ESPON

EUROPEAN OBSERVATION NETWORK
TERRITORIAL DEVELOPMENT AND COHESION

ESPON North Sea STAR
Spreading Transnational Results

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Annexes to the Interim Report

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Annex A: Synthesis: European and North Sea Regional Energy policies

A1. Introduction

This synthesis report gives an overview of the energy policies – context, drivers and trends – in the countries bordering the North Sea. It first outlines the main issues in the policy debate based on essential documents and regulations in the EU and it relates the debate to the more specific topic of green growth, competitiveness and innovation in the energy field. Secondly it presents the current situation in energy production and consumption focusing on context and drivers. Thirdly, it looks into future energy policies in the North Sea region. The section ends with some concluding remarks.

A2. European Energy policy

This section presents main issues in European Energy Policy Debates (from the Inception Report). Secondly it discusses energy issues related to the green growth, competitiveness and innovation.

A2.1 European Energy Policy Debates

Energy has been at the centre of EU policy since the European Coal and Steel Community (1951) and the Treaty of Rome (1957), which established the European Atomic Energy Community (Euratom) alongside the European Economic Community (EEC). A major step was taken by the Treaty on European Union (the Maastricht Treaty) in 1992 by giving the Community the task of creating 'trans-European networks' in energy, telecommunications and transport. In 1994 eight priority energy projects of European significance were identified. More recently, the Treaty of Lisbon (2007) has enhanced the EU's objectives for energy policy.

Current policy: Energy 2020 and the Energy Roadmap 2050

EU law and policy on the energy sectors of oil, gas and nuclear, electricity transmission, energy efficiency, renewable energy and other matters is set out in more than 170 directives, regulations and decisions together with many communications and other statements. The current policy framework is set out in two main documents: 'Energy 2020 A Strategy for Competitive, Sustainable and Secure Energy' (CEC 2010) and the 'Energy Roadmap 2050' (CEC 2011).

The immediate goal is '20-20-20'. By 2020 in the EU, there should be at least a 20 % reduction in greenhouse gas emissions compared to 1990; a saving of 20 % of energy consumption compared to projections for 2020; and 20 % share of renewable energy in consumption. These policies are made in light of the need to provide for Europe more security of energy supply and recognising the contribution that energy production makes to climate change.

Energy 2020 sets out the ‘urgent need for far-reaching changes in energy production, use and supply’ (CEC 2010, p5). Some member states will have to renew up to a third of energy generation capacity by 2020 because of redundancy of existing installations. This will require an investment of one trillion Euro to replace and diversify existing sources. Europe is in a particularly vulnerable position in the face of ‘peak oil’ given that it is the world’s largest energy importer.

Evaluations show that implementation of these aspirations is weak, with energy systems adapting slowly, notably in the switch to low-carbon renewable energy sources and more energy efficient transport. In addition energy legislation is slow to be enacted locally, forcing the Commission to take action against many member states for failures to implement EU law. Among the reasons for the slow progress, the Commission highlights the fragmented European market which is hindered by ‘different national rules and practices’, barriers to competition, and national subsidies that are environmentally harmful.

The new EU Energy 2020 strategy focuses on five priorities:

1. Achieving an energy efficient Europe by reducing waste and achieving a 20% saving by 2020, with emphasis on the building stock and transport sector, making industry more energy efficient and gaining more efficiency in supply and consumption;
2. Building a truly pan-European integrated energy market: dismantling existing national monopolies, supporting the 20% target for renewable energy supply by 2020, and facilitating pan-European infrastructure to support the free flow of energy across Europe, and to support streamlined ‘permit procedures’ for projects of ‘European interest’;
3. Empowering consumers so that they can access energy at the most affordable prices, and achieving high levels of safety and security;
4. ‘Extending Europe's leadership’ in energy technology and innovation; with technology roadmaps in wind, solar, bio energy, smart grids and nuclear fission; and four major pan-European projects on linking European electricity grids, electricity storage, sustainable biofuel production and energy saving technology in ‘smart cities’; and
5. Strengthening the external dimension of the EU energy market by reaching agreements with neighbours who adopt the EU market model.

In the Roadmap 2050 it is acknowledged that uncertainty about policy and conditions beyond 2020 is not conducive to making investments now, but at the same time there is an urgency to make changes that will take many years to deliver improved performance in the energy sector. The Roadmap proposes that a ‘decarbonised European energy system by 2050’ is possible and required, though requiring ‘structural changes’ in terms of much higher capital expenditure to replace and change sources; increasing the role of electricity including in transport; higher consumer costs; an important contribution from renewables and low carbon sources, particularly nuclear; and a strong linkage between energy and ‘climate action’, though not at the risk of economic competitiveness.

The trade-offs between goals of energy security, climate action and economic competitiveness illustrate the many tensions and dilemmas in implementing EU energy policy. There is little attention paid to the ‘territorial dimension’ in the policy. Yet the impacts of the policies will vary considerably across Europe, depending on the specific conditions and potentials of regions. Furthermore, implementation is largely a matter for member states and regions acting cooperatively in transnational groupings, where cross-border cooperation can assist in achieving objectives. This has been recognized by the Commission which established in 2006 ‘regional initiatives’ ‘to provide a forum for regulators, network operators and other stakeholders of neighbouring countries’ (CEC 2010, p. 2).

This then sets the broad direction in policy terms, and individual nation states will be pursuing their own programmes of activities depending on their country specificities. Through a number of more directed policy initiatives, usually in the form of directives, the EU is seeking to provide further guidance on how the direction of travel outlined above can be effectively operationalized. Much depends on effective and consistent reporting of data, often at the level of the nation state, and the three key objectives have been subject to various forms of European policy initiative.

The examples given below are illustrative rather than exhaustive. First, longstanding concerns regarding the polluting impacts of large scale fossil fuel combustion plants has led to restrictions and limits on the pollution such activities can generate. The Large Scale Combustion Directive of 2001 seeks to control the emissions of sulphur dioxide, nitrogen oxides and dust of these plants, which alongside other initiatives such as emissions trading, have helped to move Europe towards the target of reducing the greenhouse gas emissions by 20% from this form of energy production. The 2009 Renewable Energy Directive requires nation states to produce a certain proportion of their total energy consumption (including transport) from renewables by 2020. These targets, set against a 2005 baseline, vary depending particular circumstances and range from 10% of energy consumption from renewables in Malta to a 49% target for Sweden. Key to delivering these targets is the requirement to produce national action plans and to report on performance on a national basis following a common template.

The Commission, in reviewing progress towards the 20-20-20 targets remains confident that reductions in gas emissions and the renewable targets are likely to be achieved, but have serious reservations regarding the objective of improving energy efficiency, which in turn should reduce demand for energy. To provide momentum and encouragement to this part of the agenda, the Energy Efficiency Directive was adopted in October 2012. The Directive seeks to liberalize energy markets; requires energy producers and suppliers to become more efficient in delivering resources and national governments to report on progress. It also emphasises improving the energy efficiency of residential and commercial buildings, with a special focus on public buildings being used as an exemplar of what could be achieved. With such direction it seems likely that future European funding programmes might particularly support this form of activity, although it is worth noting that a recent European

Court of Auditors report has questioned the cost effectiveness of investing in public buildings when the payback period could be anything from 50-150 years. The report was based on evidence gained from Cohesion Countries and the expectation was that greater scrutiny of such projects should be made before they are approved.

Hence within Europe, energy production and consumption is seen as being a critical component of the potential for global competitiveness, economic development and social cohesion and well-being. Much of the European wide statistics are provided at a national scale only and looking at the countries that border the North Sea as a whole some interesting trends become visible, and these are briefly outlined here as providing a broad context of the current situation.

Currently Europe's overall dependency on the import of energy is growing over time, from 46.7% in 2000 to 52.7% in 2010 (as is shown in Table 1). Against this back drop it could be argued that the countries that border the North Sea are performing reasonably well. Norway (-517.4%) and Denmark (-18.2%) are net exporters of energy, based around their exploitation of oil and gas reserves in the North Sea. The availability of such reserves also means that other North Sea countries, (with the exception of Belgium) are less dependent on energy imports than the rest of Europe. However it is evident from the available statistics that this level of self-sufficiency is declining and growing dependency on imported energy is increasing for countries in the region.

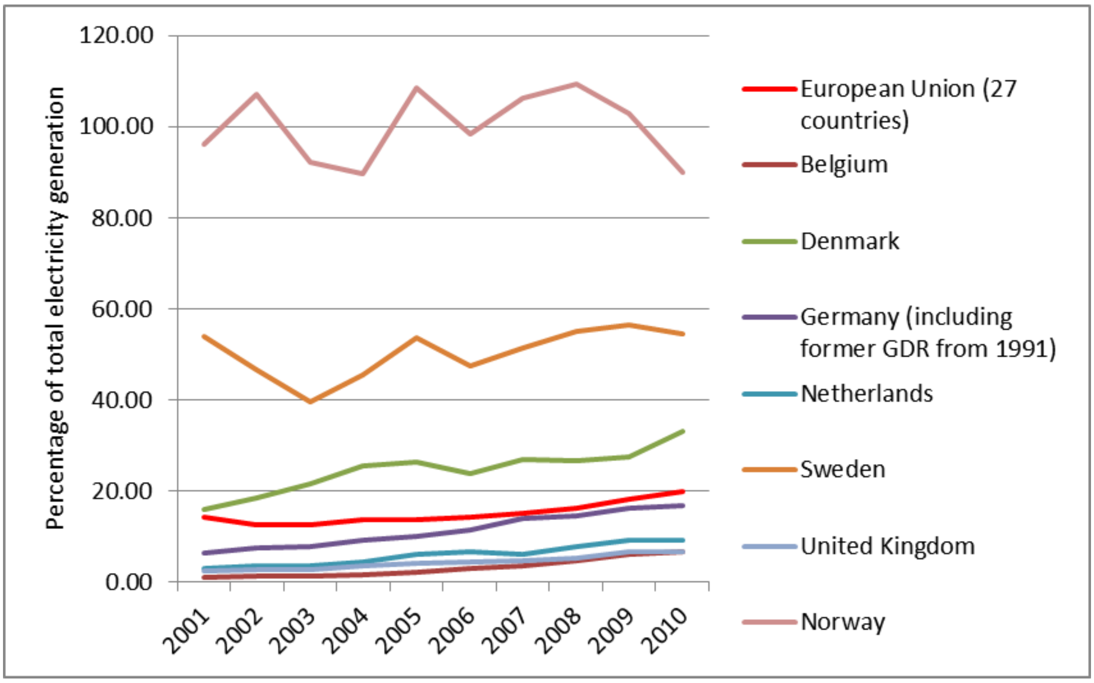
Table 1: Energy Dependency Ratios by Countries Adjacent to the North Sea (all products)

	2000	2006	2007	2008	2009	2010
EU27	46.7	53.7	53	54.6	53.7	52.7
Belgium	78.1	79.7	77.1	79.9	74.3	76.8
Denmark	-35.3	-35.9	-24.7	-22.9	-20.6	-18.2
Germany	59.5	60.7	58.1	60.5	61.5	59.8
Netherlands	38.7	37.4	38.9	34.4	36.5	30.7
Sweden	39.2	37.8	36.3	37.9	37.1	36.5
UK	-17	21.2	20.4	26.2	26.2	28.3
Norway	-731	-664.8	-654.4	-612.3	-639.1	-517.4

(Source: DG Energy, 2012)

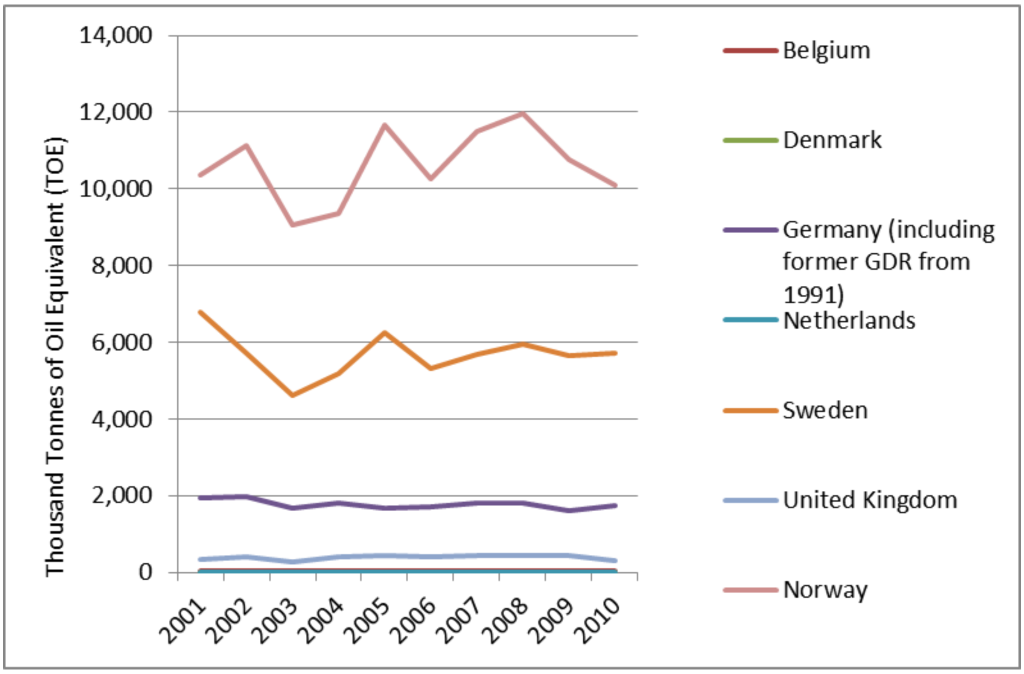
Furthermore, a region's propensity to produce its energy needs from renewable resources in part depends on its natural resource asset base. Renewable energy is divided into two broad categories, renewables utilizing natural assets (wind, water and photovoltaic) and renewables that have been produced or manufactured, such as bioenergy and biofuels. The following three figures (1, 2 and 3) provide an overview of renewable energy production for the countries bordering the North Sea.

Figure 1: Percentage of Electricity Generated from Renewables by Countries Adjacent to the North Sea, 2001-2010



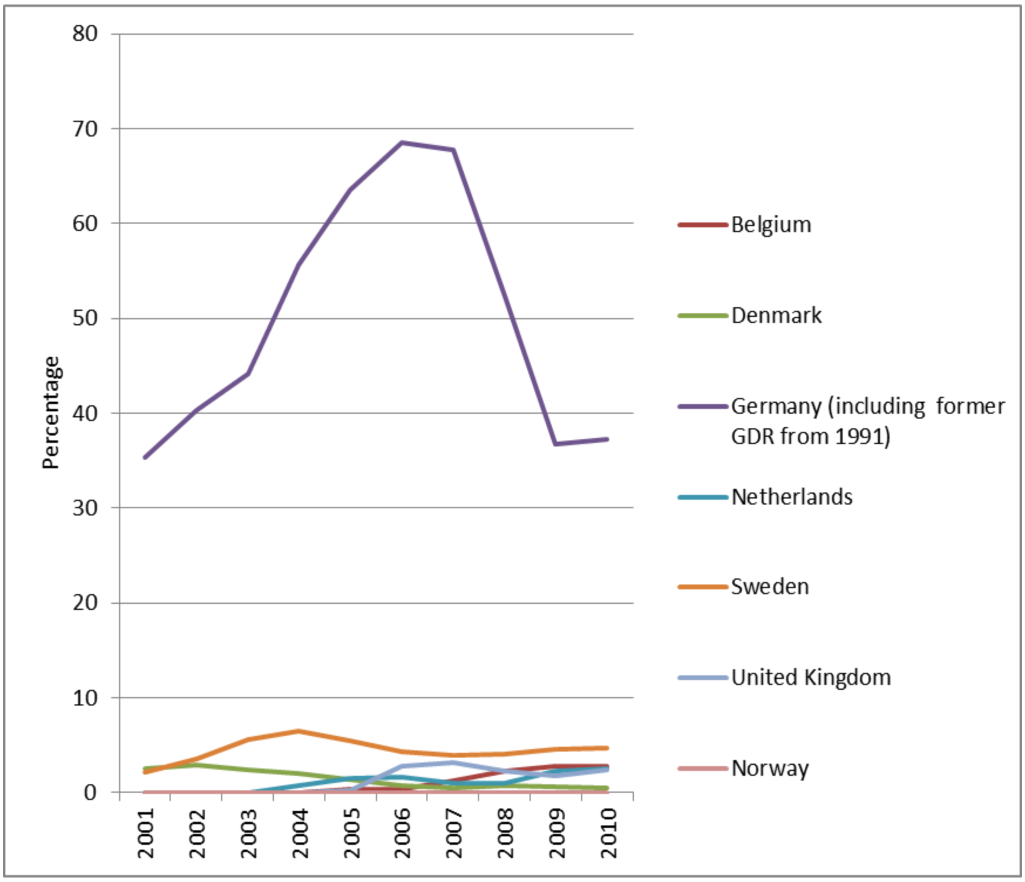
Source: Eurostat (2013) Electricity generated from renewable sources - annual data [nrg_ind_333a]

Figure 2: Production of Energy from Renewable Sources by Countries Adjacent to the North Sea, 2001-2010 (TOE, tonnes of oil equivalent)



Source: Eurostat (2013) Supply, transformation, consumption - renewables (hydro, wind, photovoltaic) - annual data [nrg_1072a]

Figure 3: Production of Biofuels as a Percentage of total EU Biofuel Production by Countries Adjacent to the North Sea, 2001-2010



Source: Eurostat (2013)

The availability of natural resource assets, particularly in Norway and Sweden means that a significant proportion of their primary electricity needs are generated from hydro resources. Elsewhere there is greater reliance on wind and photovoltaic sources which, albeit from a very small base, are becoming more significant as an energy source. They generally remain limited in overall energy dependency terms, although their significance in terms of electricity generation is growing. Biofuels are a very small contributor to total energy production across Europe, although it is interesting to note how Germany is a big producer of biofuels and this could be quite an important fuel for transportation. The biggest user of biofuels for transport is Poland, where 17% of private transport miles were fuelled in this way (Eurostat 2012).

A2.2 European Energy Policy – Key Challenges

The policy debate in Europe has changed somewhat in recent years. The economic crisis has redirected political attention from climate change issues to economic recovery. The Emission Trading Scheme (ETS) is in turmoil and global investments in renewable energy fell in 2012, carbon Capture and Storage (CCS) has not taken off and there was a shortfall in delivering the EU's 2020 energy efficiency target. However, the 20-20-20 targets seem to be surpassed by 2020 but mainly due to economic recession. Reducing patterns of consumption and the goal of 80-95% decarbonisation by 2050 is still in force (Hanrahan, 2013).

The key challenges for European energy policy are related to target setting for 2030, balancing national and European dimensions, competiveness, energy security, the EU position for a 2015 global deal, policy coherence and getting the policy right.

What kind of target regime is appropriate to 2030 is perhaps the most contested issue in the current policy debate. How many targets should Europe have and how should they be applied? The emission target for 2030 aiming at 40% reduction is in line with the Low Carbon and energy Roadmap 2050. The renewable target is more uncertain due to negative prices and internal market impacts. Neither is the energy savings target pursued in the current situation when economic growth needs to be stimulated. Stakeholders are divided on the target regime. Many environment and development NGOs are in favour of a three-target approach whereas the power industry associations support a single-target approach. The renewables and energy efficiency industries have a strong preference for a two-target approach – renewables and energy efficiency – in order to promote growth and innovation in the sectors.

The second issue (after targets) relates to the tension between a re-nationalisation of energy and protecting the integrity of the Internal Energy Market. EU Member States are given a rather free scope on how they should implement the headline targets. There exist numerous instruments and support schemes for renewable energy across the Member States. These create barriers to cross-border operation and several unilateral decarbonisation strategies generate risk for fragmenting the Internal Energy market.

A third challenge for the 2030 package is how to ensure the best outcome from a competitiveness point of view and how to minimise price impacts for domestic consumers. This is a significant issue, particularly since the energy competitiveness gap between Europe and the US is widening. In 2012, industry gas prices in Europe were four times higher than in the US. Similarly, real electricity prices for industry in Europe increased by 38% between 2005 and 2012, whereas they decreased in real terms in the US by 4%. (Hanrahan, 2013). This affects particularly energy-intensive industries but also private consumers and makes it harder to implement support schemes for renewable energy, where the market is either directly subsidised by national governments or consumer prices with both seeking to stimulate private investment in these areas.

Enhancing energy security is a fourth challenge that will have to be addressed. Europe is the world's biggest energy importer and its dependency could increase from 54% to 70% in 2030. In addition, the imports come from just a few countries; Russia, Norway and Algeria together account for 85% of Europe's natural gas imports, and 50% of the crude oil imports (Hanrahan, 2013). This calls for more integrated and efficient energy markets and more indigenous European energy resources, i.e. more renewables. With regard to energy security a three target regime seems to be most appropriate.

A fifth challenge is balancing the EU's outward-facing negotiations on a 2015 global deal with its inward-facing negotiations on targets for 2030 and looking ahead to 2050. The international community is heading towards an agreement on a global climate deal in 2015 which should come into force in 2020 (Durban Platform for Enhanced Action). Such a deal must be both economically feasible and politically palatable from a European perspective.

The sixth challenge is to enhance policy coherence in the energy framework and to limit the overlap between the three targets and their underpinning instruments. Multiple targets are more complex to handle than a single- or two-targets approach. A single emissions target is optimal from a policy coherence perspective and ETS functioning. An emissions target supplemented by an efficiency target would be preferable to a trio approach with a renewables target.

A final challenge in the 2030 debate is to "getting the politics right". The politics around the ETS reform do not generate confidence that even a long-term solution will be achieved. The European Commission and the Parliament are pulling in opposite directions on several issues. Between the Member States there seem to be two camps - those advocating a single emissions target (the UK), and those advocating at minimum a renewables target in addition (Denmark and France). A complex electoral landscape in 2013/14 and the stagnant economic situation make it very difficult to reach a common agreement for the European energy policy.

A3. Green Growth, Competiveness and Innovation

Innovation is a key driver in the transition to a green, sustainable economy. A highly relevant research approach to this fundamental challenge is the sustainability transitions perspective. Being broad and trans-disciplinary, the starting point for transitions research is a recognition that many environmental problems, such as shift in energy systems, climate change, loss of biodiversity, resource depletion (clean water, oil, forests, fish stocks), are formidable societal challenges, whose solution requires deep-structural changes in key areas of human activity, including our energy, agri-food, housing, transport, manufacturing, leisure and other systems. Realising a new energy system based on renewables and a green economy more generally will require fundamental socio-technical changes implying a radical transition towards a more sustainable society (Grin, Rotmans & Schot, 2010). However, existing energy systems tend to be very difficult to 'dislodge' because they are stabilized by various lock-in processes that lead to path dependent developments and 'entrapment'. Highly institutionalised processes perpetuate existing systems and make it difficult for innovative sustainability alternatives to find space to develop and influence radical structural transformations.

The challenge is to develop concepts, theories and policies that help us understand how to unlock processes and stimulate path-breaking changes towards a more sustainable, green economy and society. The following topics make up the core of the ST-research agenda:

1. Framework conditions, governance, power and politics,
2. The role of firms, industries, innovation, business development and management in transitions,
3. The geography of transitions: scale, place, region, land use, resources, and
4. Sustainable consumption: transitions in practice, everyday life and culture.

