of primary energy as well as their transformation into electricity and other energy carries and transmission and utilization by end users. The fact that technology enables the utilization of energy sources implies that the energy sector is characterized by a mutual dependency between accessibility to energy sources and technology (Galera-Lindblom, et al., 2012). According to Müller et al. (2011, p. 16) first-mover countries that have specialized in renewable energy technology such as Denmark and Germany are characterized by high knowledge intensity and learning potential.
Specificity for the green economy	
Provable impact on the green economy spheres	
Trade-offs: mixed +/- impacts on green economic spheres?	
Externalities: impact on other sectors / case studies	
Interactions with other factors	
Causal level of operation (proximate/direct versus underlying/indirect factors)	
Spatial level of operation (internal versus external factors)	The availability of technology can be domestic, in other words, developed locally by actors directly or indirectly involved in the energy sector, or it can be imported.
Type of market force involved	

Policy recommendations: making the link between policy and non-policy factors	• Strategically, locally developed technologies are often more advantageous than dependence of imported ones, not only because new jobs and value added are generated but also because it allows the energy sector to rapidly adapt to shifts in energy markets. • However, imported technology serves in many cases as the foundation for the creation of new industries, often referred as the 'fast followers'. This was the case of the Navarra province in Spain where wind energy technology was initially imported from Denmark. Strong support from public agencies and private companies and long tradition in R&D and innovation gave the bases for the creation the Navarrese wind energy industry which currently is recognized as one of the world's leaders (Rasmussen, et al., 2010).
Possible indicators	

Human capital and innovation capacity

Description	Human capital needed in the energy sector comprises of a high diversity of labour groups. Human capital is therefore a crucial asset that not only makes the energy sector's operation possible, but most important it enables adaptation processes through innovation (Rasmussen, et al., 2010). The energy sector is dependent of the availability of technology and therefore innovation capacity of both professionals and researchers play decisive role in how efficient the operations perform and enable adaptation.
Specificity for the green economy	Innovation capacity does not only involve the process of developing technologies for the transformation and transmission of energy but also involves other non-technical operations A good example is the case of Kalundborg in Denmark were the key aspect of success in the establishment of the so called 'industrial symbiosis' was the creation of solutions to improve collaboration between energy producers and industries (Rasmussen, et al., 2010).
Provable impact on the green economy spheres	Innovation is central in energy development as it enables the energy sector to adapt to new circumstances and increase productivity and efficiency. While the correlation between green growth and regional development is strong, investments in energy development are usually higher in regions with well-developed R&D policies.
Trade-offs: mixed +/- impacts on green economic spheres?	
Externalities: impact on other sectors / case studies	A new phenomenon in the energy sector is the incorporation of new sectors. This implies that sectors diversify their activities and open access to new markets that are economically viable in the long term (Müller, et al., 2011) (Galera-Lindblom & Rasmussen, 2008).
Interactions with other factors	

Causal level of operation (proximate/direct versus underlying/indirect factors)	
Spatial level of operation (internal versus external factors)	
Type of market force involved	
Policy recommendations: making the link between policy and non-policy factors	•
Possible indicators	

Economic capital

Description	A great challenge related to RES technologies has been the large amount of investments required for their development and introduction in markets. Moreover the lifecycle of RES projects are long implying that investors seek long-term planning regimes that can provide stability and predictability for their investments. Generally large scale RES projects are perceived by investors as risky because the technology's profitability has not been proven until demonstration is successful a situation that hinders developers to secure the necessary financing. This phenomenon commonly known as the 'valley of death' incurs when financial means are absent before energy technologies reach commercialization (Müller, et al., 2011). The combination of technology-push by governments and market-pulls forces from business in early stages of RES technologies plays a fundamental role on how these develop. Lack of funding often occurs when a mismatch of these two phenomena occurs. Here, governments represent the technology-push through RD&D support, grants and direct investments while business provide direct investments later in the market pull, when technologies are commercialized (Müller, et al., 2011).
Specificity for the green economy	
Provable impact on the green economy spheres	
Trade-offs: mixed +/- impacts on green economic spheres?	
Externalities: impact on other sectors / case studies	
Interactions with other factors	

Causal level of operation (proximate/direct versus underlying/indirect factors)	
Spatial level of operation (internal versus external factors)	
Type of market force involved	
Policy recommendations: making the link between policy and non-policy factors	• A general understanding in RES deployment is that countries that are most able to afford a package of measures necessary to promote RES are likely to be early adopters and developers of these technologies.
Possible indicators	

Environment protection

Description	The exploitation of energy resources implies impacts on the environment and landscape. However, the degree of these impacts depends of several factors including the type of exploitation, the methods, the modes of transportation and the sensibility of the ecosystem and the landscape subject to exploitation: Exploitation of fossil fuels, such as **coal and lignite** implies often that larger quantities of soil are removed, a process that alters not only the geophysical characteristics of those areas but also generates soil waste products, changes ground and surface water regimes, releases both hazardous organic compounds and heavy metals into water streams, etc. (Mamurekli, 2010). **Oil and gas extraction** involves various environmental risks, most notably oil spills from oil tankers or pipelines transporting oil. Residual process water is also generated, which contain varying amounts of oil, chemicals and heavy metals. Being a fossil fuel emissions resulting from oil combustion contain the same type of pollutants present in coal combustion. Even if **biomass production** is entirely based on residues it still implies environmental risks if proper measures are not taken. Both in the case of agriculture and forestry residues help to preserve the soil structure and nutrient balance. Moreover, dead wood in forest serves as habitat for different organisms including insects, fungi and plants. This means that limitations regarding the amount of residues that may be removed have to be considered. Cultivation of monocultures both in agriculture and forestry can also have negative impacts on biodiversity the cultural landscape (Galera-Lindblom, et al., 2012). In terms of emissions energy generation from biomass consumption is less convenient compared to other renewable energy sources. This is because biomass combustion can result in relatively high levels of SO_2 and NO_2. However, emission levels are strongly dependent on the composition of the biomass and on harvesting conditions, transport and conversion processes (Müller, et al., 2011). **Climate change mitigation** is considered the main driver for the integration of environmental policy in European energy policy since the 1990's, in particular in connection to the Rio Conference in 1992. While perceptions of security of supply and economic development vary among MS, climate change as the consequence of fossil fuel energy

Specificity for the green economy	Very specific
Provable impact on the green economy spheres	RES technologies play already an important role in reducing CO_2 emissions and therefore their deployment is a central measure in climate change mitigation. In Europe only, CO_2 savings in 2008 accounted for 297 million tonnes, and globally 1,718 million tones (Müller, et al., 2011, p. 20).
Trade-offs: mixed +/- impacts on green economic spheres?	The sustainability of biomass production for energy purposes from agriculture and forestry has been questioned. In the case of agriculture it has been considered having negative impacts on food production while in forestry conflicts with wood dependant industries have already been experienced, for example in Sweden and Finland. Due to those reasons biomass from agriculture and forestry is becoming oriented towards harvesting residues, especially in the case of forestry (Galera-Lindblom, et al., 2012) From a land-use perspective production of biomass from agriculture and forestry show several trade-offs with the traditional 'hosting' sectors. In particular, both agriculture and forestry also give room for 'multifunctional land uses' as they can be combined with activities such as tourism and wind power generation (Galera-Lindblom, et al., 2012).
Externalities: impact on other sectors / case studies	
Interactions with other factors	
Causal level of operation (proximate/direct versus underlying/indirect factors)	Proximate driver through policy enforcement.
Spatial level of operation (internal versus external factors)	
Type of market force involved	

Policy recommendations: making the link between policy and non-policy factors	•
Possible indicators	

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A3 Sector sector policy analysis - a snapshot

EU policy tables for the energy sector

Table 11 Policy analysis table for the Energy Roadmap 2050

<table>
<tr><td>Type of policy and hierarchy</td><td colspan="2">Roadmap</td></tr>
<tr><td>Name</td><td colspan="2">Energy Roadmap 2050 [COM (2011)885]</td></tr>
<tr><td>Description</td><td colspan="2">On 15 December 2011, the European Commission adopted the Communication ‘Energy Roadmap 2050’. In the context of the EU is committed to reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050 the Commission explores through the Energy Roadmap 2050 the challenges posed by delivering the EU's objectives on decarbonisation, ensuring security of energy supply and competitiveness. The Energy Roadmap 2050 is the basis for developing a long-term European framework together with all stakeholders (European Biofuels Technology Platform, 2012). Here the commission outlines ten conditions to be met in order to reach Europe energy targets:

An immediate fully implementation of the EU’s Energy 2020 strategy.
A dramatically more efficient energy system and society.
Particular attention to be given to the development of renewable energies.
Higher public and private investments in R&D and technological innovation.
Well-designed market structure instruments and new ways of cooperation needed for achieving a fully integrated market by 2014.
Energy prices need to better reflect costs.
A new sense of urgency and collective responsibility to bear on the development of new energy infrastructure and storage capacities across Europe and with neighbours.
Continuity in strengthening the safety and security frameworks and international leadership in the energy field.
A broader and more coordinated EU approach to international energy relations.
The creation of concrete milestones for Member States and investors.
</td></tr>
<tr><td>Targets</td><td colspan="2">Reducing greenhouse gas emissions to 80-95% below 1990 levels by 2050</td></tr>
<tr><td rowspan="2">Territorial implication</td><td>Characterisation</td><td>Average</td></tr>
<tr><td>Description</td><td>Average is seen here as something between weak and strong.