The ST-approach represents a fairly new perspective in research on post-carbon energy systems and solutions. The ST-approach employs a broad systemic focus, encompassing complete resource life cycles, environmental, societal and economic sustainability, value added and market orientation and multi-disciplinarily in order to ensure economic and societal relevance. Within OECD, EU, IEA and other international organisations and communities there is on-going efforts to shape and design policies and strategies aiming to realise a green, competitive economy more generally and a new post-carbon energy system based on renewables in particular. In the following, such policies and strategies are further scrutinized.

A3.1 The Need for Green Growth Strategies

According to Andoura and d'Oultremont (2012, p.1) “The energy transition of Europe by 2050 takes place within the framework of the transition towards a competitive low-carbon economy by 2050. The EU transition to a low-carbon society may be described as the “third industrial revolution”, requiring a massive transformation of the energy sector from production, transport and distribution to use and storage.” (ibid, p.3-4) “The energy transition will much depend on research in new clean technologies and the pace of their technological development and deployment on the mass market. The research, development and deployment of new clean technologies can offer huge opportunities for the EU in terms of environment, competitiveness, job creation and economic growth. However, all large economies like China, Japan and the US are embracing the race to compete in this field, potentially impacting on the global competitiveness of European industry.”

OECD (2011a, p.17) claim that “The world faces twin challenges: expanding economic opportunities for a growing global population, and addressing environmental pressures that, if left unaddressed, could undermine our ability to seize these opportunities. Green growth strategies are needed because:

- The impacts of economic activity on environmental systems are creating imbalances which are putting economic growth and development at risk. Increased efforts to address climate change and biodiversity loss are needed to address these risks.
- Natural capital, encompassing natural resource stocks, land and ecosystems, is often undervalued and mismanaged. This imposes costs to the economy and human well-being.

- The absence of coherent strategies to deal with these issues creates uncertainty, inhibits investment and innovation, and can thus slow economic growth and development.

This underscores a need for better ways of measuring economic progress: measures to be used alongside GDP which more fully account for the role of natural capital in economic growth, human health and well-being.

While different country situations will demand different responses, clear and predictable policy signals to investors and consumers will deliver benefits from greening growth in the form of:

- Economic gains from eliminating inefficiency in the use and management of natural capital.
- New sources of growth and jobs from innovation and the emergence of green markets and activities.

OECD has developed a framework for green growth (OECD 2011a, p.19). “The overarching goal of the framework is to establish incentives or institutions that increase well-being by: improving resource management and boosting productivity; enticing economic activity to take place where it is of best advantage to society over the long-term; leading to new ways of meeting these first two objectives, i.e. innovation.” (ibid, p.21) “The need to reframe growth is becoming increasingly important due to imbalances being created by the impacts of economic activity on environmental systems.” (ibid, p.21) “The absence of coherent strategies to deal with these dynamic issues can place a further drag on growth because of uncertainty about future regulatory conditions that inhibit private sector initiatives and investments in greener growth opportunities. Such effects are likely to be especially pronounced in the current economic climate.

In addition, economic and policy decisions have long-lived consequences due to the slowly evolving nature of the physical capital stock. Indeed current patterns of growth, consumer habits, technology and infrastructure all reflect an accumulation of past innovations and also past incentives that misguide behaviour, partly reflecting inappropriate government policies. Inefficiencies referred to earlier are to some extent hard-wired into the way economies function. This “path dependency” may continue to exacerbate systemic environmental risks and economic inefficiencies even after more basic valuation and incentive problems have been addressed.

In this regard, a key element of any green growth strategy is to set incentives that will boost innovation along a growth trajectory which diverts from inefficient patterns of the past. In this context, sound economic policy, robust competition and private sector innovation remain central drivers of growth and necessary conditions for unleashing new economic opportunities. Similarly, labour market conditions and educational opportunities need to be supportive of emergent industries and structural change.”

According to OECD (2011a, p.24) “Under “business as usual”, we would certainly see increased pollution, negative impacts on human health, and constraints on the improvement of living standards due to increasing prices of essential commodities like food and energy, though not at a rate that would be sufficient to spur greener behaviour without targeted policy intervention. In reality, business is never "as usual". Markets, societies, and policies are constantly changing. Aware of environmental and economic challenges, governments have already implemented policies or promulgated strategies to affect a shift towards cleaner production, to promote greener business practices and green innovation."

A3.2 The Policy Framework for Green Growth

OECD (2011a, p.35) discusses three issues for why "Policies for greening growth will differ across countries, according to local environmental and economic conditions, institutional settings and stages of development. However, in all cases they need to: (i) integrate the natural resource base into the same dynamics and decisions that drive growth; (ii) develop ways of creating economic payoffs which more fully reflect the value of the natural resource base of the economy; and (iii) focus on mutually reinforcing aspects of economic and environmental policy.

In addition to changing the payoffs in the economy, "policy will also need to address inertia, the risks of technology lock-in, and the roles of innovation, infrastructure and institutions in enabling change:

- Innovation. Government plays an important role in fostering green innovation. It can lend support by funding relevant research, supplying finance tailored to differing stages of technology development and using demand-side instruments such as standards, regulations and public procurement. Ensuring wide diffusion and international transfer of green technologies and practices is important. This requires reducing barriers to trade and foreign direct investment, effective protection and enforcement of intellectual property rights, and efforts aimed at the least developed countries.
- Infrastructure investment programmes in sectors such as water, energy, and transport. Well-planned programmes can help drive development, reduce water and air pollution, curb unsustainable land use change, and enable the deployment of next generation technologies. Financing these programmes needs to focus on leveraging private sector investment.
- Institutional and governance capacity to implement wide-ranging policy reform is an essential condition for greening growth. Governments need to integrate green growth objectives into broader economic policymaking, development planning and poverty reduction strategies.

(OECD 2011a, p.36) "Innovation needs to be marshalled to help provide ways around old patterns of production and consumption and generate new sources of growth that better reflect the full value of economic activity to society."

- ***Innovation***

  "The core of transforming an economy is innovation. Innovation and the resulting creative destruction mean new ideas, new entrepreneurs and new business models. It contributes to the establishment of new markets, leads to the creation of new jobs and is a key ingredient of any effort to improve people's quality of life (OECD 2011a, p.51).

  Innovation today is as much about firms and organisations finding new ways of doing things or ways to use novel technologies as about breakthroughs that occur in the lab. Technological breakthroughs and their diffusion in the market are of course extremely important, but so too are the organisational and systemic changes that need to accompany them. For example, green innovation aimed at transport systems and cities will involve major organisational and institutional changes. Technologies are often only effective in enhancing performance when accompanied by complementary investments, e.g. in skills (OECD, 2004). Without innovation, it will be very difficult and very costly to address major environmental issues."

- ***Green Innovation***

  (OECD 2011a, p.53-54) "Innovation with an environmental or "green" flavour faces additional barriers which exacerbate existing ones. When firms and households do not have to pay for environmental services or the costs of pollution, the demand for green innovation is constrained and there are fewer incentives for companies to invest in innovation.

  Boosting green innovation therefore benefits from clear and stable market signals, e.g. carbon pricing or other market instruments addressing the externalities associated with environmental challenges. Such signals will enhance the incentives for firms to adopt and develop green innovations, and help to indicate the commitment of governments to move towards greener growth. They will also enhance efficiency in allocating resources by establishing markets for green innovation, and will lower the costs of addressing environmental challenges. Taxes and other pricing instruments are included in Japan's recent "New Growth Strategy".

  Recent experiences suggest that carbon pricing contributes primarily to incremental rather than disruptive innovation, however. This tends to increase efficiency but may also lead to growing consumption, as has been the case in personal transport. Given the other market failures that green innovation is facing, complementary policies are needed. A key question in this context is: how and where governments should focus their efforts. In terms of how, there are three key ways that governments can lend their support to green innovation.

- ***Strengthening Research and Development***

  One is in funding relevant research, whether public or private. According to OECD (2011a, p.54): "Investment in basic and long-term research underpins much of the innovation process and provides the foundation for future innovation. Such research has a long time horizon and often has no immediate commercial applications, which implies it is unlikely to be undertaken by the private sector. It can help address fundamental scientific challenges and help foster technologies that are considered too risky, uncertain or long-gestating for the private sector."

- ***Supporting Innovation and Deployment***

  Another way to support green innovation is to target barriers to its early-stage commercial development (OECD 2011a, p.54). Access to finance is especially difficult for firms engaged in green innovation, due to the relative immaturity of the market, and thus greater perceived commercial risk. Markets are likely to price this risk more accurately as they mature (OECD, 2011f), but this may take time. According to OECD (2011a, p.57) "Investing in relevant research is only one approach towards green innovation. Another way is to address specific barriers and market failures to green innovation. Such barriers include the relative immaturity of the market for green innovation, as well as the dominance of existing designs in energy and transport markets, which can create entry barriers for new technologies due to, for example, the high fixed costs of developing new infrastructures. In particular, when projects face high technology risks and are capital intensive, they are very hard to fund with either project or debt financing or venture capital and can fall into a funding "Valley of Death".

  Where governments should direct their support is a difficult issue to grapple with. In picking where support should go there is always a risk of promoting activities that may have occurred anyway. Similarly, there is a risk that more appropriate technologies or practices will emerge that should have been supported but policy has locked the economy into a less desirable pathway. On the other hand, too little support can preclude the achievement of environmental objectives. In many cases, such as driving low-carbon growth or decarbonising energy systems, large scale system-wide changes need to happen in a relatively short space of time. This presents both costs to the environment and potentially costs to growth."

- ***Demand-Side Policies***

  "A third way to strengthen green innovation is to use demand-side innovation policies (OECD 2011a, p.54). Standards, well-designed regulations and public procurement, for example, can encourage green innovation in markets where price signals alone are not fully effective. For instance, following the introduction of the German packaging ordinance in 1989, there was a take-off of patents of biodegradable packaging (OECD, 2010l)." (OECD 2011a, p.59) "Demand-side instruments, such as public procurement, can help foster markets for new products and services, for example through demonstration effects, and counter gaps in the supply of finance at the early stages. They can also help accelerate the emergence of technologies for which there is an urgent time-bound societal need and that are subject to specific barriers, such as network effects and market dominance. One example is the electric car, where public procurement could potentially play a role in strengthening market acceptance and boosting the development of the necessary network. Public procurement also plays an important role in the greening of governments. As with direct support, governments should generally ensure that their procurement policies are technology neutral and focused on performance. Demand-side policies often imply a lead role for the public sector. However, the public sector is not always best placed to support the innovation process, and new capacities may need to be developed."

- ***Policy Considerations***

  "There is no single recipe to follow for driving green innovation. There is a diversity of possible approaches depending on the context. This diversity commends special attention to governance arrangements around the policies to foster green innovation. In particular, this requires policies with a medium- and long-term perspective, and attention from policy makers at the highest level. Governance also involves co-ordination of simultaneous policy actions and consideration of possible interactions with policies with other objectives. Simply developing additional policies will not improve coherence; existing policies may have to be adjusted or phased out. Yet, policies for green growth and innovation often remain compartmentalised in different departments and agencies, including at various geographical scales. This can create obstacles to co-operation and lead to a proliferation of duplicative and wasteful innovation policies. The budget process, as one of government's main decision-making tools, can help lead to effective innovation policies (OECD 2011a, p.62).

  Policies to foster green innovation will benefit from continued evaluation and monitoring, to improve the effectiveness and efficiency of policies over time, and to take advantage of the development of new scientific insights and new technologies and innovations. The required policy changes resulting from evaluation will have to be balanced against the need for policy stability over time. Fostering a diverse range of potential options for action, and delaying some of the most lumpy and irreversible investments, may also help in preserving options for the deployment of new technologies and innovations as they emerge. This is one additional reason for a strong policy effort focusing on research, innovation and entrepreneurship, as these all contribute to the process of experimentation that underpins the emergence and development of new options. In addition, having a strong focus on policies to strengthen the market for green innovations, may also help in ensuring that policy does not get unduly locked into poor supply-side decisions".

- ***Social Innovation***

  (OECD 2011a, p.62) "Finally, green innovation is not only about new technologies. Non-technological innovation, including changes in cities and transport systems, as well as organisational and behavioural changes, will play an important role in accompanying the introduction of green technologies. Examples include the introduction of environmental management systems, or of new business models, such as energy-saving companies (OECD, 2010m). Governments should foster such innovation, and need to consider whether their framework policies are sufficiently conducive to such innovation, e.g. in addressing regulatory barriers in product markets that might limit the necessary structural change. Labour market policies are also important, as they help firms and workers adjust to change."

A3.3 Applying Green Growth Strategies to the Energy Sector

The OECD report *OECD Green Growth Studies: Energy* (OECD 2011b) “highlights the challenges facing energy producers and users, and how they can be addressed using green growth policies. Because energy underlies the global economy, the decisions made today in the energy sector will be critical to achieving greener growth. We have a window of opportunity for establishing a policy framework to enable transformational change in the energy sector, including by facilitating technological innovation and the creation of new markets and industries, to reduce the sector’s carbon-intensity and to improve energy efficiency.”

(OECD 2011b, p.11) “The energy sector poses a particular challenge in the context of green growth due to its size, complexity, path dependency and reliance on long-lived assets. The current energy system is highly dependent on fossil fuels, whose combustion accounted for 84% of global greenhouse gas emissions in 2009. Global demand for energy is rapidly increasing, due to population and economic growth, especially in large emerging countries, which will account for 90% of energy demand growth to 2035. At the same time, nearly 20% of the global population lack access to electricity. A major transformation is required in the way we produce, deliver and consume energy.

A large-scale transformation of the global energy sector is possible, though it will require significant investment.” (OECD 2011b, p.12) “There is a window of opportunity to establish the policy framework to enable transformational change in the energy sector, including facilitating technological innovation and the creation of new markets and industries, to reduce the sector’s carbon-intensity, and improve energy efficiency. Overall, there are 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: Failing to address environmental concerns and not managing natural resources effectively poses risks to long-term economic growth, for example, via the growing scarcity and rising price costs of increased environmental damage of conventional fossil fuels and to well-being through the impairment of human health caused by pollution, for example.
- Innovation to achieve environmental and economic objectives: Innovation is fundamental to the objectives of green growth in that it can help to decouple environmental damage from economic growth. It is also at the core of economic objectives such as productivity growth and job creation. Innovation is particularly important in the energy industry, as we search for forms of energy that impose fewer environmental costs and for ways of improving efficiency in use as prices rise.
- Synergies between environmental and productivity growth objectives: Improved resource productivity and energy efficiency, through innovation or deployment of energy technology or processes, supports decoupling between economic growth, environmental damage and resource degradation.

- Opportunities for new markets and industries: Shifting toward green growth in the energy sector will require new technologies, fuel sources, processes and services that can spur new markets and new industries. Firms that are proactive in the face of these changes will be well-positioned to both contribute to and benefit from them."

Policies for green growth in the energy sector

(OECD 2011b, p.12-13) "Aligning the energy sector with a green growth framework requires a clear understanding of national priorities. While fostering greener growth will require international co-operation, it is largely a national matter and the policy mix will therefore differ across countries, according to local environmental and economic conditions, institutional settings and stages of development.

Policies will need to take into account the inter-relationships between economic sectors, transports, land-use patterns, social welfare and environmental integrity. A range of mutually reinforcing measures is required to address market failures and barriers, and create the enabling policy conditions for large-scale private-sector investment. This includes: rationalising and phasing-out inefficient fossil fuel subsidies; setting a price signal to value externalities; establishing sound market and regulatory frameworks; radically improving energy efficiency; and fostering innovation."

Fostering innovation and green technology policy

(OECD 2011b, p.46) "Innovation is a key driver in the transition to a green economy. It will be very difficult and very costly to address global environmental dilemmas such as climate change without successful innovation." (OECD 2011b, p.46) "Innovation is likely to be coupled with a process of creative destruction to bring new ideas and new business and institutional models to enable green growth. Such changes may include: the redesign of electricity delivery mechanisms to improve efficiency by cutting line losses, which amount to about 9% of global electricity production; accommodating low-carbon variable and decentralised supply sources; facilitating active network control and flatten peak demand curves to make better use of capital-intensive assets; and engaging consumers in demand-side management through price signals. This requires policies to promote innovation in technologies such as high-voltage direct current lines, information and communication technology (ICT) platforms and smart meters to name a few, but also new market and regulatory models."

(OECD 2011b, p.47) "Some conclusions arising from Fostering Innovation for Green Growth have particular relevance for the energy dimensions of green growth, as summarised below:

- Public investment in research is needed to help lower the costs of green innovation, to expand the scope for technological breakthroughs and to create new opportunities.

- Governments need to encourage the process of experimentation to bring about favourable options at the lowest cost. This involves a vigorous process of national and global competition among alternative technologies and innovations, to bring about those that have the best performance.
- Where solely private efforts are unlikely to be sufficient to commercialise technologies, government action, including public support, may be required to overcome market failures and barriers, such as dominance by existing business models and technologies. The primary market failure is the risks and time frames before profits are realizable can be too great for industry without government support. However, such policies should be well-designed to avoid capture by vested interests and regularly evaluated to ensure that they are effective and efficient in meeting public policy objectives.
- Countries may want to prioritise their efforts in areas where they have capabilities and a certain critical mass and focus on green technologies and innovations that are particularly relevant in the national context. In other areas, international collaboration provides a means to gain access to relevant research and work together for solutions to global issues. At the same time, international competition will be essential to drive down the costs of green innovation and benefit from the global process of experimentation."

A4. North Sea Regional Energy Profile (Current Situation)

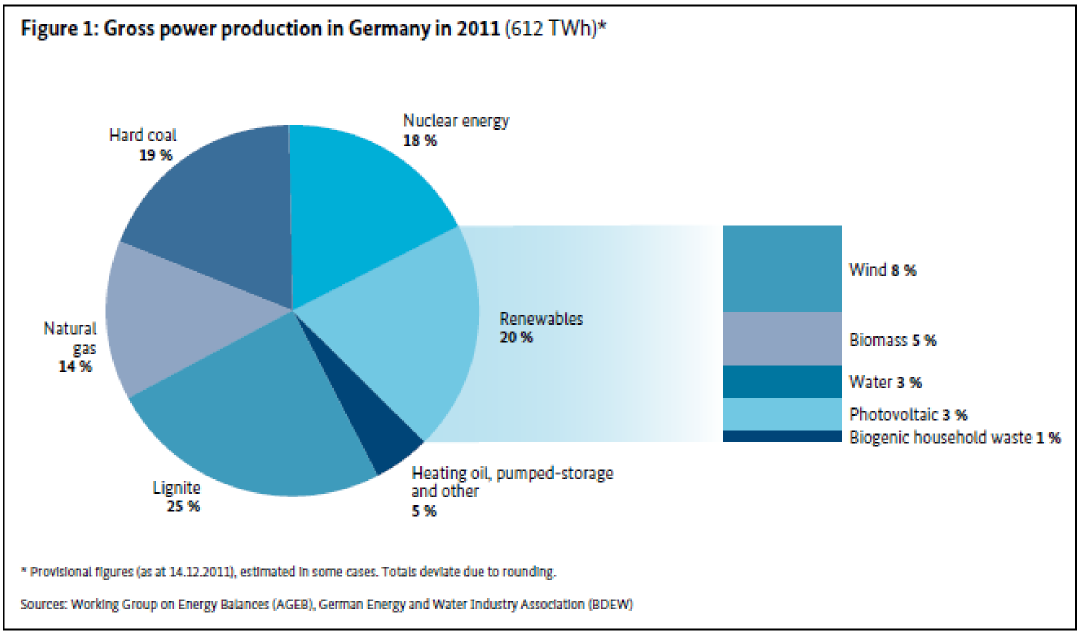
There are large differences in production and consumption between the countries that border the North Sea. Norway is a large net exporter of energy based on oil and gas, just as Denmark. The other countries are net importers with Belgium and Germany at the top with the UK at the other end of the range. The national/regional variations in energy consumption are mainly due to use of different energy carriers (energy types): hydro power dominates in Norway, renewables are relatively big in Germany and Denmark, bio-fuel and waste is significant in Sweden, gas in The Netherlands and oil and natural gas in the UK.

A4.1 Context – Production and Consumption

Belgium**:** The production of energy from primary sources in Belgium was at 740 PetaJoules (PJ) in 2011. The majority (70%) of this production stemmed from nuclear heat, roughly 100 PJ (14%) from renewable and waste resources, of which industrial waste contributed a 94% share. In the same year, gross inland energy consumption in Belgium lay at 2,500 PJ and final energy consumption (excluding energy used by power producers) lay at 1,600 PJ. Industry (34%) and transport (28%) were the largest consumers of the available energy in Belgium (Eurostat, 2013a). The consumption of energy by industry exceeded the European average which lay, in 2010, at 25% (Eurostat, 2013b). In 2011 Belgium relied on 73% of its energy production coming from imports (Eurostat, 2013c).

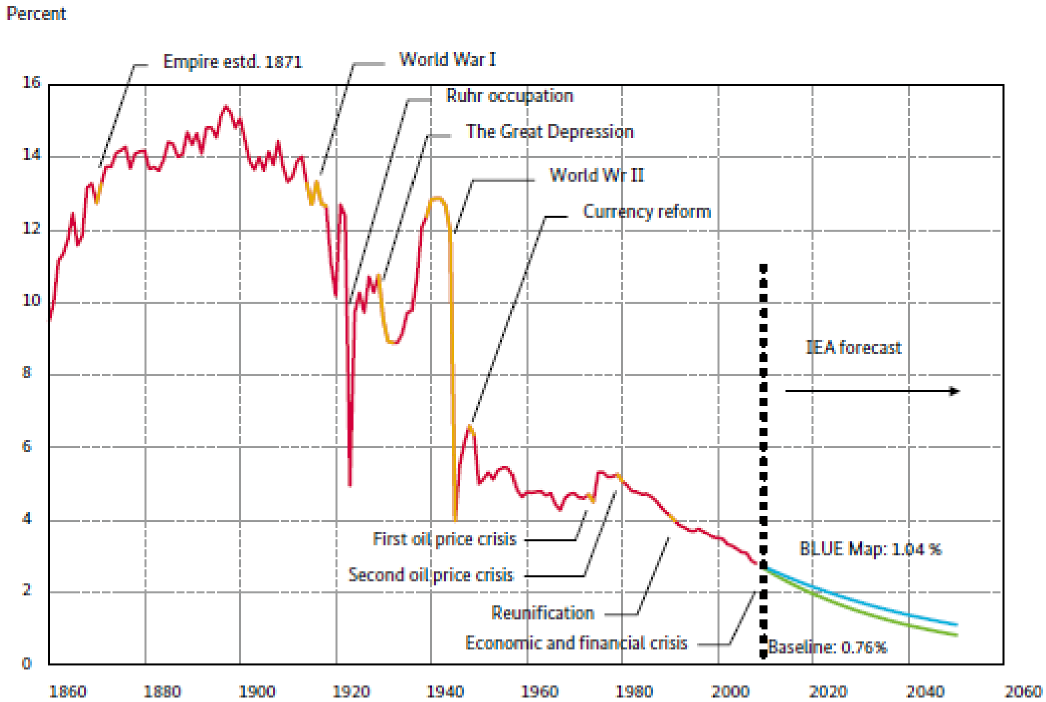
Germany**:** Power production in Germany relies on non-renewable and renewable sources. Renewable energy from wind, biomass etc. makes up for 20% of gross power production (see Figure 4). Lignite is the largest non-renewable source with 25% followed by hard coal 19% and nuclear energy 18%. Germany's share in Global Primary Energy Consumption is decreasing and projected to be become even smaller over the next decades (Figure 5). The production and consumption of electric energy in Germany has increased over the last 35 years, while the shares of the different exploited energy sources varied due to the incorporation of nuclear fuels and renewable sources (Figure 6). Renewable energy now makes up for 12.5% of total final energy consumption in Germany (Figure 7) (BMU 2012).