Weak reflects the fact that this is a general roadmap and does not include any direct discussion of implementation of place-based approaches at the regional or local level.
At the same time, the notion that emissions should be cut by the extent suggested means that policy actions will have to be executed at all governing scales, from the EU to the local. For instance, public procurement at all scales will have to be greened substantially in the coming 10 years in order support more widespread take-up of green technologies and behaviours.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>Strong reflects the fact that in order to achieve the goals that underpin the roadmap planning, development and management of local energy systems (both in terms of supply via renewables and demand-side improvements) will have to increasingly take place at the local and regional level. This is the primary reason why green energy issues are an important element of EU regional development funds, and many local/regional stakeholder networks for these issues are supported by the EU.</td></tr>
<tr><td>Indicators</td><td colspan="2">N/A because the Roadmap discusses many factors, where each would have their own respective indicator (i.e. emissions, renewables, efficiency, international connections for infrastructure, etc.</td></tr>
<tr><td>Distance to target (Graph or map should be provided in support of the distance to target analysis)</td><td colspan="2">N/A. See above.</td></tr>
<tr><td rowspan="2">Policy effectiveness</td><td>Characterisation</td><td>Unknown</td></tr>
<tr><td>Description</td><td></td></tr>
<tr><td rowspan="2">Transformative character of policy</td><td>Characterisation</td><td>Radical</td></tr>
<tr><td>Description</td><td>The Roadmap does not necessarily reflect a paradigm shift (although it might), but its targets of an almost a complete reduction (80-95%) of CO2 emissions suggests that energy issues will involve a major shift in the way we think about environmental issues (not just socially, but also in terms of the way energy market acknowledges environmental protection).</td></tr>
<tr><td rowspan="2">Green economy implication</td><td>Characterisation</td><td>Unknown</td></tr>
<tr><td>Description</td><td>It is completely impossible to suggest the implications of a policy package that is so broad in scope and duration.
There are obvious positive implications in terms of the environment as the goals of the roadmap fundamentally suggest.
There are obvious positive implications in terms of territory because to achieve these goals increased local regional actions are needed in terms of planning and managing energy services. Not least, this includes the local, place-based nature of renewable energy, as well as community energy systems.
However, there are potential negative impacts in terms of society. The ESPON project ReRisk suggests that energy poverty is not only a concern in Europe, but is also a reality. As such, development of more sustainable energy solutions across all sectors will have to mitigate the reality that energy is already a burdening expense for some people in many, if</td></tr>
</table>

		not all, member States. • Ideally, achieving the goals of the roadmap will imply that technologies are developed in Europe that can be exported globally. This would imply an economic gain and a clear contribution to the green economy. However, the reality is that countries like China are developing these technologies faster and cheaper than in Europe, thus implying that some policies supporting the this roadmap will result in export leakage (requiring investment in foreign technologies) and may not generate direct economic gains.

Table 12 Policy analysis table for Energy 2020

Type of policy and hierarchy	**Thematic Strategy**	
Name	**'Energy 2020: A Strategy for competitive, sustainable and secure energy' [COM(2010) 639]**	
Description	The objectives of from this strategy are part of the European Union's 2020 Strategy and the Resource Efficient Europe Initiative and are built on the so far achievements in European energy policy in order to make far-reaching changes to Europe's energy production and consumption patterns (European Union, 2012b). This strategy focuses on five priority areas: • Achieving an energy efficient Europe: The Commission proposes to mainstream energy efficiency into all relevant policy (sector) areas and concentrate efforts on the whole energy chain from production to final consumption (European Commission, 2012b). • Building a truly pan-European integrated energy market: measures oriented towards the implementation of legislation on the internal energy market, including the establishment of a blueprint of the European infrastructure for 2020-2030 concerning the development of the European Network of Transmission System • Empowering consumers and achieving the highest level of safety and security: This priority consist of two actions; making energy policy more consumer-friendly and continued improvement in safety and security • Extending Europe's leadership in energy technology and innovation (making a technological shift) • Strengthening the external dimension of the EU energy market (Strong international partnership, notably with our neighbours. This priority seeks the integration of energy market and regulatory frameworks with Europe's neighbours, promoting the global role of the EU for a future of low-carbon energy and legally binding nuclear-safety, security and non-proliferation standards.	
Targets	The 20/20/20 target: 20% RES consumption, 20% reduction on GHG and 20% reduction in primary energy.	
Territorial implication	**Characterisation**	***Average***
	Description	Average is seen here as something between weak and strong. Weak reflects the fact that this is a general strategy and does not include any direct discussion of implementation of place-based approaches at the

		regional or local level. At the same time, the notion that emissions should be cut via new energy sources and improved efficiency means that policy actions will have to be executed at all governing scales, from the EU to the local.
Indicators	N/A because the strategy discusses many factors, where each would have their own respective indicator (i.e. emissions, renewables, efficiency, international connections for infrastructure, etc.)	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	N/A. See above.	
Policy effectiveness	**Characterisation**	
	Description	
Transformative character of policy	**Characterisation**	***Incremental/radical***
	Description	Incremental in terms of the fact that the targets underlying the policy are not binding, but are only guidelines and recommendations. Radical from the perspective that if the targets are achieved there will undoubtedly be a radically transformed market for green energy technologies that will drive research and eco-innovation.
Green economy implication	**Characterisation**	***Unknown***
	Description	It is completely impossible to suggest the implications of a policy package that is so broad in scope and duration. There are obvious positive implications in terms of the environment as the goals of the policy fundamentally suggest. Positive implications in terms of territory relate to the need for increased local regional planning and management of energy services. Not least, this includes the local, place-based nature of renewable energy, as well as community energy systems. However, there are potential negative impacts in terms of society. The ESPON project ReRisk suggests that energy poverty is not only a concern in Europe, but is also a reality. As such, development of more sustainable energy solutions across all sectors will have to mitigate the reality that energy is already a burdening expense for some people in many, if not all, member States. Ideally, achieving the 20/20/20 goals will imply that technologies will continue to be developed in Europe that can be exported globally. This would imply an economic gain and a clear contribution to the green economy. However, the reality is that countries like China are developing these technologies faster and

		cheaper than in Europe, thus implying that some policies supporting the this roadmap will result in export leakage (requiring investment in foreign technologies) and may not generate direct economic gains.

Table 13 Policy analysis table for Directive 2009/28/EC on the promotion of the use of energy from renewables

Type of policy and hierarchy	**Directive and accompanying strategy and progress reporting**	
Name	**Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.**	
Description	As a policy basis to reach the goals of the 20/20/20 targets (thereby more than doubling the renewable energy production compared to the 2006 level of 9.2%) the EU adopted the 2009 Renewable Energy Directive. The directive provides each MS with a differentiated legally binding national target to reach the overall 20%, together with a requirement to put in place national policies in order to achieve that national target. This includes that each MS should establish *National Renewable Energy Action Plans* (NREAP) which set the share of RES consumed in transport, in the generation of electricity and heat for 2020 and take into account the effects of other energy efficiency measures on final energy consumption (European Union, 2012b). Setup of joint projects between MS concerning the production of electricity and heating from renewable sources are allowed by the Directive, as well as the establishment of cooperation with third countries as far the electricity generated is consumed in the Community. MS are also required to guarantee the origin of electricity, heating and cooling produced from RES. In order to provide consumers with information on the composition of different electricity sources (European Union, 2012b). The Directive also requires MS to build the necessary infrastructure for transmissions of RES, and to provide priority access for this type of energy. It addresses the removal of major non-economic barriers and provides measures to streamline procedures and grid access. With regard to biofuels and bio-liquids the directive stipulates sustainability criteria. It implies that emission savings of bio-liquids shall be at least 35% in order to be taken into account. Their share in emission savings should be further increased to 50% by 1 January 2017. It is also stipulated that biofuels and bio-liquids shall not be made from raw material obtained from land with high biodiversity value including primary forest, nature protected areas, highly bio diverse grassland, wetlands or continuously forested areas.	
Targets	National targets that amount to an increase to 20% of final energy consumption in Europe coming from renewables and a 10% share of energy from renewables in transport by 2020.	
Territorial implication	**Characterisation**	***Average***
	Description	Average is seen here as something between weak and strong. Weak reflects the fact that this is a general strategy and does not include any direct discussion of implementation of place-based approaches at the regional or local level.

		At the same time, the notion that emissions should be cut via new energy sources and improved efficiency means that policy actions will have to be executed at all governing scales, from the EU to the local.
Indicators	Share of Renewable Energy to Final Energy Consumption with normalised hydro and wind in EEA countries.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)		

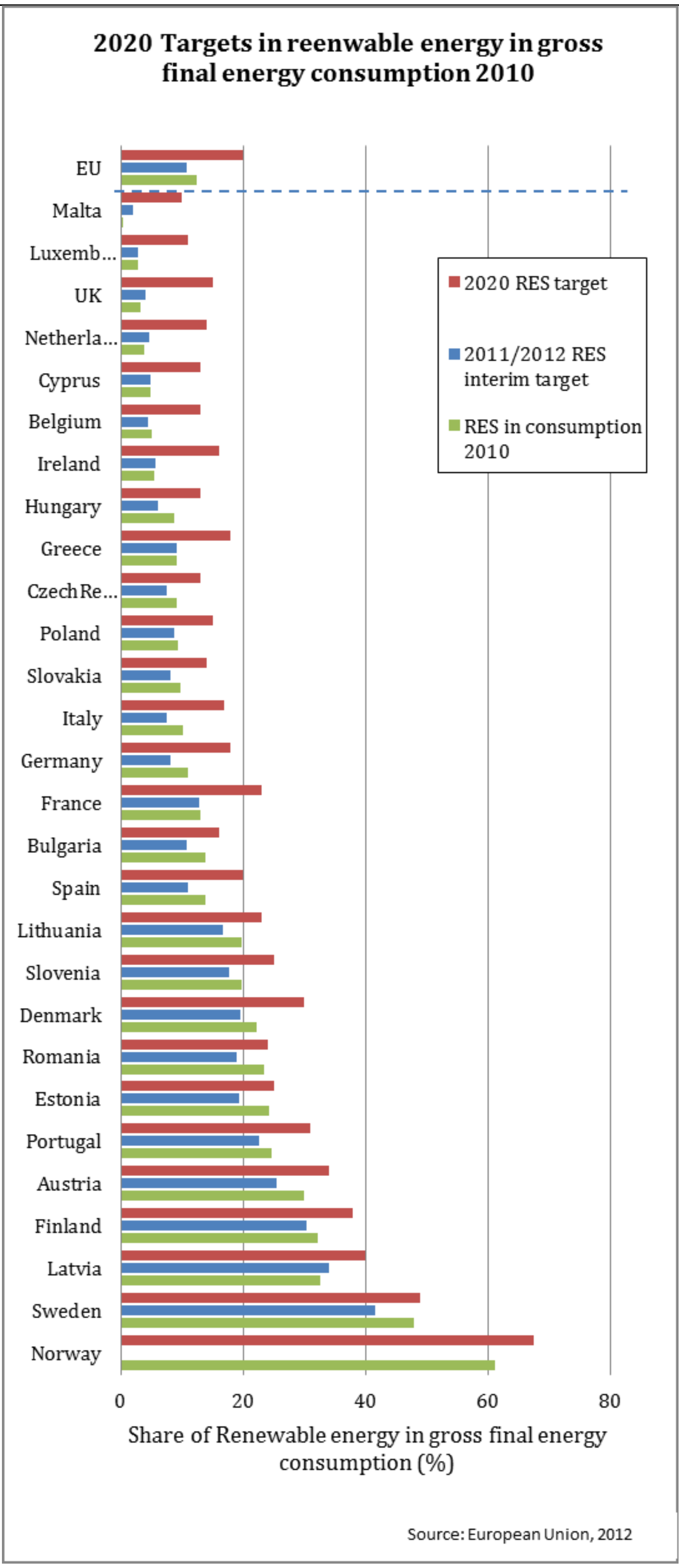


Figure 33 Share of Renewable Energy to Final Energy Consumption, compared to both the 2011/2012 interim target and the 2020 RES target for each MS.