Figure 4: Contributions to Germany's power production in 2011



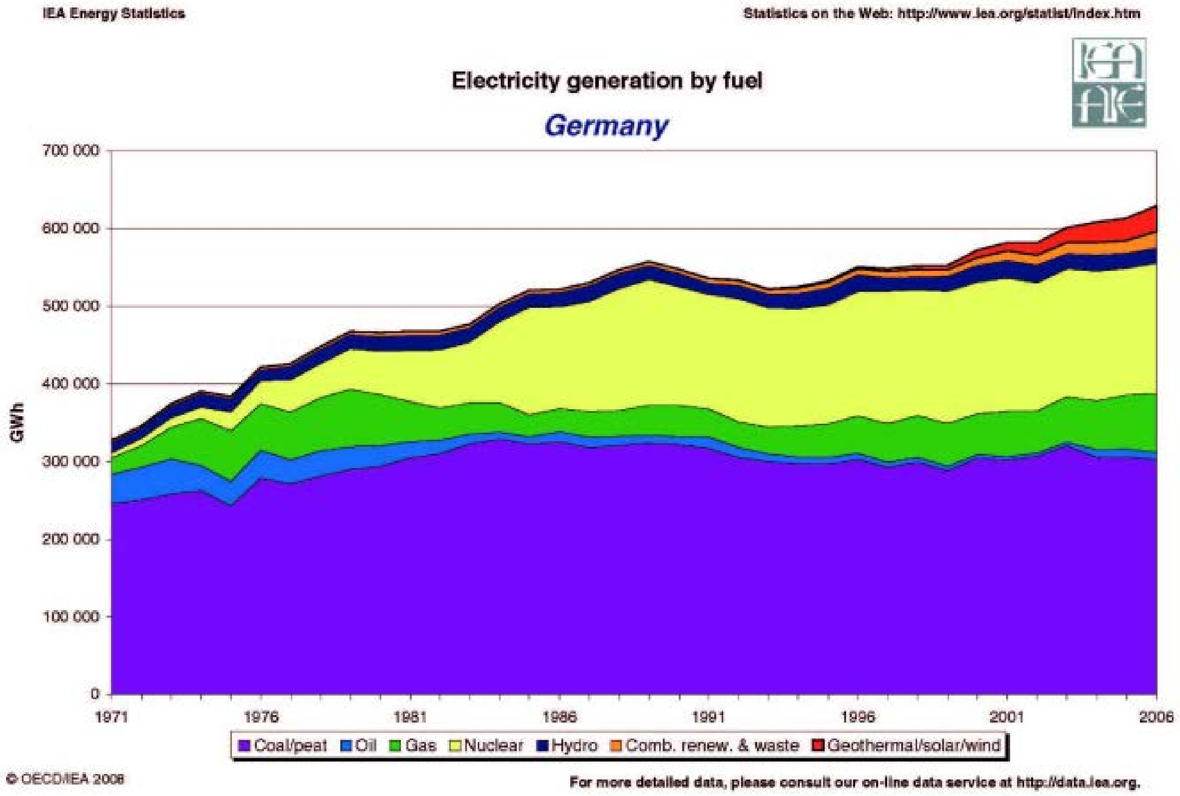
Source: BMWI, 2011a

Figure 5: Germany's Share in Global Primary Energy Consumption



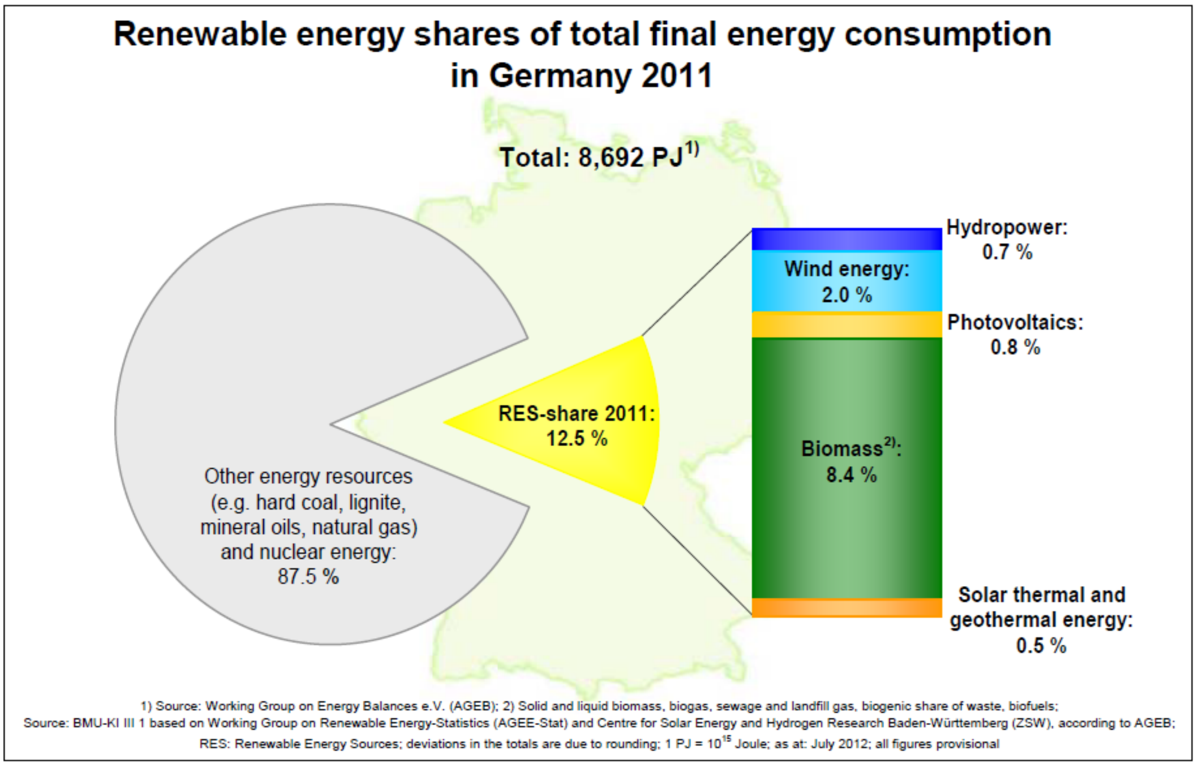
Source: BMWI, 2011a

Figure 6: Historical trends in contributions to overall electricity generation in Germany



Source: BMU, 2012

Figure 7: Contribution to the energy consumption mix in Germany in 2011



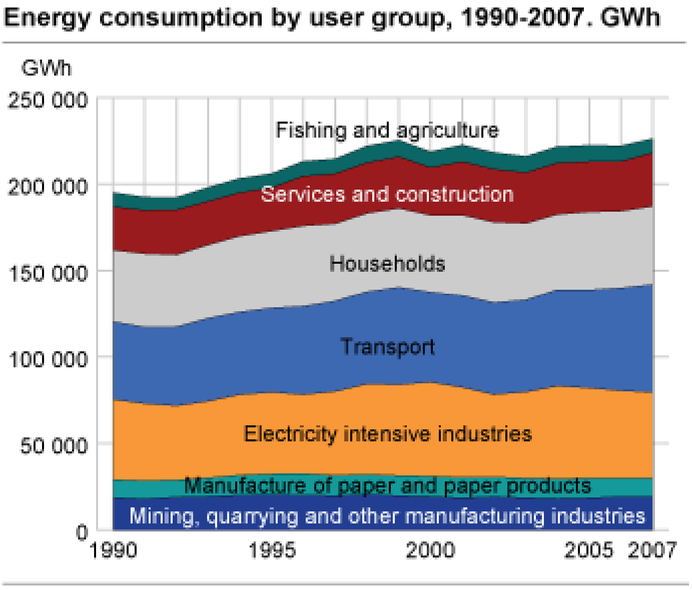
Source: BMU, 2012

The Netherlands: In 2011 the primary production of energy in The Netherlands lay at roughly 2,700 Petajoules (PJ). 90% of this production stemmed from gas, 5% from renewable sources with biomass (3.5%) being the most important among these (Statline, 2013a). In the same year the gross inland energy consumption was 3,250 PJ (Statline, 2013b). Consumption patterns, when looking at the percentage with which sectors participated in the final consumption (2,100 PJ), resembled European averages, with the exception of consumption by agriculture (6% compared to a European average of 2%). Dutch households consumed, compared to European averages, relatively little energy (19% versus 27%). When distinguishing consumption by energy source, gas (45%), oil (38%) and coal (10%) had the largest shares. The export of gas from Dutch gas fields grants The Netherlands, in comparison to other European countries, low energy dependency. The Dutch economy relied in 2011 for 30% upon imports in order to meet its energy needs (Eurostat, 2013).

Norway: The Norwegian energy system utilises both renewable and non-renewable resources. Renewable energy is converted from resources such as water, wind, bio mass and tidal water to electricity or heating. Norway is a large producer of energy and a net exporter but mainly of non-renewable energy such as fossil fuel. Norway is also the sixth largest producer of hydro power in the world and the largest one in Europe (NOU 2012:19). According to the Energy balance sheet for Norway the production of primary energy commodities was 2 314 TWh in 2011. The main bulk of this - 2 058 TWh - which is mainly oil and gas, was exported. Extraction of crude oil and gas on the Norwegian continental shelf amounts to more than 90 per cent of the total production of primary energy carriers in Norway. The third largest energy source is waterfall and wind, but wind power represents only about 1 % of the electricity supply in Norway (http://www.vindportalen.no). There is no energy production from nuclear power in Norway.

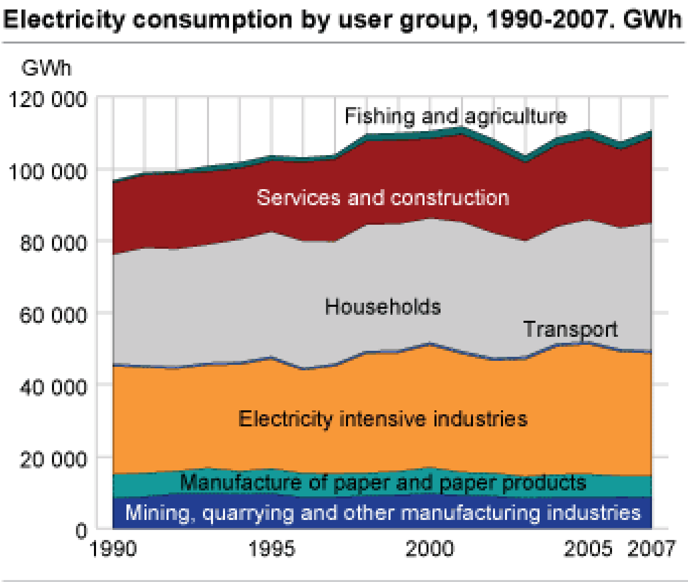
The total energy consumption in Norway amounted to 282 TWh in 2009 (Figure 8). Much of this energy is used in manufacturing industries, households, oil and gas extraction and road transport (Figure 9). In the period 1990-2009, the total energy consumption in Norway rose by 28 per cent. An important reason for the large increase in energy consumption in Norway is the increased activity in oil and gas extraction and road transport (Figure 10) (SSB 2011). Around 50 per cent of the end consumption of energy is electricity and hydropower accounts for about 98-99 per cent of the total electricity production. Petroleum products are the second largest user category with 35 per cent. Transport, energy-intensive industry and households represent the three largest energy consumption user groups. Energy-intensive industry and households (Figure 11) are also responsible for the largest electricity consumption.

Figure 8: Norwegian Energy Consumption, 1990-2007



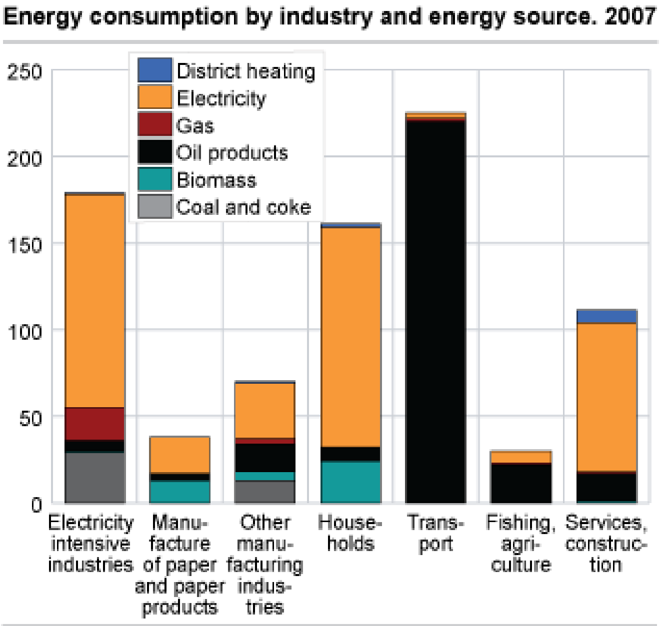
Source: Statistics Norway

Figure 9: Norwegian Electricity Consumption, 1990-2007



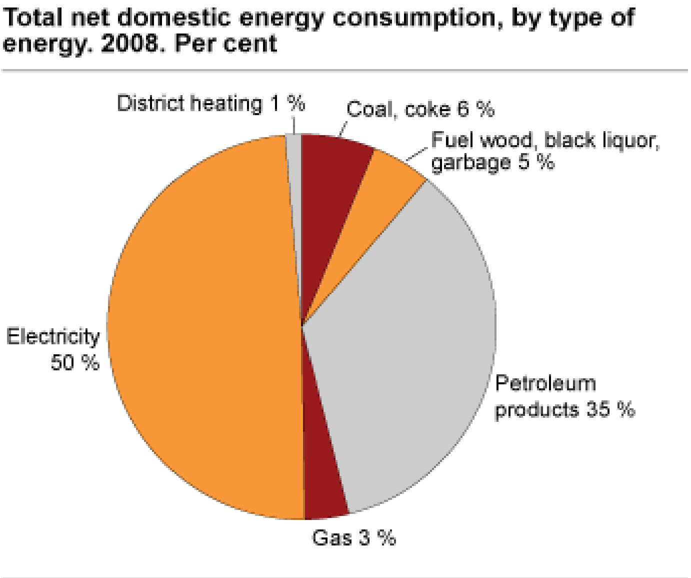
Source: Statistics Norway

Figure 10: Norwegian Energy Consumption by Industry, 2007



Source: Statistics Norway

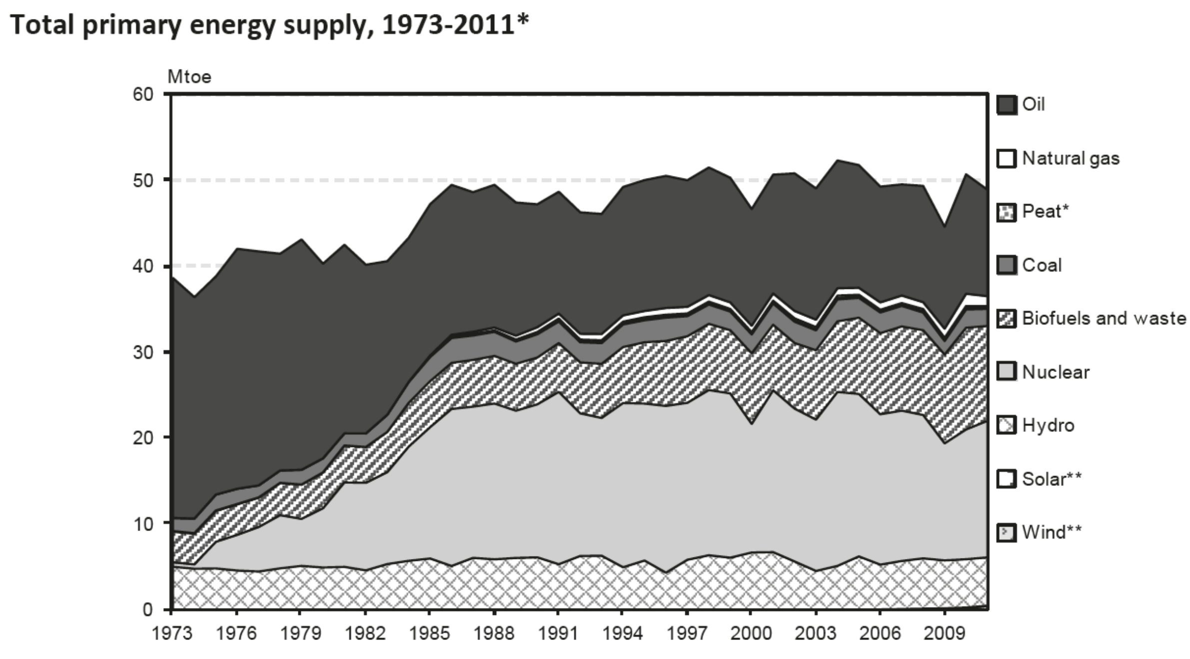
Figure 11: Norwegian Net Domestic Energy Consumption, 2008



Source: Statistics Norway

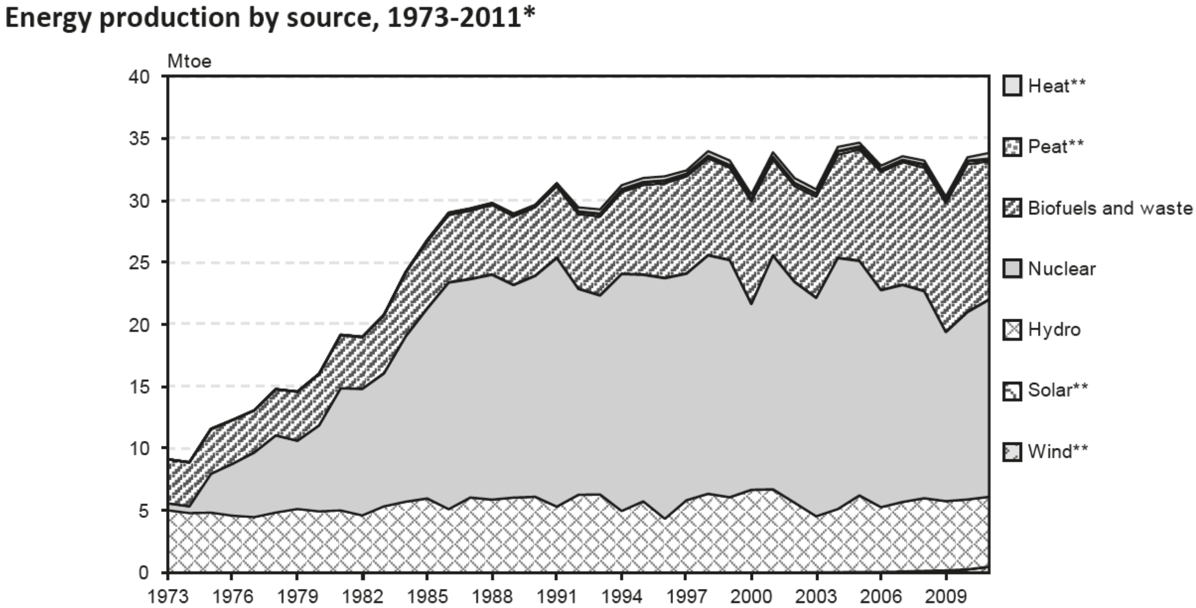
***Sweden*:** In 2011, Sweden's total primary energy supply (TPES) was 48.9 million tonnes of oil equivalent (Mtoe), a level which has remained fairly stable over the last three decades, growing 2.8 % since 2000 and with a sharp drop in 2009 amid the global financial and economic crisis (see Figure 12). Fossil fuels, oil, coal and natural gas, represented 31.8% of TPES in 2011, in addition to 35.5% renewables and 32.5% nuclear. Sweden is the International Energy Agency (IEA) member country with the lowest share of fossil fuels in its energy mix (without nuclear). The average share in IEA member countries was 81% in 2011. Sweden's share of coal accounted for 4.1% and natural gas for 2.4%, compared to the IEA average of 20% and 25% respectively. The TPES per capita was 5.2 toe compared to the IEA average of 4.7 toe. Oil accounts for the lion's share of the fossil fuels supplied to Sweden, amounting to 25.3% of TPES and 78.2% of all fossil fuels. Nuclear makes a large contribution to the Swedish electricity mix, accounting for 15.9 Mtoe or 40.5% of its total electricity generation at the level of 150.5 TWh in 2011 (as shown in Figure 13 below). Other larger contributors are hydropower which represents 44.1% and biofuels and waste with 8.5%. Additional contributors are wind 4%, natural gas 1.2%, coal 0.8%, oil 0.5% and peat 0.4%. Sweden's share of nuclear in TPES was the second-highest among IEA member countries after France. Inland energy production in 2011 was 33.9 Mtoe, approximately 69.3% of TPES while the country relies on 15 Mtoe import, approximately 30.7% of TPES. Figure 14 shows that he industry sector consumed the largest share of energy, accounting for 13.3 Mtoe or 39.3% of the country's final consumption. It was followed by transport (24.1%) and the residential sector (22.5%), while the commercial, public services and agricultural sectors amounted to 14.1% of total final consumption in Sweden in 2011.