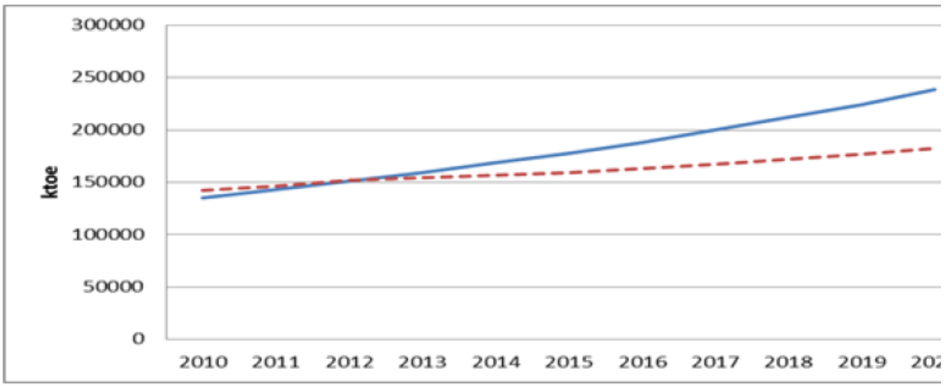
<table>
<tr><td></td><td colspan="2">

Figure 34 Planned (blue) versus estimated (red/dotted) trend in EU renewable energy production (published Renewable energy progress report COM(2013) 175 final).</td></tr>
<tr><td rowspan="2">Policy effectiveness</td><td>Characterisation</td><td>Average</td></tr>
<tr><td>Description</td><td>The information in the previous graph provides some indication of the progress towards the 2020 targets – showing countries such as Sweden, Estonia and Romania as seeming to be close to their targets while other countries have a long way to go. However, this very overarching view can be misleading.
The recently published Renewable energy progress report COM(2013) 175 final is a key component of Energy 2020 and the RES directive as it serves to benchmark progress as the MS level. It mentions that the 2010 renewable energy shares of 20 Member States and the EU as a whole were at the level of or above 2010 commitments set out in their national plans and above the first interim target for 2011/2012. This is shown in Figure 30 above.
However, further EC funded analysis reveals that the cumulative 2020 target may not be reached. The analysis limits estimates to growth based on current policies that are in place, effects of the economic crisis, ongoing administrative and infrastructure barriers and disruptions of existing policies and support schemes. Figure 31 therefore shows that even though progress was above planned levels through to 2012, trends suggest that, due to stalling support for development, the EU will collectively fall well short of its target for 2020. The report then provides five additional graphs for onshore wind, offshore wind, biomass, biofuels and solar PV – each showing a shortfall to their specific 2020 target. Estimates for solar PV come closest to its target while the greatest shortfall appears</td></tr>
</table>

		to be in terms of off-shore wind. The report makes a particular emphasis on troubles in the wind sector as being due to reduced national efforts (policy support) and infrastructure difficulties. In terms of the latter, this was a key reason for the recent release of **Regulation (EU) No 347/2013 of the European Parliament and the Council on guidelines for trans-European energy infrastructure.** This document points out that additional infrastructure investments are needed in order for the EU to reach its 2020 goals. The report specifically focuses on: connections across borders (part of creating a common market and balancing RES with traditional sources in space and time), refurbishment of existing infrastructure, and further development of smart grids in order to support decentralised (renewable) energy production.
Transformative character of policy	**Characterisation**	***Incremental***
	Description	This is difficult to characterise, but one could say that renewable energy policy in Europe has an incremental transformative character because it only attempts to reach a level of 20% of final energy consumption coming from renewables. As such, its target acknowledges that the switch to RES is a long, incremental process that must take place within the confines of existing market conditions – both in terms of supply cost and energy affordability. Furthermore, considering that key funding policies such as feed-in tariffs will continue to be key drivers of the sector, it is also assumed that renewables will not have a clear competitive advantage over traditional sources by 2020.
Green economy implication	**Characterisation**	***Positive Average (++ or +++)***
	Description	It is undoubted that the EU's RES strategy has positive implications on the environment – not lease due to the reduction of carbon intensive energy sources and the mandated sustainable uptake of renewable sources (that acknowledges environmental consequences of RES development. It also certainly has a positive impact on territory, particularly in terms of its importance on regional knowledge and strategies for place-based development of renewables. This is part and parcel with the nature of RES as part of decentralised energy strategies, and RES development has been a

		core rationale of the Intelligent Energy Europe Programme and the associated establishment of Regional Energy Agencies throughout Europe. It is perhaps too early to suggest the economic implication of RES development. On one hand it, RES technology for domestic development and export is an important contribution of generating a low-carbon economy, but only time will tell if this type of economic strategy will help keep Europe as a world economic leader. On the other hand, countries such as China are rapidly moving on their competitive advantage in the development of renewable energy technologies and this could have major consequences for the economic benefits that EU countries may have related to RES development. It is also difficult to determine the implications on the social sphere. On one hand, an improved environment means improved social welfare, but it is crucial that RES development takes place in a way that allows for all MS to adapt to new a new energy paradigm. Without such coordination, varying impacts will cause winners and losers, and through increased energy poverty will likely go against the goals of social cohesion in Europe.

Table 14 Policy analysis table for Directive 2012/27/EU on energy efficiency

Type of policy and hierarchy	**Directive and accompanying strategy and progress reporting**
Name	**Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC [OJ L315 p.1]**
Description	As the EU's main directive concerning energy efficiency, it has a host of policies and thematic strategies underneath it. Perhaps most notably, this includes the 2011 adopted strategy **Energy Efficiency Plan 2011 (EEP 2011)**, which sets out a strategy for MS to implement the details of the directive. However, the EU's most comprehensive policy strategy affecting the market conditions of any sector is – the EU Emissions Trading Scheme (Directive 2003/87/EC) (EU-ETS). This aims to set a common market for emissions from 'energy intensive' industries – the revenues of which can be reinvested in energy efficiency measures or RES development. Yet, as such a decisive policy programme for the EU, it is surprising that the ETS is not closer aligned with goals of energy efficiency in the EU. For instance, this 2012 Directive on energy agency only acknowledges the role of the ETS once – in saying that in order to implement the 20% energy efficiency target, the Commission will have to ensure that incentives within the ETS continue to reward low carbon investments.

	The primary reason for releasing the 2012 EE directive is the indication that the EU will fall woefully short of its 20% target for increased efficiency. As shown by Figure 32, the most recent projection indicates that we will only achieve a 9% savings; less than half of what was expected.

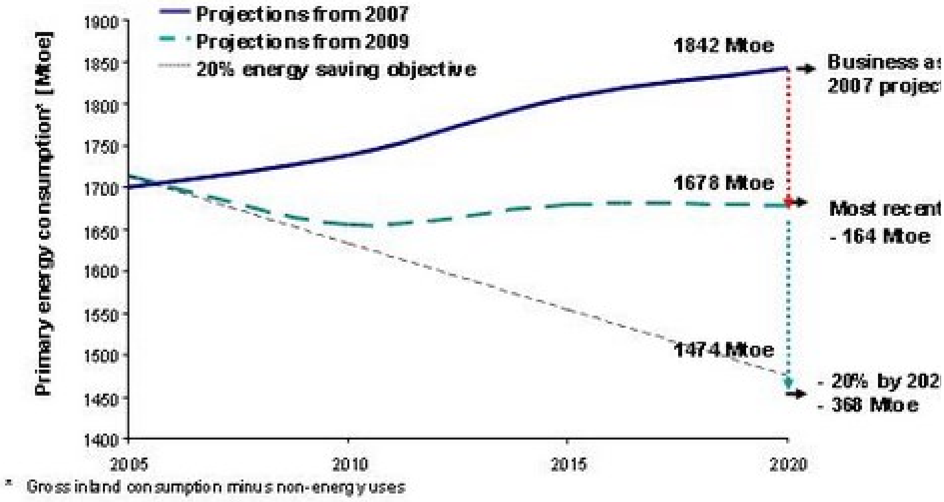


Figure 35 Projection of primary energy use for the EU by 2020 (MEMO/11/440 of the EC)

As a result, the directive proposes a number of new or revised measures. Highlights include:

- Legal obligation to establish energy saving schemes
- energy distributors or retail energy sales companies will be obliged to save every year 1,5 % of their energy sales
- Public sector to lead by example: for instance, every year they are required renovation works covering at least 3% of their total floor area
- To motivate MS to improve investment in energy infrastructure.

In addition, the Commission proposes that:
(1) Member States set themselves **non-binding national energy efficiency target**
(2) The Commission will propose binding national targets if in 2014 we come to the conclusion that the EU is not likely to achieve the 20 percent target.

What is notable through the Directive is that while the theme energy efficiency has an overarching perspective it is very much elaborated in terms of a) the EU ETS for energy intensive sectors and b) through sector specific interventions for auxiliary sectors. For example, this relates to the building and construction sector (cf. Directive 2010/31/EU on the energy performance of buildings) and the transport sector (cf. White Paper on Transport, adopted 28 March 2011). As such, much of the actual policy discussion on energy efficiency is rooted within the individual sector reports.
As a part of this Directive, all MS are responsible for developing and implementing national energy efficiency action plans.

Targets	20% increase in energy efficiency compared to business as usual. See Figure 32.	
Territorial implication	**Characterisation**	***Strong***
	Description	The directive and its supporting

		documentation has a very string territorial implication. First and foremost, its decisive focus on leading by example through public sector investment means that local and regional governments (owners of public buildings and infrastructure) are essential to the process of achieving the EU's energy efficiency goals. As such, the directive points out a number of governance networks, policies and funding sources directed towards local and regional authorities. This includes: • The EU Covenant of Mayors – especially in terms of developing integrated approaches to energy savings, complete with action plans. • Managenergy – energy efficiency and renewables at the local and regional level. • The Intelligent Energy Europe programme – for instance through the establishment of regional energy agencies. • JESSICA funds in support of urban projects targeting efficiency. • The ERDF and Cohesion fund will both extend their focus on energy efficiency issues in the 2014-2020 period.
Indicators	While Figure 32 provides an EU level appraisal of the progress towards the 20% reduction in energy efficiency – no breakdown at the national level has thus far been found.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	N.A.	
Policy effectiveness	**Characterisation**	*Weak-Average*
	Description	As shown in Figure 32, current forecasts suggest that the EU will not even achieve half of its goal towards energy efficiency. As such, the main reason for this directive in the first place is due to the overall lack of progress towards the 2020 target. Here, emphasis is placed on the incredible variation towards improvement among member states, the lack of direct public investment compared to what is needed and the need for additional financial measures supporting energy efficiency improvements (cf.