Figure 12: Total Primary Energy Supply of Sweden, 1973-2011



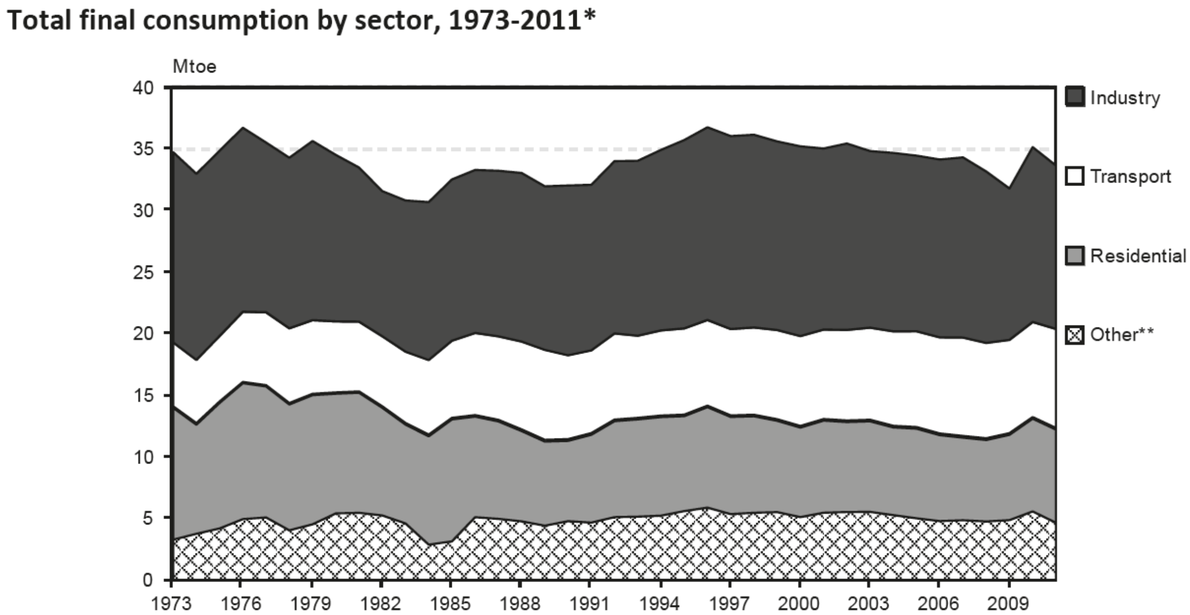
* Provisional for 2011. ** Negligible.
Source: IEA/OECD (2013) Energy Policies of IEA Countries: Sweden, 2013

Figure 13: Energy Production in Sweden by Source, 1973-2011



* Provisional for 2011. ** Negligible.
Source: IEA/OECD (2013) Energy Policies of IEA Countries: Sweden, 2013

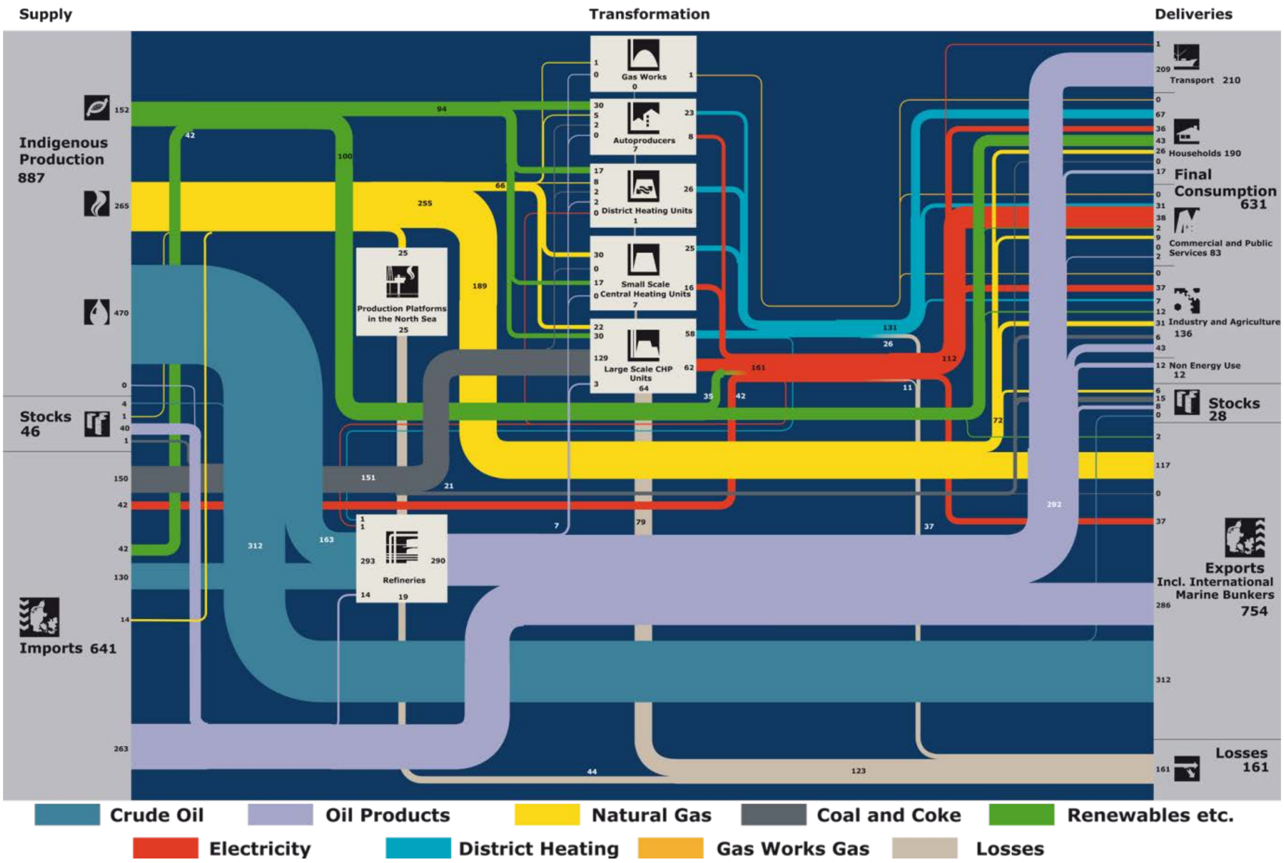
Figure 14: Total Final Energy Consumption in Sweden by Sector, 1973-2011



* Provisional for 2011.
** *Other* includes commercial, public service, agricultural, fishing and other non-specified sectors.
Source: IEA/OECD (2013) Energy Policies of IEA Countries: Sweden, 2013

Denmark: The domestic energy production in Denmark is based on crude oil (470 PJ), natural gas (265 PJ) and renewables (152 PJ) (all numbers: 2011). Denmark is a net exporter of energy, mainly of fossil fuels such as crude oil, oil products and natural gas. Nonetheless Denmark also imports energy. These imports mainly encompass processed oil products, crude oil to operate Danish refineries with full capacity, and coal. Nearly one quarter (42 PJ) of the renewable energy consumed in Denmark in 2011 was imported (Figure 15).

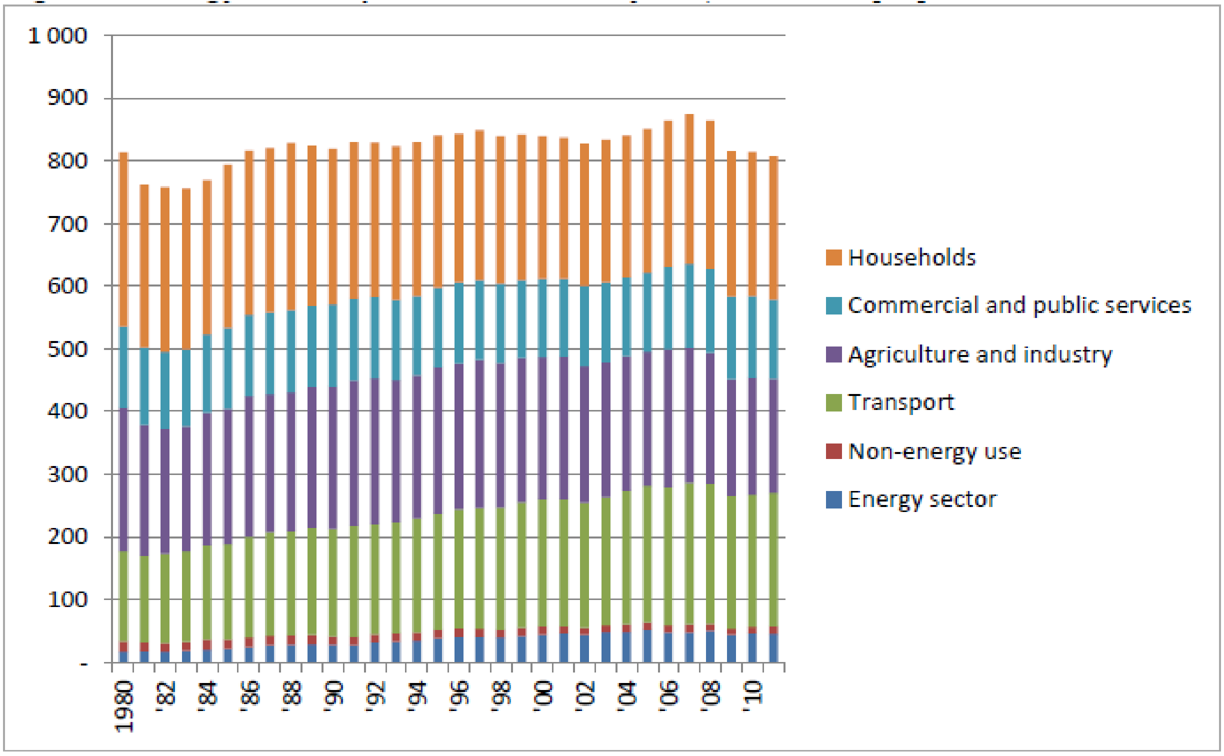
Figure 15: Energy Flow in Denmark, 2011



Source: ENS, (2013), all numbers in Peta Joule (PJ)

Denmark's energy consumption rests upon a small number of energy carriers. Before transformation (e.g. production of electricity and heat) oil has the largest share with 39% in 2011 (Figure 16) followed by renewables with 22%, natural gas with 20% and coal with 17%. After transformation oil remains the largest energy product with 37% followed by electricity with 32 %, natural gas with 12% and district heating with 11% (all numbers: 2011). Renewables have a share of 8% in these statistics which considers the consumption of renewables by end-users, mainly households. About one half of the energy provided by renewables is transformed into heat and electricity (cf. Fig. 15).

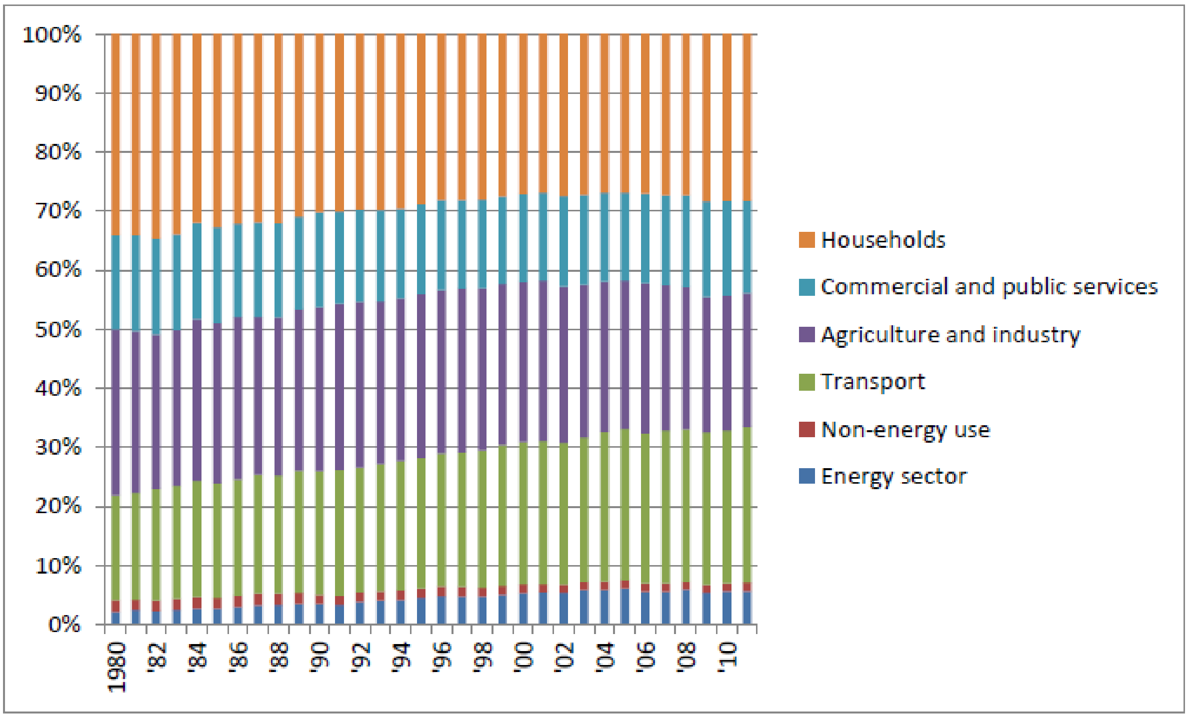
Figure 16: Energy consumption in Denmark by use, 1980-2011 [PJ]



Data source: ENS, 2013

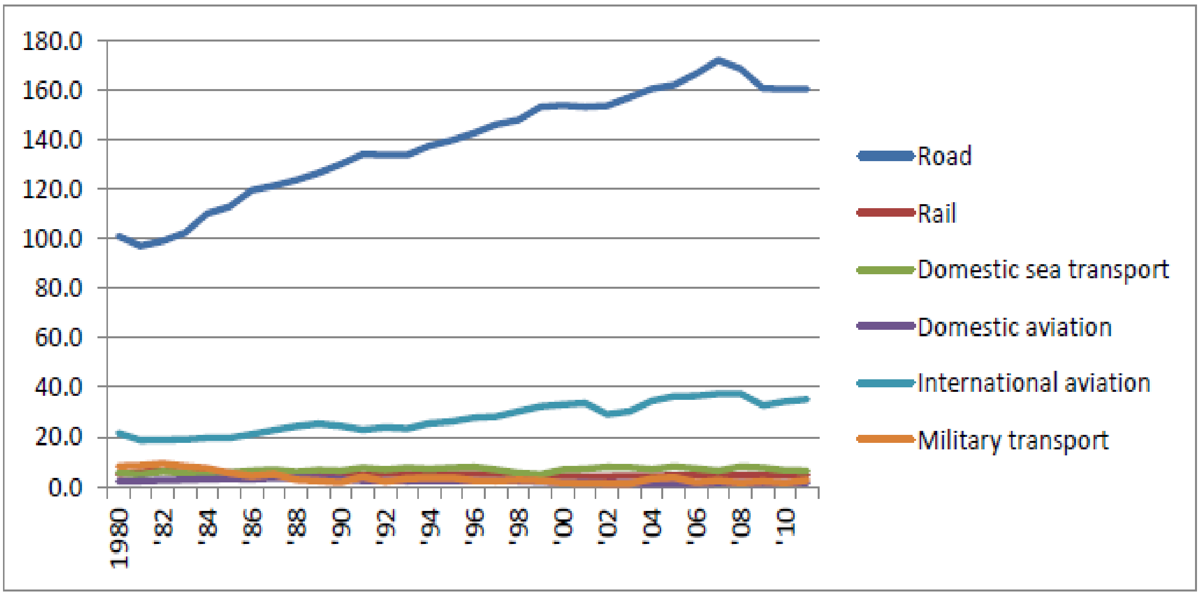
The total consumption of energy in Denmark has been relatively stable over the last three decades. However, the share of single uses in total energy consumption has partly changed (Figure 17). In particular the transport sector has shown an increase from 18% (1980) to 26% (2011) (144 vs. 213 PJ). This development is mainly driven by increasing consumption in road traffic (Figure 18). Another driving sector for increasing energy consumption is the energy sector itself. Its share in total energy consumption increased from 2% (1980) to 6% (2011) (17 vs. 45 PJ). The increase in energy consumption in these two sectors is compensated by a slightly decreasing consumption in agriculture and industry, where the share has fallen from 28% (1980) to 23% (2011) of which about 2% seem to be caused by the global economic slowdown since 2008 (228 vs. 183 PJ). Energy savings have been achieved mainly at households whose share decreased from 34% (1980) to 28% (2011) (277 vs. 228 PJ). While the progress in energy savings in households has been achieved mainly prior to the year 2000 this situation is different in the agricultural and industrial sectors. Here energy savings are noticeable in national consumption statistics mainly from the year 2002 onwards while savings in households stagnate. These numbers are based on total consumption. Under consideration of growth of both the Danish economy and population an increase of energy efficiency can be stated for all sectors. On average energy efficiency in Denmark increased by 1.1%/year since 1990.

Figure 17: Share of total energy consumption in Denmark by use 1980-2011[%]



Source: own calculations

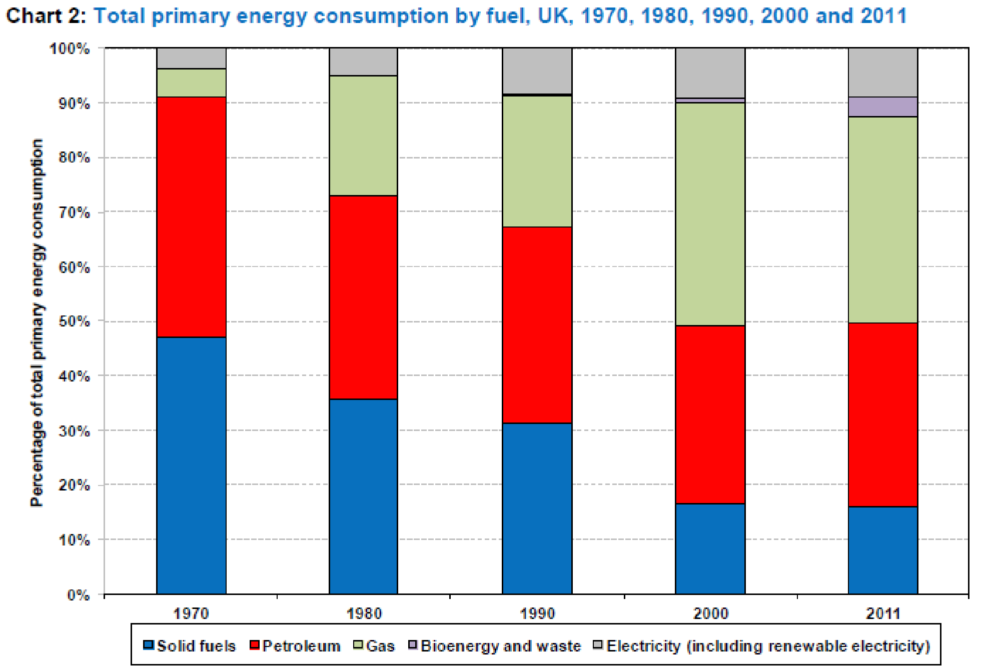
Figure 18: Energy consumption for transport in Denmark by type, 1980-2011 [PJ]



Source: ENS, 2013

The UK: In 2009, total primary energy supply (TPES) in the UK was 197 Mtoe and natural gas had the highest share with 39.7%, oil 32.5%, coal/peat 15.2% nuclear 9.2% and renewable 3.3 % (IEA 2011). In 1970, fuel consumption was dominated by solid fuels use (47 per cent of all energy consumption in the UK) and petroleum (44 per cent), with gas contributing a further 5 per cent and electricity 4 per cent. By 1980 the fuel mix had evolved with natural gas making up 20 per cent of all energy consumption in the UK, solid fuels (36 per cent) and petroleum (37 per cent). In 1990, the split between fuels was similar to that in 1980; however by 2000 with changes in electricity generation, natural gas consumption had become the dominant fuel responsible for 41 per cent of all energy consumption in the UK, whilst solid fuels had fallen from 31 per cent in 1990 to 17 per cent in 2000. By 2011 more renewable fuels had entered the energy mix for both electricity generation and bioenergy consumption. Figure 19 shows the change in fuel consumption every ten years between 1970 and 2000, and 2011 (DECC, 2012).

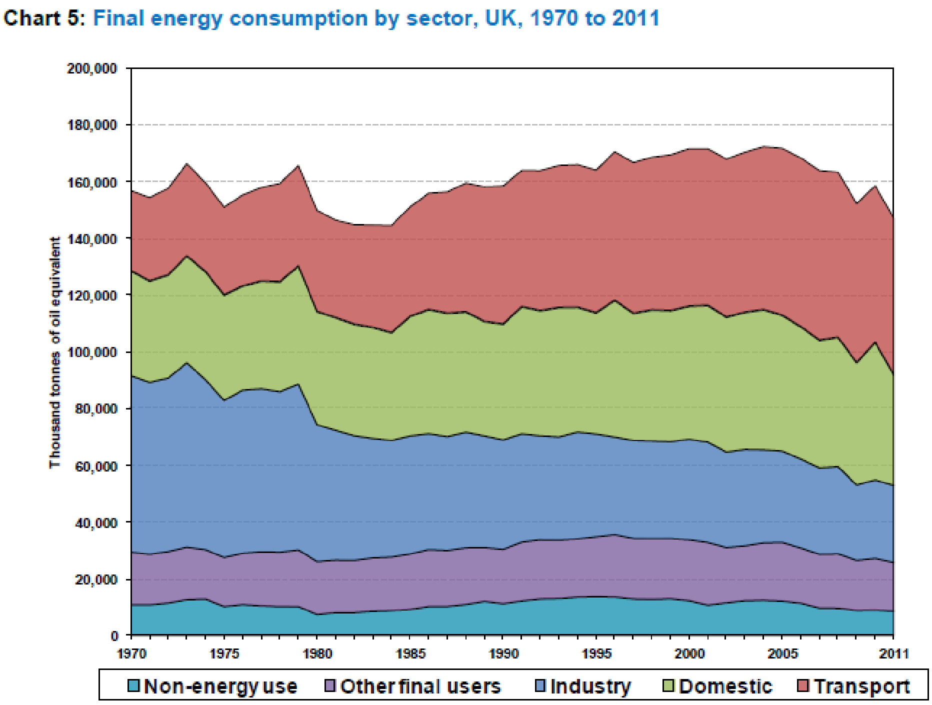
Figure 19: Total Primary Energy Consumption in the UK, 1970-2011



Source: DECC, ECUK Table 1.7

Figure 20 shows the changing levels of energy consumption by sector. In 1970, the industry sector was responsible for 40 per cent (62,333 thousand tonnes of oil equivalent) of total final UK consumption, followed by the domestic sector 24 per cent, transport 18 per cent and other final users 12 per cent (mainly agriculture, public administration and commerce), with 7 per cent being used for non-energy purposes. However, by 1990 industrial consumption had fallen to 24 per cent of total final energy consumption in the UK, whilst transport consumption had risen to 31 per cent. Domestic use had increased slightly to 26 per cent whilst other final users and non-energy use remained at 12 per cent and 7 per cent respectively. The decreasing trend in industrial consumption continued and in 2011 was 18 per cent of total final energy consumption in the UK, with transport consumption responsible for 38 per cent and domestic 26 per cent.

Figure 20: Final Energy Consumption by Sector in the UK, 1970-2011



Source: DECC, ECUK Table 1.4

A4.2 Drivers of Energy Policy

The main drivers of the energy policy in the countries bordering the North Sea are drawn up in several common EU documents, such as the Energy 2020 strategy and the Energy Roadmap 2050. This implies a policy which aims to achieve a low-carbon economy more based on renewable energy, increased energy efficiency and improved security of supply. Although there are many similarities between the North Sea countries, there are also some differences with regard to drivers of energy policy.

Belgium: Belgium is committed to goals as they are set out by the European Union and the Kyoto protocol. Targets for CO_2 reductions differ in regions. The national benchmark for the share of energy from renewable resources in energy consumption is set at 13% in 2020. Belgium has in 1999 announced to phase out the utilisation of nuclear power. As in other European countries, this development is expected to lead to a more important role of renewable energies in energy market structures. The high dependency of Belgium on the import of energy makes this development specifically urgent. The Belgium federal government promotes the European Emissions Trade System (ETS). The effect of applications is monitored at the regional level. Specifically in the highly industrialized Flemish region effects are (as the environmental balance in general) strongly influenced by ups and downs of economic development.

Germany: The Federal Government of Germany set out its binding Energy Concept in September 2010 with an objective to achieve the transition to an era of renewable energy latest at 2050. The Energy Concept's guidelines opt for an environmentally sound, reliable and affordable energy supply within that time frame. The long-term objectives are of particular importance to the future direction of energy research policy (BMWI, 2011b). The key targets for 2050 are as follows: (i) Reduce emissions of greenhouse gases by between 80% and 95% compared with 1990 (by 40% by 2020), (ii) Cut primary energy consumption by 50% compared with 2008 and (iii) Curb overall electricity consumption by approximately 25% compared with 2008 (by 18% by 2020), (iv) Ensure that energy from renewable sources accounts for 60% of gross final energy consumption (18% by 2020) or 80% of gross electricity consumption (at least 35% by 2020). The energy agendas set at all the levels of the German political and administrative system (from Federal via -State to -regions and municipalities) consider this framework. However, the energy strategies and schemes reflect the different natural and societal conditions and the geographical and political context.