		Financial support for energy efficiency in buildings COM(2013) 225 final).
Transformative character of policy	**Characterisation**	***Radical***
	Description	The goals of the directive require parallel development of new markets for energy efficiency goods and services, as well as behavioural changes in the ways of thinking about energy consumption. This requires that we move from a condition now where energy is very much considered as a residual cost of a transaction towards energy issues being considered at the forefront of investment decisions. This policy also has a radical transformative character because of its crucial importance for achieving the EU's climate change goals, as well as improving security of supply and reduced dependency on energy imports.
Green economy implication	**Characterisation**	***Positive Strong (++++)***
	Description	All four spheres of the green economy would benefit under a condition where a 20% improvement in energy efficiency takes place. First, the environmental importance goes without saying – energy efficiency is absolutely essential to EU meeting its short, medium and long term climate change goals. Socially, we are more resilient to fluctuating energy prices, just as we are less dependent on foreign energy sources. Urban systems are likely put in focus for their energy efficiency benefits and these are marketed on their parallel benefits for social well-being. No least, this includes good access to public transit and high quality leisure space. Economically, we are investing in green technologies that are not only energy efficient for us at home, but we are able to export these goods and services at the global scale. Territorially, achieving the EU's energy efficiency goals requires increased action at the local and regional level. These actions not only consider that important of local context in the development of policy (e.g. via the development of regional energy agencies for example), but improvements to Europe's building stock (the main consumer of energy in the EU) and urban mobility require participation from knowledgeable local and regional authorities.

Cross-sectorial policies

The Lisbon Strategy

The general goal of the Lisbon Strategy (2000) was that Europe shall become the most competitive, knowledge-based economy in the world while preserving or improving social cohesion and maintain environmental sustainability (Johansson, et al., 2007). The Strategy sets also a framework for national and regional policies aimed to achieve these goals. Emphasis on energy policy in the Lisbon Strategy was made mainly within the second cycle (2005-2008) presented through the Communication '*The renewed Lisbon strategy for growth and jobs*' [COM(2007)803][11]. This Communication highlighted the importance of four priority areas: investing in knowledge and innovation, unlocking business potential, modernizing labour markets and developing an energy-efficient low-carbon economy. Within this last priority The Commission proposed that the EU should:

- seek to reduce greenhouse gas emissions by at least 20% and achieve a renewable energy share of 20% by 2020;
- promote an industrial policy geared towards more sustainable production and consumption, focusing on renewable energies and low-carbon and resource-efficient products, services and technologies;
- review the taxation of energy in the light of EU's energy and environmental objectives;
- strengthen the requirements regarding the energy performance of buildings.

Hence, it is clear from the Lisbon priorities that, EU builds its future policy development around the notion of competitiveness and places the knowledge and innovation together with entrepreneurship, security of supply, energy efficiency and climate change mitigation as indispensable tools at the heart of its regional development objectives (Rasmussen, et al., 2010).

Europe 2020 a strategy for European Union growth COM(2010) 2020

The Europe 2020 strategy[¡Error! Marcador no definido.] replaces the Lisbon Agenda, adopted in 2000, which aims at enabling the European Union (EU) to achieve growth that is:

- *Smart*: through the development of knowledge and innovation;
- *Sustainable*: based on a greener, more resource efficient and more competitive economy;
- *Inclusive*: aimed at strengthening employment, and social and territorial cohesion.

In addition, the Commission proposes a series of targets to be achieved by 2020:

- increasing the employment rate of the population aged 20-64 to 75 %;
- investing 3 % of gross domestic product (GDP) in research and development;

[11] Communication from the Commission to the Council of 11 December 2007, 'Strategic report on the renewed Lisbon strategy for growth and jobs: launching the new cycle' (2008-2010) Part I [COM(2007) 803]

- reducing carbon emissions by 20 % (and by 30 % if conditions permit), increasing the share of renewable energies by 20 % and increasing energy efficiency by 20 %;
- reducing the school dropout rate to less than 10 % and increasing the proportion of tertiary degrees to 40 %;
- reducing the number of people threatened by poverty by 20 million.

Thus, this strategy has a clear integrative approach as it fully incorporates the energy sector by reflecting the goals set in the 20-20-20 strategy. The energy sector is addressed in the *'the resource-efficient Europe'* initiative which aims to support the sustainable management of resources and the reduction of carbon emissions, while maintaining the competitiveness of the European economy and its energy supply.

Implementation of EU incentives at regional level

A study survey carried out by the Assembly of European Regions in 2011 (Podralska, et al., 2011) provides a good overview of which European incentives are applied on 27 member regions and how these are applied. According to this survey at least 82% (7% has did not responded) ofCF the regions have adopted at least one energy strategy during the last 10 years.