***The Netherlands*:** Policies to achieve benchmarks are largely taken by the Dutch Ministry of Economic Affairs. Many measures seek to realize CO_2 reductions while sustaining the important role that the Dutch grey energy sector takes in the production, refinement and trading of energy carriers in North West Europe. The most important building block in Dutch energy policies is the European Emission Trade System (ETS). The Dutch government intends to broaden the application of this system by including other than the up until now defined economic sectors in the trading of rights. Gas plays a significant role in Dutch energy market structures and in the Dutch economy and it causes relatively low CO_2 emissions. The Dutch government supports a transition of the gas sector from focusing on production to trading and refinement of gas by facilitation of carbon capture and storage (CCS), transport capacities and diplomatic and trade missions (Ministerie van Economische Zaken, Landbouw & Innovatie, 2011). Increased use of renewables has also been encouraged by subsidies and obligation of the transport sector to replace fossil fuels with bio-fuels. All Dutch provinces that are part of the North Sea region as well as a range of governance arrangements in the area have drawn up structural visions to guide spatial development that leads to more sustainable production and consumption of energy. Regional energy self-sufficiency is a re-occurring theme of these visions under construction. There are, however, currently neither regional energy authorities nor policies to address specific trends in regional energy production and consumption.

***Norway*:** Norwegian energy policies are closely interrelated with the other Nordic countries and there are several common features in their energy policies. Norway has, as the other Nordic countries very long-term ambitious goals towards decarbonising their energy systems. Decarbonisation is vital in the areas of electricity generation and energy use in industry, transport and buildings; it also requires deployment of carbon capture and storage (CCS) for cost-effective reduction of greenhouse-gas (GHG) emissions (IEA, 2012). The use of energy in Norway in a long-term perspective will be influenced by factors such as economic growth, industrial structure, demographic development, technological development and policies. The population is estimated to grow from 5 million in 2013 to 6 – 8 million in 2050 (Statistics Norway). This in itself will lead to increased consumption but since the economy probably will be less energy-intensive than today and, since the strongest population growth will be in the largest cities, increased urbanisation together with more energy-efficient economic production and living may contribute to reducing the total energy consumption. However, this requires increased energy efficient use and more production based on renewable energy sources. Norway has high ambitions and has also implemented several measures which will contribute to reduce total use of energy and increase renewable energy production and use.

***Sweden*:** Sweden’s energy policy – integrated with climate policy – is guided by two government Bills 2008/09:162 and 163) which were approved by the Swedish Parliament in 2009. The bill on *En integrerad energi- och klimatpolitik* (“integrated climate and energy policy”) sets out ambitious targets in support of and beyond the 20/20/20 objectives of the EU, in pursuit of a sustainable policy for the environment, competitiveness and long-term stability (Energy Policies of IEA Countries: Sweden 2013 IEA/OECD Paris, 2013. 34) . Short- to medium-term targets for 2020 are 40% reduction in greenhouse gases

(GHGs) or about 20 million tonnes of carbon dioxide equivalent (Mt CO_2-eq), compared to 1990, to be achieved outside the European Union Emissions Trading Scheme (EU-ETS) with two-thirds in Sweden and one-third by investments in other EU countries or the use of flexible mechanisms; at least 50% share of renewable energy in the gross final energy consumption; at least 10% share of renewable energy in the transport sector; and 20% more efficient use of energy compared to 2008. The long-term priorities are that by 2020, Sweden aims to phase out fossil fuels in heating; by 2030, Sweden should have a vehicle stock that is independent of fossil fuels. Sweden is committed to develop a third pillar in electricity supply, next to hydro and nuclear power, with increased co-generation, wind and other renewable power production to reduce vulnerability and increase security of electricity supply; and by 2050, the vision is that Sweden will have a sustainable and resource-efficient energy supply with zero net emissions of GHGs. Sweden sees a role for natural gas as a transition fuel in industry and co-generation. The Swedish Environmental Agency, supported by the Swedish Energy Agency and other national authorities, presented a proposal for a Climate Roadmap in December 2012. The roadmap identifies scenarios for achieving the long-term 2050 priority and is to be adopted in the course of 2013.

***Denmark*:** In November 2011 the Danish government passed an energy strategy (Danish Government, 2011) aiming for an ambitious goal: the entire energy supply – electricity, heating, industry and transport – is to be covered by renewable energy by 2050. This goal of 100% renewables has been renewed by the Energy Agreement passed in March 2012 (KEMIN, 2012). With this strategy the Danish Government plans to over-fulfil Europe’s 20-20-20 goals. The national energy strategy includes a few milestones which illustrate how the implementation of this goal shall be achieved. Energy savings play a major role to achieve this strategy. By the year 2020 the share of renewables in final energy consumption shall be more than 35% and approximately 50% of the electricity consumption shall be supplied by wind power. To achieve this both offshore and onshore wind farms shall be expanded and new planning tools shall encourage an increase in net capacity of onshore wind power (repowering). Even more important than wind farms shall be the role of biomass, e.g. as a substitute for coal and natural gas in combined heat and power plants. Denmark’s economic policy encompasses intensive green growth ambitions including intensified development of various kinds of renewable energy products. However, competitiveness has deteriorated in the past decade and productivity growth has been weak, eroding potential growth (OECD, 2013). The OECD (2013) currently states a potential of these green growth ambitions to translate into new sources of growth, but recommends also to review energy and climate change policies to achieve better results at low cost. Further challenges are the development of storage techniques and facilities as well as the reorganisation of electricity and pipeline networks. Another yet unsolved question is how the increasing consumption of oil products by the transport sector, especially road traffic, can be decreased and substituted by an alternative energy carrier.

***The UK*:** Central Government sets the broad approach to energy policy and whilst most of its activities are designed to shape domestic production and consumption patterns it is interesting to at least note some of the production challenges are in part being met by international collaborations. For example, recently (January 2013) the UK and Irish governments have signed a Memorandum of Understanding focusing on the potential of importing substantial gigawatts (GW) of green energy (predominantly produced by wind) from Ireland to the UK. The broad policy framework is set out in the Renewable Energy Roadmap which was updated in December 2012. Given the broad range of producers and consumers the incentive packages to encourage production and reduce consumption are very wide ranging. The following paragraphs deal with both consumption and production issues to provide a flavour of the incentives on offer. It is not intended to be a comprehensive summary.

Furthermore as noted earlier, whilst the direction of travel is the same the devolved administrations (most notably in this case Scotland) are able to set their own policy objectives and within their own devolved competencies provide the framework for this to happen. For example, the aspiration that 100% of Scotland's electricity demand will be generated by renewables is driving the development of both onshore and offshore wind farms and with it local planning controversies.

A5. Conclusions

Energy has been at the centre of EU policy since the European Coal and Steel Community (1951) and the Treaty of Rome (1957), which established the European Atomic Energy Community (Euratom) alongside the European Economic Community (EEC). A major step was taken by the Treaty on European Union (the Maastricht Treaty) in 1992 by giving the Community the task of creating ‘trans-European networks’ in energy, telecommunications and transport. In 1994 eight priority energy projects of European significance were identified. More recently, the Treaty of Lisbon has enhanced the EU’s objectives for energy policy. The current policy debate centres on Energy 2020 and the Energy Roadmap 2050. The EU strategy focuses on *energy efficiency*, achieving a 20% saving by 2020; an *integrated energy market* and supporting the 20% target for renewable energy supply by 2020; *empowering consumers* and ensure energy security; extending Europe's leadership in *energy technology and innovation* related renewable energy; and strengthening the *external dimension of the EU energy market* by reaching agreements with neighbours who adopt the EU market model.

The policy debate in Europe has changed somewhat in past years. The economic crisis has redirected more of the political attention from climate change issues to economic recovery. The Emission Trading Scheme (ETS) is in turmoil and global investments in renewable energy fell in 2012, carbon Capture and Storage (CCS) has not taken of and there was a shortfall in delivering the EU’s 2020 energy efficiency target. However, the 20-20-20 targets seem to be over-delivered by 2020 but mainly due to economic recession and the goal of 80-95 % decarbonisation by 2050 is still in force (Hanrahan, 2013). The key challenges for European energy policy are related to target setting 2030, balancing national and European dimensions, competiveness, energy security, the EU position for a 2015 global deal, policy coherence and getting the policy right.

Innovation is a key driver in the transition to a green, sustainable economy and the *sustainability transitions perspective* is a highly relevant research approach to this fundamental challenge. This perspective indicates that realising a new energy system based on renewables and a green economy more in general will require fundamental socio-technical changes which imply a radical transition towards a more sustainable society. Innovation is a key driver in the transition to a green economy and the energy sector will be critical to achieving greener growth.

There are large differences in production and consumptions between the countries that border the North Sea. Norway is a large net exporter of energy based on oil and gas and Denmark is also a net exporter. The other countries are net importers with Belgium and Germany on the top with the UK in the other end of the range. The national/regional variations in energy consumptions are mainly due to use of different energy carriers, hydro power dominates in Norway, renewables are relatively big in Germany and in Denmark, bio-fuel and waste is significant in Sweden, gas in The Netherlands and oil and natural gas in the UK.

The main drivers of the energy policy in the countries bordering the North Sea are drawn up in several common EU documents, such as the Energy 2020 and the energy Roadmap 2050. This implies a policy which aims to achieve a low-carbon economy more based on renewable energy, increased energy efficiency and improved security of supply. Although there are many similarities between the North Sea countries, there are also some differences with regard to drivers of energy policy.

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Annex B: Energy Data and Mapping

B1. Energy Supply and Demand in the North Sea Region: Data Availability and Data Gaps

In order to produce maps of energy data for the North Sea Region, a first activity has been to analyse the potential sources of energy data, using a multi-scale approach. An initial overview of potential data sources was presented in Annex 2 of the Inception Report. First, different sources at international level were analysed, including mainly databases generated and updated by international organizations and boards, databases generated by research centres or enterprises and outputs from international collaborative projects. In the case of international projects the information produced has, in some cases, a good quality - that is the case of ESPON projects ReRisk, Climate or Greeco, however these cases also have problems in that they are not devoted to provide data regularly and hence there is no guarantee of updating. In the case of research centres (mostly funded by European Commission), the problem is that their goal is to assess present datasets rather than generating datasets, as JRC's Institute of Energy and Transport does. Sometimes both projects and research institutes face a lack of resources to update the information generated in their research projects. Enterprises are more focused on specific issues of their interest and the datasets they generate are not free to use, for example good energy infrastructure maps have been generated by Infield Systems Ltd or Wood Mackenzie.

The most important international organizations and boards providing energy data are either energy related organisations or statistics agencies. In both cases the data available is complete and the indicators provided are very well organized. As stated in Annex 2 of the Inception Report, the main organizations where consistent data exists are Eurostat and the International Energy Association (IEA, on behalf of National Statistic Offices and other energy institutions). The datasets from these sources are complex and useful for our aims in the North Sea STAR project, being the depiction of energy production and consumption in the region

The data produced by these two organizations is sufficient to cover the state of production and consumption of energy at national level because they cover almost all thematic fields related to energy. The connections between datasets of both organizations are clear, with Eurostat feeding into the database of the IEA. This coherence between databases decreases the uncertainty in filling the gaps between databases if needed and gives more robustness to the datasets generated. That is why the main statistics used for evaluating the state of the energy at national level (in this project) have been those produced by Eurostat.

The North Sea Region, as defined in the North Sea Programme, is a maritime region implying several coastal administrative units in some cases smaller than a country. The second goal, hence, was to find data at subnational level to have a clearer and more precise picture. However, no international organization was able to provide data related to energy at sub-national level. Therefore the sources for these datasets are the national/local statistical offices for every country of the North Sea Region. The North Sea STAR project team performed a search of their national statistical institutes and energy boards to find out if any further information was available. The results of this exercise (again, reported in Annex 2 of the Inception Report), was diverse depending on the country and on the thematic field, but in most cases the availability of energy data at a sub-national level is poor and not always coherent and compatible

The research showed that for the most important indicators (data on production, consumption, electricity generation and energy intensity) most of the countries of the North Sea region don't have available data at sub-national level. Denmark, Germany, Netherlands and Norway don't have data of these thematic areas at regional level. For those macro-figures Sweden has data on energy supply and consumption, UK has data at sub-national level on energy consumption.

Some specific datasets are provided by different countries at regional level, such as potential of wind energy or capacity of inland wind turbines (Belgium), energy budget and projections for solar energy (Germany), wind power or average consumption of gas per household (Netherlands) and renewable energy production (Sweden). The cases of Belgium and the UK are special in the sense of providing NUTS2, NUTS3 or LAUs data for only specific territories (e.g. Flanders, Wales). Table 2 (below) indicates the availability of data at sub-national level. The factors determining the availability of data are diverse. The data provided by the national offices of energy or statistics is influenced by the interests of the countries. Therefore, in terms of putting together national/ local datasets in a regional / North Sea context, a major problem is data comparability.

Table 2: Data availability at sub-national levels

	Data on production and consumption at sub-national level	Other ancillary data at sub-national level	Intra-regional disparities in the provision of data
Belgium	NO	YES	YES
Denmark	NO	NO	NO
Germany	NO	YES	NO
Netherlands	NO	YES	NO
Norway	NO	NO	NO
Sweden	YES	YES	NO
UK	YES	YES	YES

National statistical offices do not provide the same indicators in different countries. For example, UK's DECC provides data related to oil and gas by oil field and gas facility. At the same time, Norway, being a major producer of fossil fuels does not offer data about the location of their oil fields or gas facilities. Also, the size of the country seems to have an influence on the availability of data at different administrative levels. Small countries such as Belgium, Denmark or the Netherlands appear to have less data at sub-national level than bigger ones. Differences between the data compiled by different regions have been found, as is the case of Flanders and Belgium, or the case of Scotland (NUTS1 regions with non-disaggregated data) and England (NUTS1 region with data disaggregated into NUTS2 regions). However, the main problem seems to be a general lack of interest from the countries to provide such energy statistics at a regional level. The result is that, with the information now available it is difficult to draw a picture of the supply and demand of energy at subnational level, and due to the size of some countries the national scale is far too small to provide useful conclusions for the North Sea Region.

The countries that provide the most subnational data are Sweden and United Kingdom. In Table 3 below the difficulties in providing comparable indicators for a common region are shown. No indicator is available for both countries, as energy consumption is not available at NUTS2 level for Scotland. Besides, the statistical definition of the indicators can have small variations (e.g. Final energy consumption is not the same as Energy Available for Final Consumption)

Table 3: Comparison of Sweden and UK energy indicators

	Sweden	***UK***
Energy supply	NUTS2 and NUTS3	NUTS0
Renewable energy production	NUTS2 and NUTS3	N/A
Installed capacity of sites generating electricity from renewable sources	N/A	NUTS1 (Scotland) and NUTS2 (England)
Energy consumption	NUTS2 and NUTS3	NUTS1 (Scotland) and NUTS2 (England)

Regarding energy infrastructures, the lack of information is also notorious. Some relevant maps were produced by private companies, as in the above mentioned examples, but the methodology is not easily accessible and the information is not available free of charge.

B2. Mapping Activities

For the purposes of this Interim Report a series of maps were produced from Eurostat information. Based on the publication EU Energy in figures, Statistical Pocketbook (2011, 2012 and 2013[1]) and the formulas to calculate the energy indicators provided by Eurostat, 4 indicators have been generated and represented in maps:

- Primary production for Europe and Primary production by Fuel for North Sea Region
- Import dependency by fuel for North Sea Region
- Gross inland consumption by fuel for North Sea Region
- Final energy consumption by fuel for North Sea Region

The selection of indicators was performed by energy and policy experts from the range of indicators provided by Eurostat.

In addition, mapping of NSR project partners involved in energy related projects has been undertaken, using lists of project partners from the North Sea Region website and NUTS2 regions as a common basis for locating partners that may be regions, municipalities, academic or other public institutions and private sector bodies.

B3. Data Gaps

A major problem in trying to produce maps of energy data for the North Sea Region is that national statistics are diverse, making it difficult to build up a dataset with regional data for the whole area. In order to try and overcome these difficulties it has been necessary to analyse thoroughly the data provided by the national statistic offices compiled by members of the project team, which are those statistics provided on a regional basis. The coincidences between data from different countries are few.

In order to reduce data gaps in future, the way to proceed would be to agree on a specific core set of indicators and apply a top-down approach. National statistical offices or energy boards should be committed to compile these statistics. With energy being a sensitive issue (sometimes commercially sensitive), the recommendation is to have a very limited number of core indicators and geographical information about energy facilities (production and transportation, including main national grids). These indicators could help to understand what the regional energy balance is.

[1] EU Energy in figures, Statistical Pocketbook (2011, 2012 and 2013).
http://ec.europa.eu/energy/publications/doc/2012_energy_figures.pdf

The Eurostat Statistical Pocketbook is an annual publication of Eurostat showing the main figures in the energy sector for Europe. Some key indicators are selected from the Eurostat comprehensive statistics every year. Minor changes have been observed between different editions but a number of indicators remain from one edition to another. This set of core indicators should be used as the basis for a recommendation to the national statistical offices or boards to gather energy indicators at regional level.

The Eurostat Pocketbook provides a good starting point to define a core set of indicators, and a thorough analysis should be undertaken by experts to define what the most relevant indicators for future collection are. Production, transformation and consumption of energy are maybe the clearest themes to be covered. However, energy can be consumed without being processed into electricity. This is the case of heating and water heating from geo-thermal facilities. In addition, transport is the largest consumer of energy directly from processed commodities without being transformed into electricity. Finally, information about infrastructure (location and power of infrastructures devoted to energy) would also be useful, as environmental and social impacts depend on the specific location of energy infrastructures. Energy experts should be involved in the definition of most relevant indicators.

B4. Usefulness of Data Sets for Monitoring Purposes

At the moment, for monitoring purposes, data provided by Eurostat is fully comparable. Although only present at NUTS0 level, Eurostat datasets are stable in the time and the time series are long. The indicators produced at this level can be easily updated and fit the requirements for monitoring purposes at the North Sea level.

As far as there is no uniform data at sub-national level it is not possible to assess the monitoring potential of the set of indicators. If a methodology to build up regional indicators form national datasets is developed, the potential for monitoring would depend on the indicators (proxies) used to assign the values of energy to every region and/or to every specific place. Such a methodology needs to be data driven, and needs to focus on the comparability of the datasets among the different countries/ regions.

B5. Possibilities for Building up Data Sets from National to North Sea Level

Potentials

To build up datasets from national level to regional level is one of the possibilities to solve the problem of lacking regional datasets. A potential method for building up regional data is to use proxies to assign national data to the different regions of the North Sea or even to a predefined grid, for example using a 1km^2 grid to map the datasets in a regional North Sea context. The success of this methodology would depend on the different groups of indicators such as: energy production, energy consumption, electricity, heat, CHP and transport.

Primary energy production is an indicator for which applying a proxy is expected to be difficult because data for production from different production plants (or the energy grid) is needed. The way to downscale national data into regions would be to set the different origins (by fuel: solid, petroleum, gas, nuclear, renewables and waste non-renewables) of energy production and to use a proxy to approximate the location of such activities spatially. Location and installed capacity of nuclear plants would be the proxy for downscaling the national figure of energy production by nuclear. Location and installed capacity of thermal power stations would be the proxy for downscaling the analysis units of energy production by fossil fuels, oil and gas, and so on. Regarding electricity, heat and CHP, information about the power of plants would be absolutely necessary to assign production data to the regions, however intra-regional flows through the grid system would also need to be taken into account.

The downscaling of energy consumption to provide a lower level indicator is an easier problem to resolve. Consumption depends mainly on human activities. Domestic consumption will depend on the population or number of households, but also on other factors like the temperature. Industrial consumption can be addressed by knowing the number of industrial facilities or enterprises together with the size of their installations or number of employees (finer assignation of values could be based on the sector the company belongs to). Energy consumption in the transport sector could be addressed with the number of vehicles (or vehicles/km), size of the transport network plus urban/non-urban stretches, or employment in the transport sector.

Constraints

The use of proxies to build up regional datasets from national data makes the results more dependent on different databases to be updated. These proxies should be as robust and simple as possible. And of course, the proxies used should be available at regional level for all North Sea countries, so the only present solution is to make use of Eurostat data.

The ancillary datasets should be clearly defined. An example related to energy consumption would be to define a proxy for household consumption (given that information at household level is very difficult to obtain). In this case the number of inhabitants or households (which is usually fully available) could be a proxy for domestic consumption. However, other information like the KWs installed in industrial facilities should be gathered as well to have a proxy of industrial consumption.

Annex C: Case Study Methodology

C1. Aims

A critical part of the research is to evaluate the effectiveness of energy related projects in the North Sea Region in relation to meeting the broader policy goals of both the North Sea Region and the EU in relation to energy through a case study approach.

Aims and objectives of the case studies:

- To provide a critical reflection on the impact of energy related projects in the North Sea Region;
- To explore the effectiveness of the partnership and evaluate the sustainability of the project, exploring success stories and barriers to delivery, and they will consider the contribution of the projects to wider policy objectives; and
- To assess the role of transnational cooperation projects in this process, and ascertain the added value of a project clustering approach.

The work package on case studies seeks to contribute to the broader aim of the North Sea STAR project:

> *Provide recommendations on accelerating the take-up of renewable energy technologies and supporting relevant green economic activities in the North Sea Region.*

The NSR programme has grouped projects in so called clusters. The expectation of this clustering approach is:

- To stimulate knowledge dissemination: the organisational dimension.
- To stimulate territorial integration: the territorial dimension.
- To stimulate technological innovation: technological dimension.

Research questions

The above leads to the following research question:

> *How can the take-up of policies aiming at the production of renewable energy be accelerated through effectively clustering projects, next to stand alone projects?*

Sub-questions are:

1. What have been the basic characteristics of projects?
2. What has been the territorial, technological and organisational impact of projects? Main research method: document analysis.
3. Which dimensions were strengthened by organisational innovation and cooperation, i.e. learning and on which level? Main research methods: document analysis, interviews.

4. Which benefits were strengthened through the clustering approach in particular? Main research method: interviews.

C2. Selection of Case Studies

All selected projects are funded as part of the North Sea INTERREG programme. Projects fall within two categories: projects under a cluster approach and standalone projects. The relevant clusters are:

- Low Carbon Regions in the North Sea (LOWCAP); clustered projects focused on carbon reduction and energy efficiency projects.
- Energy Vision North Sea Region (ENVSR); clustered projects focused on renewable energy projects.

In order to critically select standalone projects the following criteria have been used (in order of priority):

- Thematic scope: similar as clustered projects: carbon reduction and energy efficiency projects or renewable energy projects.
- End date: before 1. January 2014 in order to detect identifiable results.
- Geographic scope: similar as clustered projects (comparing primarily lead beneficiaries, but also other beneficiaries).
- Objectives: similar as clustered projects (various: Territorial integration and/or Knowledge dissemination).

All these steps bring us to a list of 2 clusters and 8 projects (see Table 4 below).