The Structural and Cohesion Funds (SCF) are the European Union's main instruments for supporting social and economic restructuring across the EU. They account for over one third of the European Union budget and are used to tackle regional disparities and support regional development. The Structural and Cohesion Funds budget for 2007-2013 is EUR 347 billion of which a greater proportion of the overall budget is allocated to the poorest regions where the Gross Domestic Product (GDP) per capita is lower than the EU average. Three objectives determine the eligibility of the region to use these funds, namely the 'convergence' objective, the 'regional competitiveness and employment' objective and the 'European territorial cooperation' objective.

Table 15 Priorities concerning energy supply and efficiency in EU Structural and Cohesion Funds (Energy cities, 2007)

European Regional Development Fund	– Improving security of supply, integrating environmental considerations. – Development of Public-Private-Partnerships. – Climate change mitigation. – Clean transport – Improvement of energy efficiency and development of renewable energies
European Social Fund	– Exchange of experiences and dissemination of good practice. – Mechanisms to improve good policy and programme design. – Support for interdepartmental coordination and dialogue between relevant private and public bodies. – Capacity building in delivery of policies and programmes.
Cohesion Fund	– Trans-European transport networks – Environment – Sustainable development: renewable energies, energy efficiency and clean urban and public transport.
European Regional Development Fund	– Stimulation of renewable energy production and energy efficiency – Development of efficient energy management systems. – Promoting clean and sustainable transport in urban areas.

European Social Fund	– Exchange of experiences and dissemination of good practice. – Mechanisms to improve good policy and programme design. – Support for interdepartmental coordination and dialogue between relevant private and public bodies. – Capacity building in delivery of policies and programmes.
European Regional Development Fund	– Networking, exchange of experience, transfer and dissemination of the best practice case studies on sustainable urban development (cross-border, trans-national and inter regional cooperation). – Cross-border environmental joint strategies. – Improved access to transport and cross-border energy management systems.

The EU Structural and Cohesion Funds for 2007-2013 are divided into three separate funds, the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund. Table 9 presents the priorities concerning energy supply and efficiency for each of the programmes (Energy cities, 2007).

For the programming period of 2014-2020 the European commission has proposed to almost double the proportion of the Cohesion policy budget to climate and sustainable energy expenditure to 5% or EUR 17 billion of a total budget of EUR 347 billion. Three priorities relate to investments in sustainable energy, namely research and innovation, competitiveness of Small and Medium-sized Enterprises (SMEs) and shift towards a low-carbon economy (Skäringer, 2012).

Intelligent Energy for Europe Programme

The Intelligent Energy for Europe programme was originally launched in 2003 to support projects aiming at introducing RES technology, informing and implement policies across the EU and monitoring and stimulating markets (International Energy Agency, 2008). As a measure to support the European Union’s 20-20-20 objectives the Intelligent Energy Europe II Programme (IEE II) was launched for the period 2007-2013. IEE II forms part of the Competitiveness and Innovation Framework Programme (CIP), which aims at achieving the EU energy objectives and to implement the Lisbon Agenda. The total budget allocated to the IEE II program for 2007-2013 is EUR727.3 million.

The programmes specific objectives are (Intelligent Energy Europe, 2012):

- to foster energy efficiency and the rational use of energy resources;
- to promote new and renewable energy sources and support energy diversification;
- to promote energy efficiency and the use of new and renewable energy sources in transport.

Two kind of actions have been supported with grants a, namely Promotion and Dissemination Projects and Project Development Assistance Facilities (ELENA), introduced in 2009, managed by international financial institutions.

Projects are categorized in four families (Intelligent Energy Europe, 2012):

- Energy efficiency and rational use of energy (SAVE): support projects that aim to tap the large potential for energy savings by improving energy efficiency and the rational use of energy sources, in particular buildings, products and the industry.

- New and renewable energy resources (ALTERNER): focuses on non-technological actions that contribute to the implementation of the RES Directive and on accelerating the growth of renewable energy markets to meet the EU 2020 target.
- Energy in transport (STEER): aims at promoting energy efficient modes and more rational use of energy in transport as well as stimulating the demand for alternative fuels and clean and energy-efficient vehicles.
- Integrated initiatives: are funding priorities covering more than one specific filed.

By the end of 2011 IEE has supported more than 300 promotion and dissemination projects representing more than EUR300 million. On average public bodies represented 34% of the beneficiaries while private organizations and SMEs were 21% and 45% respectively (Intelligent Energy Europe, 2012).

Projects within ALTERNER comprise non-technological actions that enhance the growth of renewable energy markets covering four key actions (Intelligent Energy Europe, 2012):

- Electricity from renewable energy sources (RES-E): aims at supporting the implementation of RES, infrastructure and sector specific actions to remove market barriers (Budget: EUR 30.8).
- Heating and cooling from RES: consists of key actions aiming at accelerating the large-scale use of renewable energy for heating and cooling in new and existing buildings, and in commerce and industry either from renewable energy systems or district heating and cooling (DHC) systems (Total budget 16.3 million).
- Small-scale applications: consists of actions aiming at accelerating the deployment of biomass, geothermal, and /or solar (thermal or PV) systems for heating, cooling and electricity in energy efficient buildings mainly by supporting policy implementation (Total budget EUR 14.8).
- Bioenergy: covers the following aspects of the bioenergy sector (Total budget: 36.1 million).

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