Table 4: Projects Selected as Case Studies

	Project		**Thematic Scope**
Clusters	1a	Low Carbon Regions in the North Sea (LOWCAP Cluster)	Carbon reduction and energy efficiency projects
	1b	Energy Vision North Sea Region (ENVSR Cluster)	Renewable energy projects
Clustered Projects	2a	Built With Care (BWC (ENVSR + LOWCAP))	Energy-efficient building design
	2b	Carbon Responsible Transport Strategies for the North Sea Region (CARE-North (LOWCAP))	Carbon reduction, transport, economic competitiveness
	2c	North Sea Sustainable Energy Planning (SEP (ENVSR + LOWCAP))	Energy consumption
	2d	Innovative Foresight Planning for Business Development (IFP (ENVSR))	Competitiveness of regions.
	2e	North Sea Supply Connect (Supply Connect (ENVSR))	Competitiveness, structural change
ne	3a	Climate changing soils (Biochar)	Biomass-to-energy processing systems

	3b	BlueGreen Coastal Energy Community (enercoast)	Regional production of biomass
	3c	E-Logistics in NSR Harbour Cities (E-harbours)	Sustainable energy logistics

C3. Case Study Methodology

The purpose of case studies is to gain an understanding of how the take-up of policies aiming at the production of renewable energy in the North Sea Region was accelerated through clustering projects. We achieve this (1) by distinguishing types of expected and realized impact associated with co-operation (spatial integration, technological innovation and organisational/policy innovation), (2) by analysing if and how knowledge dissemination in the form of learning at different levels has contributed to organisational/policy change and (3) by assessing the effectiveness of a cluster approach, i.e. its ability to facilitate learning processes, in particular.

In order to arrive at comparable case studies we have to follow a common approach. We foresee the following steps:

1) **Undertake a documentary analysis**. This should involve reviewing and analysing reports, programmes, minutes of conferences etc. We foresee two sorts of documentary analyses: a descriptive and an evaluative analysis.
2) **Interviews with key actors**. A number of interviews should be arranged with representatives from the partnerships to assess the impacts of the projects and added benefits from a cluster approach. A minimum of three interviews should be held: one with the lead beneficiary and at least two other partners.
3) **Synthesis.** The outcome of the previous two activities should be written up as a narrative that seeks to evaluate the impacts of the projects.

C3.1. Document analysis: Basic characteristics of the projects - Description

Based on available documents – especially project applications – a number of basic characteristics of the projects have to be identified. This part of the document analysis differs from the second part (see below) as it is meant to be entirely descriptive. The analysis should speak for itself as much as possible. Evaluation should be reserved for the next part of the document analysis. We foresee that some of the information we seek to assemble cannot be derived from the documents. This should be recorded and addressed in the interview stage.

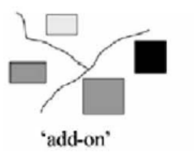
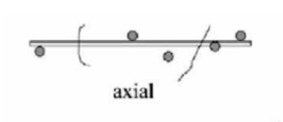
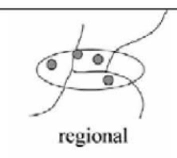
- **Geography of the partnership.** In order to assess the territorial dimension (see below) of the projects we need to know, next to basic characteristics, the geographical distribution of the partnership. There are two levels in this:
  1) the level of the main beneficiaries of the project;
  2) the level of each individual beneficiary as in many cases there will be several sub-projects in each of the participating areas.

  The results will be a description and a map. Figure 21 (below) images the dominant types of transnational cooperation networks which can be found in transnational projects which can be used as a starting point for the cartography.

- **Scope of the project**. Based on the scanning of the project descriptions (collected and made available by TU Delft) we can differentiate between the following impact indicators:

  a. **Territorial impact**: expectations about the use of geographic renewable energy potential within the participating areas as well as expectations about the perceived benefits stemming from spatial integration and territorial cooperation.

Figure 21: Types of transnational cooperation networks

	**Unbalanced cooperation** Any project in which the great majority of partners belong to the **same country**.
	**Virtual networking** Projects aiming at the **sharing of experience**, gathering together partners undergoing similar problems (e.g. other metropolitan areas), or working with the same issues (implicitly: partners which do not necessarily share geographical contiguity or functional relationships).
	**Add-on projects** Well-established **national cooperation structures** cooperating with one another on transnational projects, implying the need to adapt national forms of interaction to a new structure.
	**Axial cooperation** Project based on an existing or planned **transport axis** or waterway, with numerous possible aims (such as infrastructure development, tourism development, flood protection, water quality preservation etc.).
	**Transnational regional cooperation** Projects based on an existing or emerging (transnational) **functional region**, or on a localized transnational cluster of enterprises – usually characterized by the relative spatial proximity of the partners.

(Source: Böhme, K., Josserand, F., Ingi Haraldsson, P., Bachtler, J. & Polverari, L. (2003) Trans-national Nordic-Scottish Co-operation: Lessons for Policy and Practice, Nordregio Working Paper, Stockholm: Nordregio).

b. **Technological impact:** this is about the perceived (i.e. expected) potential for technological innovation as well as expectations about the perceived benefits stemming from sharing technical knowledge.

c. **Policy impact**: this is about perceptions of the benefits stemming from organisational/policy innovation. It concerns expectations about improved enabling conditions for the implementation of policies as well as the improvement of implementation practices. It has a lot to do with how the project was **framed** by its initiators: was the project developed as a response to a specific policy or set of policies either at the local/ regional, national or European level? In other words: to which policy strategies or objectives at what level of scale does the project refer? The above framework for classifying policy impact is rather comprehensive. At this stage we expect that some aspects such as a better use of resources for policy making, an improved and more active commitment of actors or the change of formal or semi-formal practices are not written down in project documentations. Nevertheless it is important to systematically record **espoused** objectives and expectations.

d. **Policy impact/learning:** The core interest of the case studies is to investigate how the clustering of projects has supported policy making by knowledge dissemination. This is about an anticipated added value of a cluster approach or **perceptions** of the benefits stemming from cooperation in terms of **learning.** Different levels have to be looked at:[2]

   - Learning within the project, between the people participating in the project.
   - **Organizational** learning: meaning that learning spills over in the organizations represented by individuals during project meetings and activities. What have been the expectations?
   - Local/regional and national learning: here the innovations/results diffuse across territories. Basically this is about the foreseen policy impact and policy changes at local/regional and national level.
   - Transnational and European learning: what are the objectives in terms of policy impact and policy changes across the participating areas in the North Sea Region and across Europe, including the European Union?

- **Anticipated added value of a cluster approach**. 5 out of the 8 projects we have to analyse are part of project clusters: LOWCAP or ENVSR. Two of these projects (Build with Care & North Sea Sustainable Energy Planning) are even part of both clusters. This

[2] This is an adaptation of: Colomb, C. (2007) The added value of transnational cooperation – Towards a new framework for evaluating learning and policy change, *Planning Practice and Research*, Vol. 22, No. 3, pp. 347-72.

makes it important to detect the anticipated added value of the cluster approach.

C3.2. Document analysis: project evaluation

In this step we leave the domain of mere description and start to evaluate in the sense of looking beyond objectives of projects and clusters: what has been realized? We foresee that some of the possible impacts will be difficult to record due to the limited time horizon of projects. We return to the prime documentation but add all sorts – if present – other written material: reports, programmes, minutes/reports of meetings and conferences etc. The same impact factors are addressed as in the previous steps:

1) **Territorial impact**: realized geographical renewable energy potential within the participating areas as well as realized benefits stemming from cooperation and spatial integration.
2) **Technological impact:** realized technological innovation.
3) **Policy impact**: benefits stemming from organisational innovation.
4) **Policy impact/learning:** benefits stemming from cooperation and learning.

It is very important to emphasize that there are two levels in this step: the level of individual projects and the clusters. So the challenge here is twofold: try to identify the added value of the cluster approach but also try to identify why the (three) standalone projects did not become part of a cluster and how this is perceived during the unfolding of the project.

C3.3. Interviews with key stakeholders: projects evaluation

In this step we asses a critical perspective on projects from the point of view of key actors by investigating perceived success stories and barriers. One aim of interviews is to explore their view on the factors set out above. Interviews will mainly support a synthesis of factors in the light of a clustering approach though. The interviews will be prepared based on an interim report on the document analysis. In an interview outline questions will be structured along the following issues:

1) **Characteristics and strengths of the partnership:** assessment of the level and quality of cooperation within the partnership and within the project and cluster approach.
2) **Policy impact/technological impact:** perceived success stories on technological innovation, technology improvement and transfer, perceived barriers, opportunities and obstacles for technological innovation vs. learning levels.
3) **Policy impact/territorial impact:** perceived success stories on spatial integration; territorial co-operation, perceived dilemmas, controversies and conflict, opportunities and obstacles for spatial integration/transnational co-operation vs. learning levels.

Not only under 1 but also under 2 and 3 please distinguish between clustered and stand alone and then ask something very specific about the reasons projects became involved in the clusters and what added values or indeed disincentives were derived from this approach.

C3.4. Synthesis

The outcome of the previous activities should be written up as a narrative that seeks to evaluate the impacts of the projects.

- **Synergy between projects in case of cluster-approaches:** assessment of the added value of a geographically wider coverage in the case of clustered projects.
- **Transition potential** of the projects: broad of the fulfilment of energy transition potential of the project
- **Transferability**: assessment of the organisational conditions which might hinder an application of project approaches elsewhere in the North Sea Region.

C.4. Structure and Format of Case Study Reports

Each case study report needs to be approximately 5-6,000 words in length. The case study report should be structured according to the content list below (see Appendix), using the suggested subheadings to encourage comparability. In addition to the single case study reports, a cluster analysis report of approximately 2,000 words should be written as part of an introduction to the overall report of the case study. Table 5 indicates how the case studies will be distributed amongst the research team.

Table 5: Distribution of Case Studies

	Project		Lead Beneficiary	NSS Partner
Clusters	1a	Low Carbon Regions in the North Sea (LOWCAP Cluster)	UK (Aberdeen City council)	University of Liverpool
	1b	Energy Vision North Sea Region (EVNSR Cluster)	The Netherlands (Energy Valley Foundation)	TU Delft
Clustered Projects	2a	Built With Care (BWC (EVNSR + LOWCAP))	Sweden (Västra Götalandsregionen Miljösekretariatet)	Norsk Institutt for by og-Regionforskning (NIBR)
	2b	Carbon Responsible Transport Strategies for the North Sea Region (CARE-North (LOWCAP))	Germany (City of Bremen)	University of Liverpool
	2c	North Sea Sustainable Energy Planning (SEP (EVNSR + LOWCAP))	Germany (Jade University of Applied Sciences Oldenburg)	Universität Oldenburg/Leibniz-Institut für Ostseeforschung Warnemünde (IOW)
	2d	Innovative Foresight Planning for Business Development (IFP (EVNSR))	Norway (Greater Stavanger Economic Development)	Norsk Institutt for by og-Regionforskning (NIBR)
	2e	North Sea Supply Connect (Supply Connect (EVNSR))	The Netherlands (provincie Groningen)	TU Delft
Standalone	3a	Climate changing soils (Biochar)	The Netherlands (provincie Groningen)	TU Delft
	3b	BlueGreen Coastal Energy Community (enercoast)	Germany (COAST Centre for Environment and Sustainable Development Research; University of Oldenburg)	Universität Oldenburg/Leibniz-Institut für Ostseeforschung Warnemünde (IOW)
	3c	E-Logistics in NSR Harbour Cities (E-harbours)	The Netherlands (Municipality of Zaanstad)	University of Liverpool

Structure of project case study reports

1. Introduction
2. Geography of the partnership
3. Territorial impact: expectations and realisation (in case of a clustered project: added values or incentives resulting from clustered approach)
4. Technological impact: expectations and realisation (idem)
5. Policy impact: expectations and realisation (idem)

6. Conclusion and synthesis: transition potential and transferability (idem)

The synthesis of the case study reports is the responsibility of TU Delft. A specific element of the synthesis is the evaluation of the added value of the cluster approach. The critical discussion of EVNSR will be prepared by TU Delft and LOWCAP by Liverpool University.

C.5. Appendix: Outline of a Semi-Structured Questionnaire

1. The project **partnership**:
   a. What were the main reasons to participate in a transnational project?
   b. How was the project partnership assembled: what were main reasons (including practicalities)?
   c. How well did you know the projects of the other partners?
   d. What are the main strengths and weaknesses of the partnership so far and how have you dealt with these?
   e. Considering the different sub-projects within the entire project: how do you evaluate the focus of the project? [question will probably touch upon learning potential and policy impact; see also below]
   f. If you could start all over again: is there anything you would like to do differently?

2. In case of a project which is part of a **cluster: added value** of the cluster approach
   a. When you started the project application did you already think about participating in a cluster? [question particularly relevant for the lead beneficiary, but it would not harm to ask the project partners]
   b. Why did the project become part of a cluster of projects: what were the main anticipated benefits?
   c. Do you think that the perceived benefits have materialised? Which evidence?
   d. Can you mention any barriers for realising the full benefits of the cluster?
   e. In the case of Build With Care & North Sea Sustainable Energy Planning: why did these projects became part of two clusters? [idem: question particularly relevant for the lead beneficiary, but it would not harm to ask other project partners about this]
   f. Do you think that the perceived benefits have materialised?
   g. Can you mention any barriers for realising the full benefits of this twin cluster approach?
   h. If you could start all over again: is there anything you would like to do differently?

3. In case of the three **standalone** projects (Biochar, enercoast, E-harbours):
   a. Was it a deliberate choice to go for a project which would not be part of a cluster?
   b. With hindsight: do you consider this a missed opportunity, and if so: why?
   c. In spite of not participating in a cluster: did you liaise with other NSR energy projects and if so: for what reasons and was there any added value?

4. **Territorial impact** of the project:
   a. What do you consider as prime territorial impacts of the project and its sub-projects? One can think of: changes in land-use [for instance in case

of production of bio-fuels]; impacts on the landscape resulting from installations; the need for new networks etc.

b. How were the territorial impacts dealt with in the project? For instance: did you carry out specific research or did you liaise with people/organisations dealing with issues of spatial planning/territorial governance?
c. In case you have acquired a better understanding of territorial impact: did this change the conduct of the project?

5. **Technological impact** of the project in terms of **energy transition**:
   a. How would you assess the realised technological innovation potential of you project? What evidence?
   b. What have been or still are main barriers for technological innovation and how did or are you going to deal with these?
   c. How would you assess the transferability of the project achievements? Do you think that what has been achieved in your project can be done elsewhere?
   d. If so: what kind of conditions (transferability) needs to be fulfilled?

6. **Policy impact** of the project and **learning:**
   a. Was the project developed as a response to a specific policy or set of policies either at the local/regional, national or European level? In other words: to which policy strategies or objectives at what level of scale does the project refer?
   b. Besides a having impact on spatial development and technical innovation did the project also reach policy innovation, for instance novel forms of cooperation?
   c. Do you have clear indications that what you have reached in terms of innovation (either territorial, technical or at the level of policy) has moved beyond the group of actual participants in the projects?
   d. Do you think that current policies or policy frameworks (including legislation at federal/national or European level) need to change?
   e. Which changes need to occur in the new NSR INTERREG 2014-2020 programme looking at the results of your project? (priorities, areas of intervention, budgets)

Annex D – Evaluation of Results from Existing ESPON Projects

This Annex to the North Sea STAR Interim Report provides an analysis of ESPON results from other projects that maybe useful for informing the work of the North Sea STAR project. In the specifications for North Sea STAR, a number of potentially relevant projects were listed for use in developing baseline information and scenarios related to the energy situation in the North Sea Region, alongside projects which may give insights into the development of territorial cooperation.

This Annex therefore presents an evaluation of both the baseline evidence from ESPON projects which may help to characterise the North Sea Region and recommendations which can be taken forward - either as part of the North Sea STAR project in further developing its evidence base, or by the North Sea Region Programme in preparing their new Operational Programme.

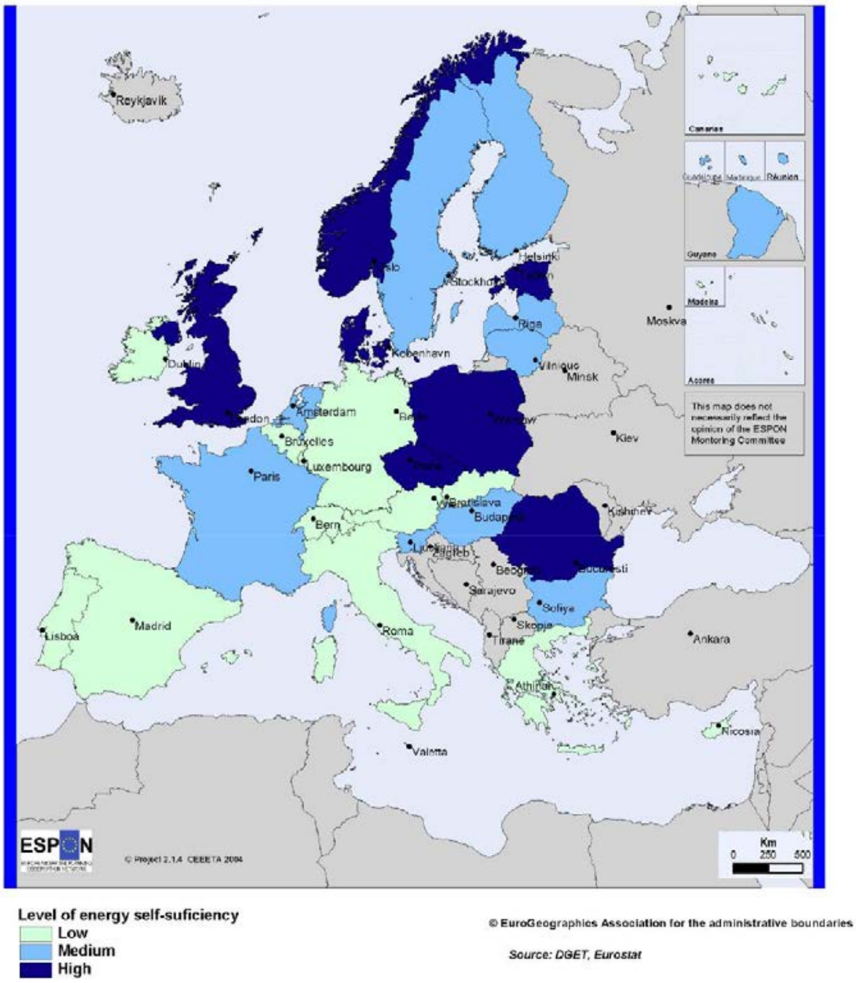
D1. ESPON Evidence as Context for the North Sea STAR Project

This section of the Annex provides an overview of evidence (data, maps and analyses) that can be used to supplement the data collection which has already taken place as part of the North Sea STAR project and is featured in both the Inception Report (Annex 2) and the main body of the Interim Report. It takes as its starting point the analysis of relevant ESPON evidence which may be used to characterise the North Sea Region in terms of its geographical features and in relation to energy, climate change and potentials for an energy transition. Following this, other maps and which may be of use for analysing the current energy situation and future scenarios for the North Sea Region are reviewed.

D1.1 Current Characteristics

A number of ESPON projects provide single data sets and typologies on energy and related themes reflecting specific features of the North Sea that have a bearing on its current energy situation and future potentials. Of these, the ESPON 2006 project “Territorial Trends of Energy Services and Networks and Territorial Impact of EU Energy Policy” provides an initial analysis of energy trends in the EU, including information on energy generation by renewables, wind and biomass potential, final energy consumption by sector and per capita. This data is largely derived from Eurostat at NUTS0 level, with figures included up to the year 2002 – meaning that there are opportunities here to provide updated information on the same topics and where possible this will be included in the North Sea STAR Final Report. One dimension that has previously been discussed in the North Sea STAR Interim Report is the notion of energy self-sufficiency within the region – in the Territorial Trends project, Denmark, Norway and the UK are seen as having the highest level of self-sufficiency and Belgium the lowest (Map 1, below) and this continues to be the case in the 2010 figures presented in the Interim Report.

Map 1: Typology of self-sufficiency of European countries in energy resources (2004)



Source: ESPON and CEETA (2005:181)[3]

However, as has already been identified in the North Sea STAR Interim Report, the availability of data below NUTS0 level which could more accurately fit the geographical extent of the North Sea macro-region remains problematic.

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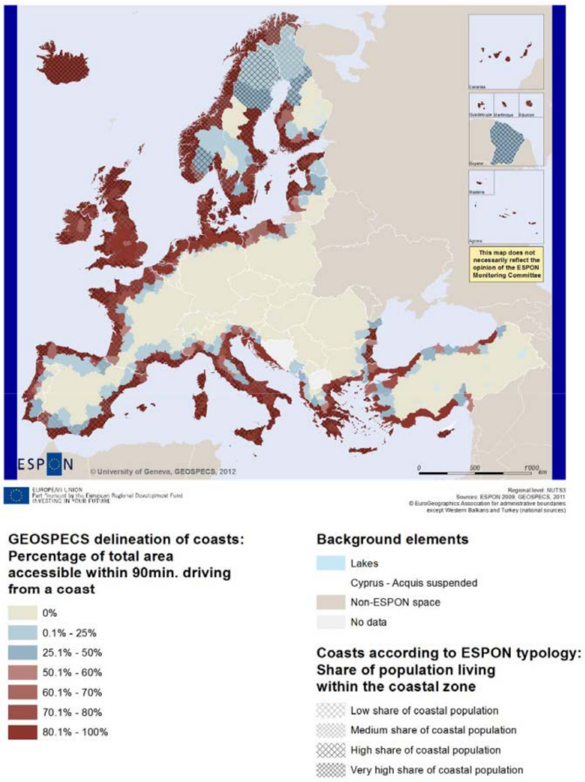
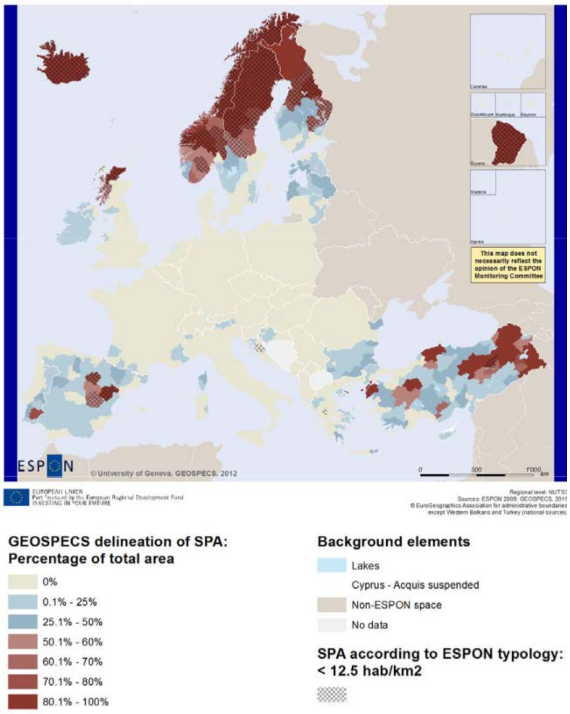
[3] Referred to as Map 35 in the *Territorial trends of energy services and networks and territorial impact of EU energy policy* Final Report.

Within the ESPON 2013 suite of projects, the Specific Types of Territories (GEOSPECS), CLIMATE and European Seas and Territorial Development – Opportunities and Risks (ESaTDOR) projects are most relevant in terms of outlining the basic environmental conditions and energy infrastructure of the region. The GEOSPECS project demonstrates the region's predominantly coastal nature, with (excluding some small areas in Norway and Western Sweden), short accessibility times to the coast from all parts of the region (Map 2) and sparsely populated areas mainly to the north (Map 3). The North Sea's importance as an energy producing region is shown by the European Seas and Territorial Development – Opportunities and Risks (ESaTDOR) project, which highlights the location of offshore oil and gas installations (Map 4) and ports handling large volumes of liquid bulk cargo (Map 5), particularly in Antwerp, Rotterdam, Amsterdam and Bergen.

Map 2 (L): GEOSPECS delineation of coasts: Percentage of total area accessible within 90 min. driving from a coast

Map 3 (R): GEOSPECS delineation of sparsely populated areas: Percentage of total area



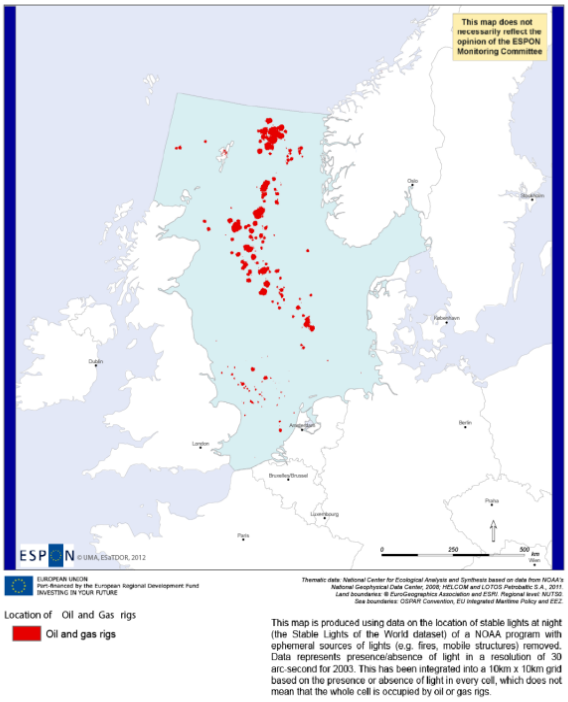


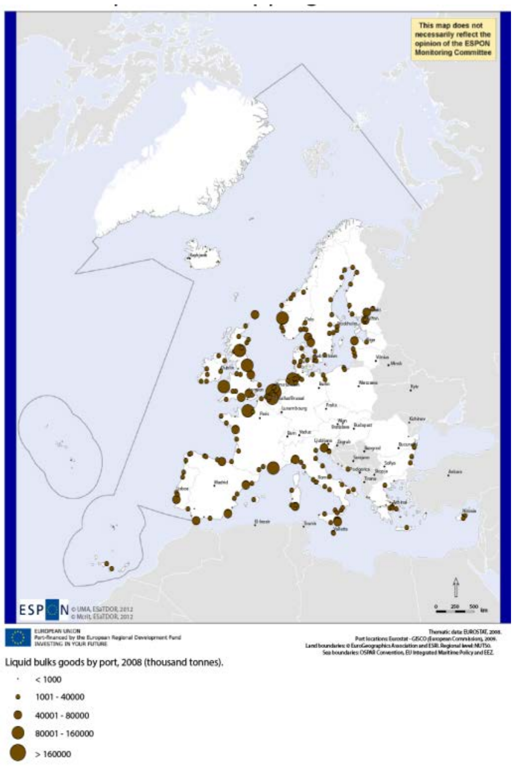
Source: ESPON and University of Geneva (2012:88 and 90)[4]

[4] Referred to as Map 4 and Map 6 respectively in the GEOSPECS Final Report, Annex C.

Map 4 (L): Location of oil and gas installations in the North Sea

Map 5 (R): Liquid bulk goods shipping by port (2008, million tonnes)



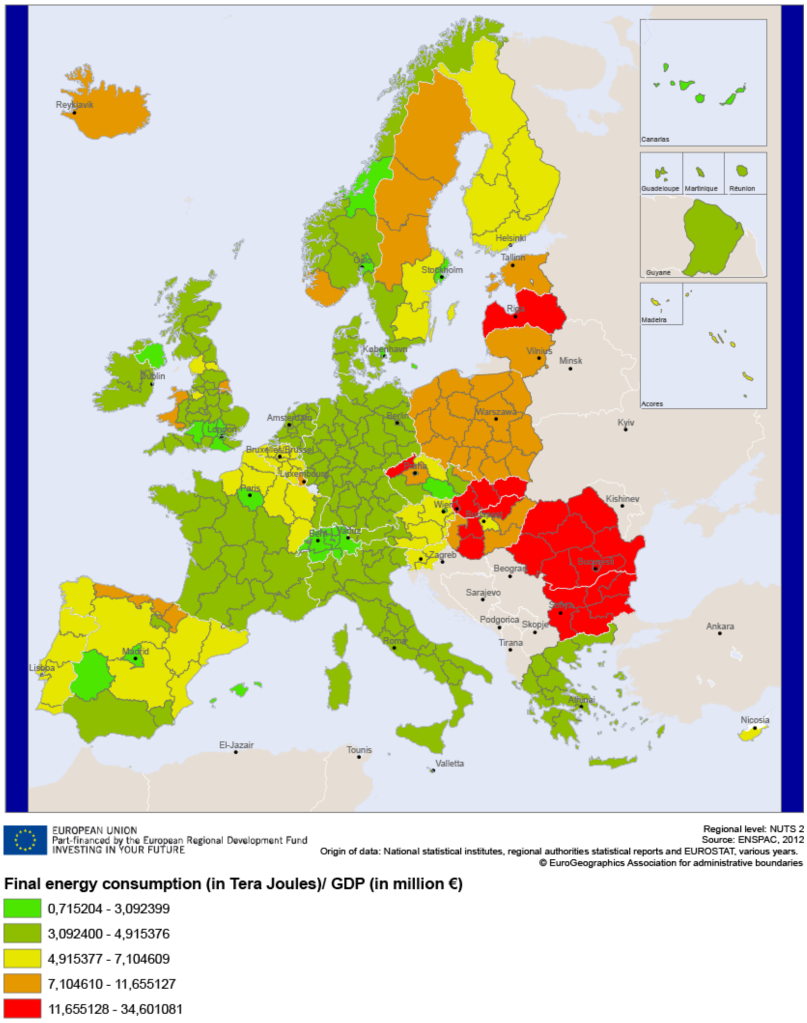


Source: ESPON and the University of Liverpool (2013: Annex 7, p42 and Scientific Report, p85)[5]

With regards to patterns of energy production and consumption, data for Europe and the North Sea Region has been mapped at NUTS0 level on primary energy production (by fuel type and by country), gross inland energy consumption and final energy consumption. These data sets provide a broad picture and can be complemented by the map of average energy intensity per NUTS2 region found in the GREECO project's Interim Report. Assuming that final energy consumption is a proxy for economic activity, this map (Map 6) shows that average energy intensity in the North Sea Region is relatively low, thereby indicating the delinking of growth from consumption – a target implicit in the Europe 2020 Strategy which seeks to increase employment whilst reducing energy consumption. However a note of caution should be applied in this case, as the dataset is based on national rather than NUTS2 figures where these are not available, and does not take into account losses in the energy industry which may occur due to the energy source or technology chosen, or the number and efficiency of energy consuming appliances.

[5] Referred to as maps N19a (North Sea oil and gas) and Map 25 (liquid Bulk) in the ESaTDOR Final Report.

Map 6: Average energy intensity by NUTS2 regions, 2000-2010



Source: ESPON and Tecnalia (2012:29)[6]

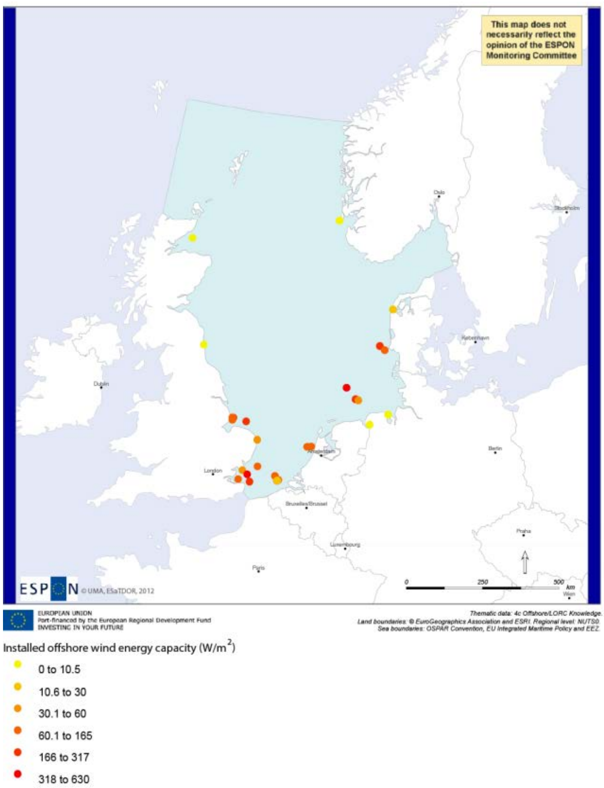
The GREECO project is likely to provide more information on energy in relation to economic growth and particular sectors in their Final Report and so North Sea STAR team will liaise with GREECO project partners in order to access anything that is pertinent to the development of the new North Sea Region Operational Programme.

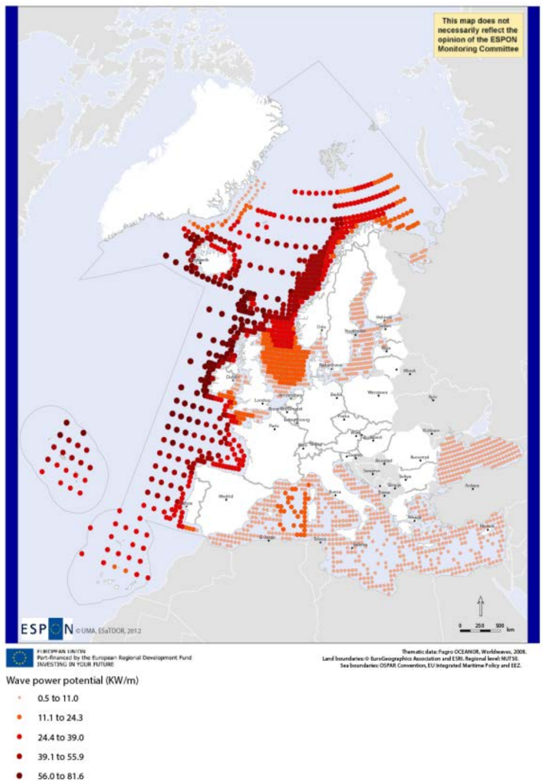
[6] Referred to as Map 1 in the GERECO Interim Report.

D1.2. Future Opportunities and Challenges

The GEOSPECS project identifies the opportunities for coastal areas to harness wind and wave power, and the existing use of offshore wind is shown in the ESaTDOR project (Map 7) with more installations becoming operational since this map was produced), and wave power potential being greatest in the areas around Scotland and the north and west of Norway (Map 8). In addition, renewable energy potentials on land – both wind and solar power – are illustrated by the ReRisk project, which shows wind power potential by NUTS2 region to be the greatest in western Sweden, the Midtjylland region of Denmark, Niedersachsen (Germany) and the Scottish borders. Solar energy systems such as passive solar design, solar water heating and photovoltaic cells, although more conventionally associated with hotter climate regions are already in use in the North Sea Region. In future they may play a greater role in energy supply, particularly at the neighbourhood and household level, though the use of such technologies must be set against the considerations of long pay-back periods for investment.

Map 7 (L): Existing wind farm generation capacity in the North Sea
Map 8 (R): Wave power potential





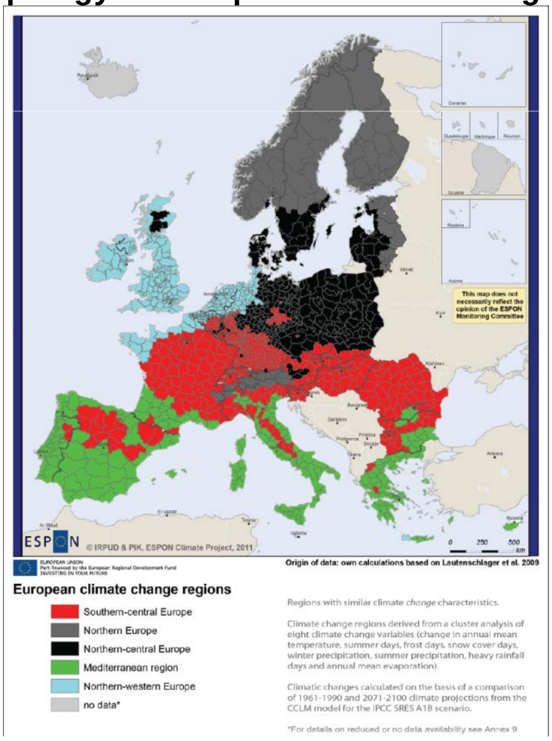
Source: ESPON and the University of Liverpool (2013: Annex 7, p45 and Scientific Report, p112)[7]

[7] Referred to as Map N20 (offshore wind) and Map 34 (wave power potential)

With the exception of solar technologies that can operate at the micro-scale, these types of renewable energy production require capital investments far beyond what is possible through Interreg projects, associated subsidiary industries, research and innovation clusters could provide opportunities for small scale projects or programmes that can draw on the energy infrastructures and networks of expertise that are already in place.

Some of the greatest challenges to the North Sea Region are those relating to climate change, with its impacts across Europe as a whole discussed in detail across a range of ESPON projects. In addition economic factors such as the decline of energy intensive industries and changes in energy prices will continue to affect national and European energy and climate policies. Within the CLIMATE project, the North Sea is seen to be made up of several climate change regions (Map 9), including northern-western, northern and northern-Central. All three regions are likely to experience an increase in mean annual temperatures, and in the northern and northern-central regions this will also be accompanied by a decrease in the annual number of frost-days each winter. The northern region (which includes Norway and western Sweden) in particular will also experience a decrease in the number of days of snow cover. Whilst this may reduce energy demand for heating in winter months, an associated increase in the number of winter precipitation days could increase flood risk.

Map 9: Typology of European Climate Change Regions



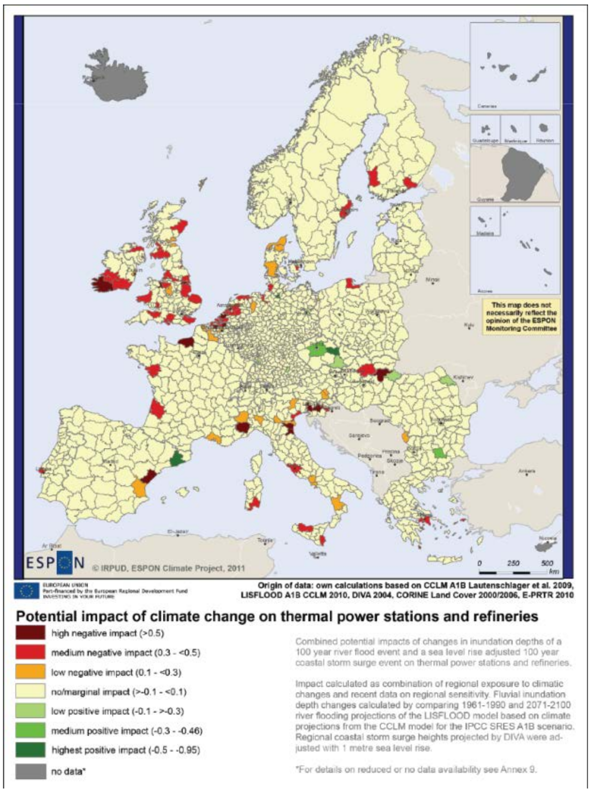
Source: ESPON and IRPUD (2011:38)[8]

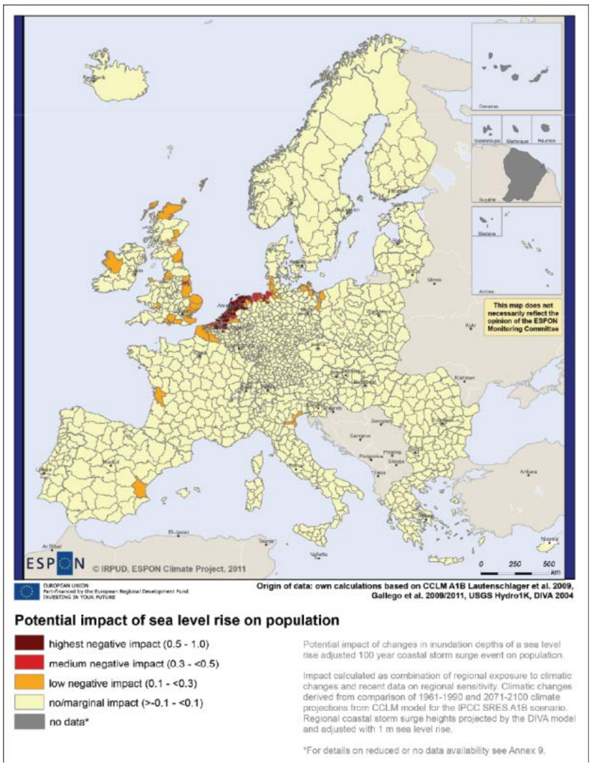
[8] Referred to as Map 11 in the CLIMATE Scientific Report

The CLIMATE project also reveals the North Sea Region's sensitivities to climate change in physical, social, economic and environmental dimensions through measuring the potential impacts of different phenomena. As with coastal populations, energy infrastructures such as power stations and refineries which are most likely to be susceptible to negative impacts due to projected increases in the incidence of river flooding events, sea level rise and coastal storm surges are in the Netherlands and the east coast of the UK. Energy infrastructures in parts of Denmark are also likely to be negatively impacted (Maps 10 and 11).

Map 10 (L): Potential impacts of climate change on power stations and refineries

Map 11 (R): Potential impacts of sea level rise on population Potential impacts of climate change on the energy sector





Source: ESPON and IRPUD (2011:89 and 93)[9]

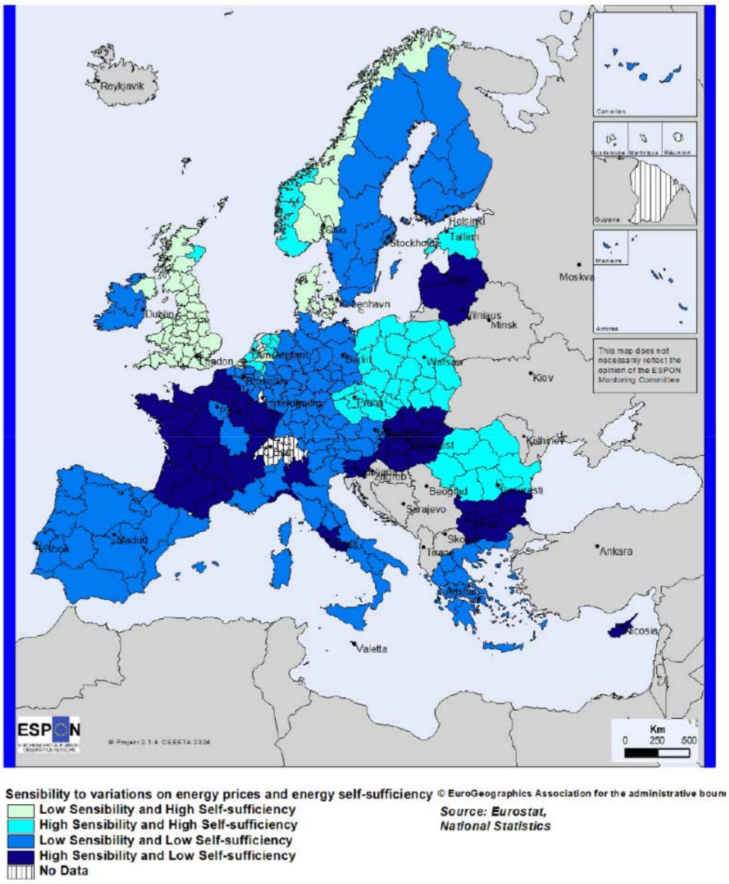
The impacts of climate change on the energy sector as whole are seen to be marginal to low, as increasing temperatures and milder winters may reduce demands for heating. However, alongside the abovementioned threats to energy infrastructures, increasing temperatures could place additional stress

[9] Referred to as Map 20 and Map 24

on water supplies from rivers which are essential for cooling processes in power stations.

Socio-economic impacts arising from changes in energy supply and pricing and the overall adaptive capacity of the North Sea Region to climate change are most clearly highlighted in the Territorial Trends, ReRisk and CLIMATE reports. Although the Territorial Trends report predates the Europe 2020 Strategy and the current economic crisis by some time, they typology of “sensibility [sensitivity] to variations on energy prices and energy self-sufficiency” and associated analysis has resonance for current energy policies. The central premise of this typology (Map 12) is that increasing the energy self-sufficiency of a country or region may require significant and costly investment, and thus different energy dependency policies can be applied that would help to achieve greater resource efficiency. For North Sea countries that remain more self-sufficient (defined here as higher net exporters of energy – UK, Denmark and Norway), they may play a role in assisting other countries that are less self-sufficient. For regions that are also self-sufficient but more sensitive to price changes (Netherlands), increasing energy efficiency is seen as the most appropriate measure to stabilise pricing before significant investment is made in new energy sources. For countries with low sensitivity to price changes, but also low self-sufficiency (such as Belgium, Sweden and Germany), investment in renewable energy is seen as the most effective way to ensure more reliable supplies. Within the North Sea Region, this suggests that energy efficiency and more decentralised forms renewable energy production should be the focus of future energy policies.

Map 12: Sensibility (sensitivity) to variations in energy prices and energy self sufficiency



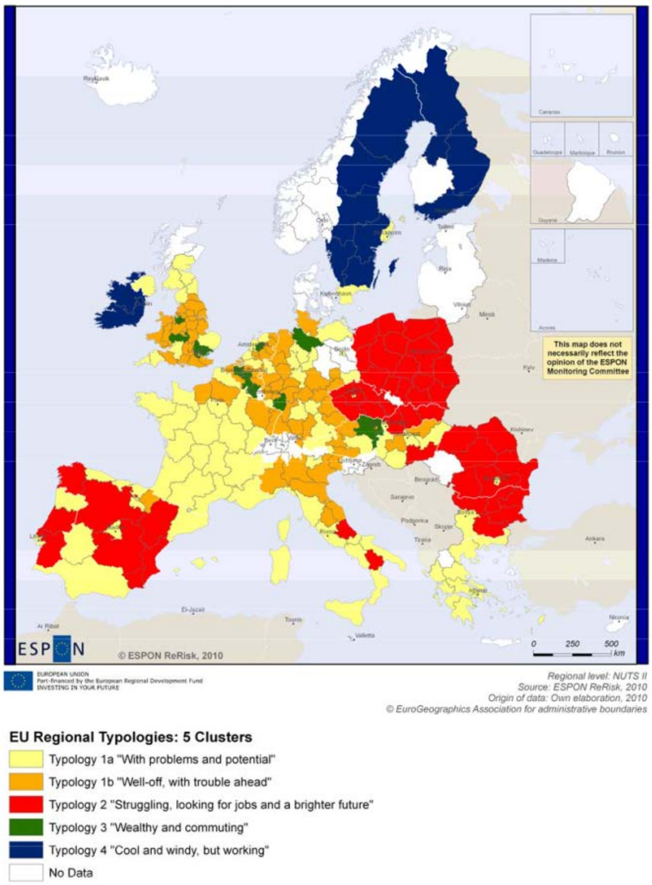
Source: ESPON and CEETA (2005:191)[10]

Bringing the energy situation more up to date and focusing more specifically on the socio-economic conditions of the population, energy consumption (in industry and transport) and production potential, the ReRisk typology of energy poverty (Map 13) shows that large parts of the North Sea Region can be classified as either "With problems and potential" or "well off, with trouble ahead". Areas with problems and potential (e.g. coastal regions of the Netherlands, and eastern regions of the UK) are characterised as being less exposed to rising energy prices for industry (somewhat contradicting the findings of the Territorial Trends typology of energy prices and self-sufficiency) and have high wind and PV potential, but may be vulnerable to changes in commuting patterns associated with rising fuel costs. This is particularly significant for metropolitan regions which may lose volume from transport hubs. Areas which are considered well off, with trouble ahead (e.g. north and north west Germany, parts of Belgium and the north east of the Netherlands) tend to be industrialised regions which may suffer due to rising energy prices if they are unable to improve energy efficiency, but may be

[10] Referred to as Map 39 in the Territorial Trends Final Report

more able to cope with rising prices due to their strong economic performance. The majority of Swedish regions fall into a third category, that of “cool and windy, but working”. Here peripherality and the high demand for energy for heating could present a high risk for energy poverty, but provided that levels of employment remain stable or improve and the high potential for wind energy is harnessed, these risks will be minimised.

Map 13: ReRisk Typology of Energy Poverty



Source: ESPON and Innobasque (2010:97)[11]

Looking further ahead, the ESPON *Territorial Scenarios and Visions for Europe (ET2050)* project explores the spatial development implications of three different development scenarios against a baseline for European policy. So far the work of this project has been focused on developing the baseline and three scenarios up to 2030, with further modelling and projections to be produced looking at the period up to 2050. In developing the 2030 scenarios, the ET2050 project makes a number of (evidence-based) assumptions about demographic, economic and other changes, including those related to energy consumption and levels of Greenhouse Gas emissions. At the global level, energy consumption and CO_2 emissions are predicted to continue growing up to 2050, despite a shift to renewable energy sources and more decentralised

[11] Referred to as Map 11 in the ReRisk report.

energy production. The market share for electric and hybrid vehicles is expected to grow, whilst oil prices will continue to rise, in part due to scarcity and costs of extraction, but also due to green taxes (ESPON and MCRIT Ltd, 2013:28).

In outlining the scenarios for 2030, the baseline (a continuation of current trends observed since 1995, adjusted to reflect the economic crisis) demonstrates the following outcomes for energy:

- (7) Reindustrialisation of the economy, with balanced employment growth in manufacturing and services. Technological innovation concentrated only in some sectors and regions. Increasing dependency on more expensive energy.
- (10) Reduction of Green-House emissions in more advanced industrial economies (*Ibid*, p46).

Under the three alternative scenarios, different energy outcomes are envisaged. In the first scenario, which concentrates on globalisation, urban mega-regions and flows (of information, capital, people), transport and energy corridors become more significant and carbon capture and storage (CCS) technology becomes more widely utilised. Such a scenario could see the enhancement of the North Sea Region's role as a net energy exporter.

The second scenario, where investment is concentrated in existing cities, reliance on nuclear power and centralised sources of renewables is the main energy feature. For this and the Europe of flows scenario, energy policy targets are only partially met.

Under the third scenario, which focuses on decentralisation, the role of small and medium sized towns, endogenous development and self-sufficiency, predicted energy trends show a more positive outcome, with decentralised energy production and lower energy consumption (due to less travel or the use of alternative fuels). In this scenario, energy targets are met.

The three scenarios all show a decline in transport-related emissions and fuel consumption in relation to 2010, due to increased efficiency and the increase of vehicles using alternative fuels (*Ibid,* p116). In the North Sea Region, where many Interreg projects have already worked to demonstrate the benefits of electric vehicles and improve the infrastructure for E-mobility, the scenarios demonstrate that this is an area where there are potentials to be gained from continuing investment.

With regards to the 2050 scenarios and attempts to produce a European territorial vision, this is on-going work for the 2050 project. However, in early considerations of the different economic, political and societal aspects which contribute to the vision, energy – a component of the ecological dimension - is viewed as being either part of a more sustainable development path, that promotes growth and maintains current living standards, or it is part of the transition to a more ecologically restorative future. Whilst energy is “at the forefront” of many policy projects, e.g. through increased efficiency, decentralisation, energy storage, zero energy balance cities and other initiatives, it is noted that there no consensus on which of these is the most appropriate path to follow (Ibid. p155-156).

Overall, the North Sea Region is better placed than some other regions to meet the challenges of the Energy 20:20:20 targets due to its high potentials for renewable energy both on and offshore. However in the shorter term, rising energy costs and the slowdown in economic growth will also play an important role in determining regional energy trends. Whilst the evidence reviewed shows that the energy situation differs across parts of the North Sea Region and this may require different policy interventions, accelerating the deployment of renewable energy and increasing energy efficiency are not only the greatest challenges but also provide the greatest opportunities for contributing to a resource efficient Europe. Over the longer term, greater efficiency and use of low carbon energy sources will help the reduction of greenhouse gases, however adaptation and mitigation strategies to address the impacts of climate change in the North Sea Region on vulnerable coastal communities and infrastructures will be needed.

D.2. Governance Issues

Governance is an important factor in ensuring a nation or region's transition to a low carbon economy and increasing resilience to climate change. Within the ESPON projects, governance is referred to in general terms as a mechanism for supporting territorial development and cohesion (which could be through cooperation programmes such as Interreg), the most appropriate actors/scales to deliver objectives and focusing more specifically on energy and climate issues in terms of adaptive capacity to climate change.

In the ReRisk project, it is noted that competences the three pillars of energy policy (security of supply, energy efficiency and environmental protection) in the EU are distributed unevenly between levels of government. The State places the most emphasis on security of supply, whilst regions have a greater role in energy efficiency and environmental protection (ESPON and Innobasque, 2010:62). In addition, regions which prioritise renewable energy (drawing at least 30% of their energy supplies from renewable sources) also tend to put stronger emphasis on efficiency and protection than regions that prioritise other energy sources.

Discussing the most significant drivers for developing renewable energy systems, the ReRisk project finds that regions which prioritise renewable energy production regard energy security, price and environmental protection ahead of international commitments. This signals a more bottom-up approach to energy development, with renewables seen as a strategy to mitigate against the risks of energy dependency. This understanding of drivers for renewables deployment could be pertinent in the context of next North Sea Operational Programme, as developing regionally-specific responses to energy issues may provide greater incentive for project development than the broader strategic aims of trying to meet the Energy 20:20:20 goals.

Whilst it is not the role of the North Sea STAR project to explore adaptive capacity per se, increasing adaptive capacity to climate change could be one of the outcomes of Interreg projects designed around energy systems or more integrated forms of energy planning. In the CLIMATE project, dimensions of adaptive capacity include, amongst other aspects, institutions and governance structures, with more well developed institutions seen to have greater adaptive capacity in planning for future challenges (ESPON and IRPUD, 2011:125). In assessing the options for future climate change adaptation within the Interreg programme the CLIMATE project does not identify energy related initiatives which may contribute to overall adaptive capacity – this may be because developing institutional capacity over the long term is a challenge for Interreg projects which operate within a relatively short time frame.

Nevertheless the contribution of smaller scale projects to meeting energy goals is central to the North Sea STAR project and the future North Sea Region Operational Programme, and therefore issues of scale (in terms of projects, their impacts and also the short-term nature of programmes) must be addressed. Ways of building more sustainable partnerships are highlighted in the TERCO project, which examines Interreg as one form of territorial cooperation. TERCO cites the example of project clustering within the North Sea Region Programme as a way of generating more strategic contribution to territorial cooperation (ESPON and EUROREG 2012:49) and the impacts of this approach will be explored further in the case studies of Energy Visions for the North Sea Region (EVNSR) and Low Carbon Regions (LOWCAP) as part of the North Sea STAR project.

Creating synergies to ensure the impact of operations is another key idea discussed by the TERCO project (Ibid, 50). In this case the linking up of small projects to bigger funding streams such as the Horizon 2020 programme is seen as being beneficial, although there is currently no clear mechanism through which this might be achieved. TERCO suggests the upscaling of Interreg activities from an initial pilot project to mainstream programmes with greater resources might be one way that ideas can be rolled out more widely.

D.3. ESPON Tools to Support Transnational Cooperation

A final point to note with regards to the use of ESPON evidence (maps) to inform the North Sea Region Secretariat is the development of tools and indicators by both the ESPON Transnational Support Method for European Cooperation (TransMEC) and Key Indicators for Territorial Cohesion and Spatial Planning (KITCASP) projects.

The KITCASP project is a targeted analysis project which aims at providing an appropriate core set of indicators for the preparation of territorial development strategies. The set of core indicators produced will draw on the territorial development goals set out in key European and national policy documents, existing ESPON data, stakeholder views and relevant policy indicators from the five participating countries in the project (Republic of Ireland, Basque Country, Iceland, Latvia and Scotland). Although at the time of writing the KTICASP project had not published a final report, the Interim Report highlights the importance of energy, not just in terms of Member States having to reach the energy 20:20:20 goals set out by the EU (20% reduction in Greenhouse Gases, 20% increase in renewable energy and 20% increase in efficiency), but also in terms of realising renewable energy potential as a driver of economic growth. This is most clearly demonstrated in the workshop reports for Scotland and Ireland (ESPON and KITCASP, 2012). The final set of indicators produced may offer examples of new indicators that can be used within the North Sea Region to measure energy performance over the course of the next Operational Programme and progress towards both national and European targets.

TransMEC aims to support the delivery of evidence based results within the context of territorial cooperation programmes. The TransMEC project has developed a range of applications based on available ESPON data and other sources (for the area covered by the Interreg IVb North West Europe Programme) that allows new overlay maps to be produced, for the purposes of:

- Identifying key territorial potentials, themes and regional stakeholders
- Visualising Programme achievements
- Monitoring of on-going Programme performance, and
- Assisting future decision making.

The potential use of the 15 TransMEC applications to provide information for the North Sea Region Programme in relation to energy issues is discussed in Table 6. Given the paucity of energy data at NUTS2 level or below and the relatively small number of ESPON projects with a distinct energy theme, the most useful of the applications outlined in the Table are those relating to the distribution and type of project partners and funds (Applications 2, 3, 8, 9 and 11). These can be used to build up a picture of achievements in Interreg IVb energy projects, and be used to track the type of projects and partners that may engage with the energy theme during the next programming period. In particular, these applications could be used to steer project development towards those regions in greatest need of building capacities related to the low carbon economy, efficiency or renewable energy, or help in the formation of project partnerships and new clusters with appropriate expertise to deliver tangible and long-lasting outputs.

Table 6: Potential use of TranSMEC applications for the North Sea STAR project

Application	Relevance/ Usefulness	Justification
1. European Wide Context Visualising the NWE programme area in a wider European context	Medium	Using territorial indicators (maps) that show North Sea Region in the wider context of Europe may help to demonstrate where the North Sea leads in specific thematic fields, e.g. energy production from renewables.
2. Partners/ERDF variation Variation between the number of participating partners OR the ERDF budget spent and comparing both maps	High	Besides providing an overview of geographical distribution of partners/projects, this information can be combined with other indicators to show how distribution of beneficiaries corresponds to other evidence available, e.g. low carbon transport projects/metropolitan areas.
3. Scale variation Variation of scale between NUTS 2 or NUTS 3	Med/High	Mapping at NUTS2 may provide clearer visualisation but lacks sufficient detail. NUTS3 level can provide greater detail of individual partner or project achievements and will be used in relation to the North Sea STAR case studies.
4. Zooming in Zooming into parts of the NWE territory	Medium	The application can be used to present the territorial evidence of a specific section of the North Sea area in detail in combination with the precise location and volume of North Sea interventions in the related field. For energy this may rely on territorial evidence presented at NUTS2 level or below, where there is a lack of suitable pan-European data, but could be applied within a specific country if lower level data (e.g. for municipalities) is found.
5. ESPON maps revisit Reassessment of ESPON maps used in the INTERREG Operational Programme	Medium	ESPON data may provide useful baseline evidence for defining programme strategies and priorities and can be updated over the course of an Operational Programme to demonstrate the achievements of programme activities. Whilst lack of lower level energy data is problematic, the maps created by North Sea STAR could be retained and updated by the Secretariat over the next Operational Programme.
6. Filtering Extraction of selected data layers from ESPON maps for specific thematic foci	Low	This requires the disaggregation of complex data sets developed by ESPON (e.g. typologies) and requires that the original datasets used are available. In this instance energy related data in the ESPON database from the ReRisk project is not sufficiently up to date for future programming.
7. Annual performance update Annual update of the programme performance against a constant background map	Medium	Mapping new projects against a constant background map at regular intervals would allow for monitoring of progress against particular calls or themes, enabling the programme Secretariat to steer territorial impacts more effectively.

Table 6 Continued: Potential use of TranSMEC applications for the North Sea STAR project

Application	Relevance/ Usefulness	Justification
8. Thematic foci of cooperation Checking thematic concentration vs. broad thematic orientation of NWE projects in a defined region.	High	Mapping specific sub-priorities can help to steer and monitor projects in order to develop targeted actions, for example ensuring regions do not over-specialise. In the context of energy projects this might be used to ensure that energy, if not a specific theme in its own right, is adequately addressed under other themes such as innovation.
9. Comparison of programme performance Comparing/Aggregating the programme performance from two different programming periods (IIIB/IVB)	Med/High	Mapping projects over two Interreg periods may provide some useful perspectives on different themes that have been covered and could facilitate further dissemination/exchanges between projects on similar themes, or help to target future beneficiaries in regions that have not previously had a high level of participation.
10. Demarcation of targeted calls Assisting the demarcation of thematically targeted calls through identification of territorial challenges	Low/Med	After the first calls for proposals, gaps in thematic or territorial coverage can become apparent and this approach would enable targeted calls to compensate for underrepresented regions. (The North Sea STAR project will be completed before first calls for Interreg Vb projects are announced).
11. Partnership composition Assisting project development respectively project actors to select partners in highly profiled territories	Med/High	This would enable potential beneficiaries to select partners with relevant competences/territorial characteristics to help meet project aims, or enable the Secretariat to profile the types of partners involved. For energy projects this may be useful to ensure a suitable mix of beneficiaries from local government, research and the private sectors.
12. Use of ESPON typologies Working with ESPON typologies for new, emerging themes	Medium	Combining Interreg Programme data with ESPON typologies can provide better understanding of territorial development in relation to certain themes (e.g. the ReRisk typology might cross-referenced with energy projects to determine differentiated patterns of development with respect to energy efficiency).
13. Differentiation of partners' institutional background Sub-differentiating different participant groups within one or more priorities	Medium	The differentiation of partner institutions (e.g. private sector, municipality, NGO etc) and mapping these against relevant typologies can demonstrate which types of partner are attracted to particular themes or projects, enabling a more refined approach to partnership composition in future activities.
14. Use of typologies combined with partners' institutional background Assessing the performance of sub-groups in the programme against new typologies: Combining Application 12 and Application 13	Low	This is a combination of applications 12 and 13 and may be used to understand the territorial dimension of new or existing themes – or to explain it another way, which partners in which places are more likely to engage in transnational cooperation.

Table 6 Continued: Potential use of TranSMEC applications for the North Sea STAR project

Application	Relevance/ Usefulness	Justification
15. Application at regional level "Changing the perspective" – Assessing territorial needs and choices of project actors at regional level	Low	This is a more qualitative application that requires direct contact with project beneficiaries at regional level and their views on how available evidence may change their perspective on territorial development linked to their region or a particular theme. For North Sea STAR the lack of lower level energy data would prevent rigorous use of this approach.

D.4. Policy Options and Recommendations with Relevance for the North Sea

In the following Tables (7 to 10), recommendations from ESPON projects are assessed in terms of high, medium or low relevance for the North Sea STAR project and a justification for their categorisation is given. In addition to identifying recommendations by their level of relevance, those with high or medium relevance can be further distinguished with reference to their most likely target audience. This could be:

- The North Sea Region Programme Secretariat,
- The North Sea STAR project team or ESPON community, in terms of providing methodological insights, e.g. for data collection and capitalisation upon project results,
- Interreg project partners and future beneficiaries, in terms of highlighting areas where new projects could be developed.

As the North Sea STAR is one of ESPON Targeted Analysis projects, the focus is on recommendations that are of most use to the North Sea STAR project team and the North Sea Region Programme Secretariat. Therefore whilst some recommendations may be important for overall energy policy and actions towards Europe's 20:20:20 goals, those recommendations which are directed at national and European level policy makers are considered to be of lower relevance here.

Table 7: Recommendations from the ESPON ReRisk Project

Recommendation	***Relevance for NSS Projects***	***Comments***
Governance		
Promote energy solidarity between regions and territories	Medium	Ensuring complementary development of energy infrastructures across regions requires a strategic approach at the EU level, although the production potential of both renewables and fossil fuels means within Europe, the North Sea Region is well placed to support neighbouring regions through its export potentials.
Strengthen regional and local networks	Medium	Strengthening networks could help increase local resilience, but improvements to these networks are partly a function of how much control local and regional agencies have over managing energy supply and demand.
Fund and stabilize transnational research agencies	High	Focus on innovation and transnational working could add value. Stronger links between academic, business and government organisations which can be promoted through the North Sea Region Programme could assist here.
Promote awareness among regional policy makers on the impact of rising energy prices and the need for economic diversification	Medium	The role of dissemination and project results may become important here in signposting ways to minimise the impacts of rising energy prices (e.g. through alternative energy sources). Economic diversification will be dependent on local and regional structural conditions.
Define a vision for a regional energy model 2050	Low	The relative importance of national v regional planning makes this challenging, particularly as different nations within the North Sea Region have diverging ambitions for renewables. However the EU’s Energy Roadmap 2050 may help to guide the formulation of broad principles.
Push municipal leadership in public-private partnerships	Medium	This kind of arrangement is beyond the scope of North Sea Region projects – the payback period for such investments needs to be carefully considered in the current economic situation.

Table 7 continued: Recommendations from the ESPON ReRisk Project

Recommendation	***Relevance for NSS Projects***	***Comments***
Spatial Planning Policies and Strategies towards a more Sustainable Territorial Management		
Develop integrated spatial planning instruments	Low	This is generally beyond the scope of North Sea Region Programme projects and not the aim of this study, but the spatial implications of the low carbon economy need greater recognition in spatial planning.
Establish urban planning principles for solar energy use	Low	New projects could have a role to play in demonstrating techniques to model solar energy potential in domestic energy settings.
Implement Urban Metabolism procedures	Medium	Studies of urban metabolism using case studies from around the North Sea Region could be an interesting transnational project.
Promote industrial symbiosis and/or industrial eco-parks	High	There are already projects designed to promote such interventions, though the benefits of such schemes should be more widely disseminated. Initiatives that support more efficient district heating could be particularly relevant for the North Sea Region.
Environmental Protection and Risk Prevention		
Sustainable use of biocrops	Low/Med	Further investigation into the use of biocrops could represent opportunities for new projects.
Prepare for climate change impacts in the regional energy infrastructure	Med/High	Although this recommendation is geared towards areas that may experience longer periods of hot, dry weather in summer, climate change mitigation is a serious issue for the North Sea Region with regards to low lying coastal areas and extreme weather events that can put stress on energy systems. Planning to increase the flexibility and resilience of energy infrastructures at local and regional levels can contribute to this.
Policies to Accelerate Deployment of Renewable Energy Sources		
Evaluate the feasible potential of all renewable sources in the region	Low	This is beyond the scope of the Programme Secretariat - the cost of such an assessment is likely to be high and shaped by national subsidy programmes in changing economic conditions.
Incorporate solar and wind facilities in urban areas	Low/Med	This may be a suitable activity for new projects, though it is difficult to see the added value of transnational working.

Table 7 continued: Recommendations from the ESPON ReRisk Project

Recommendation	Relevance for NSS	Comments
Policies to Promote Energy Efficiency		
Improve the data on energy use and efficiency in Europe	Low	An investigation of energy data availability through Eurostat and other European/international sources for the North Sea STAR project has revealed that this is an area where large improvements could still be made, and this should be a priority at national and European levels.
Accelerate the transition to non-fossil fuels in the aviation industry	Low	This is beyond the scope of the North Sea Region Programme.
Create a market for energy efficiency (White certificates)	Low	Needs to be developed and approved at a larger scale, either national or European level.
Improve efficiency of office design and work arrangements	Low	Changes to working arrangements and possibilities for the "networked office" could provide potential for projects in the next funding period, however the need for a transnational approach could be questioned given the diversity of building styles and cultures throughout the region.
BAT (Best Available Technologies) for industrial energy efficiency	Medium	For sectors identified as having a high energy purchase (e.g. iron and steel production, chemical processing) adopting more efficient technologies requires economies of scale that are beyond what the Programme can fund. However, the possibility for innovative transnational working in industrial sectors that work on a smaller scale should be considered.
Policies to Fight Energy Poverty		
Improved transparency and information on energy consumption	Low	These actions should be taken by others such as national governments and energy companies.
Consumer awareness and education; involvement of end-users	Medium	Informing consumers and end users about efficiency and low carbon sources of energy and small scale training programmes for improving skills in energy related occupations could be appropriate activities for future projects.

Table 8: Recommendations from TERCO

Recommendation	Relevance for NSS	Comments
Impact of European Territorial Cooperation (ETC) on socio-economic development		
stability of funding for European Territorial Co-operation (ETC) activities should be assured to exploit its benefits	Med	Stability of funding is crucial for ensuring that the successes of previous projects can be built on, however this is a matter for the European Union and Member States to deliver.
In order to achieve more territorial integration via ETC, it seems that the issue-based approach to ETC and good governance practices need to be implemented	Low/Med	Territorial (cross-border) integration is not the main purpose of the NSR Programme. However, adopting energy as a theme for the next Operational Programme, if not explicitly then as a cross cutting issue, could help to stimulate territorial integration.
Geographical areas of territorial co-operation		
There is no immediate need for geographical expansion of ETC programmes… However, ETC efforts would benefit from increased inter-programme cooperation	High	This recommendation supports current thinking within the North Sea STAR project regarding the proposed clustering of energy projects across Programme Areas in order to support greater synergies between projects and deliver Energy 20:20:20 targets.
If, however, new areas of co-operation are considered within ETC, there is potential for extension within Transnational and Transcontinental Co-operation.	Low	(Possible areas for inclusion in additional transnational cooperation programmes are specified within the TERCO report, including north west Germany, but it is beyond the scope of this project to consider the boundaries of Programme Areas).
Decisions on eligible areas for ETC programmes should depend on the boundaries of the issues/problems they aim to resolve rather than on arbitrary distance or the administrative boundaries of the regions.	Low	This recommendation is aimed more specifically at Interreg A programmes, but shows that the issues addressed by Operational Programmes may have a wider relevance that can assist in the development of inter-programme activities.

Table 8 Continued: Recommendations from TERCO

Recommendation	Relevance for NSS	Comments
Thematic areas (domains vs. issues) for territorial co-operation		
Rethinking the issues addressed by ETC would be beneficial…	Low	This is beyond the scope of the North Sea Region Programme.
The solution could be to specify a list of priority issues that ETC should address, but the choice of domains to tackle those issues should remain open.	Low	The recommendation/list of issues provided is more suited to cross-border cooperation programmes. Priority themes for the North Sea Region Operational Programme will be derived from the Common Strategic Framework and stakeholder engagement.
…Policy-makers could consider 'Territorial Keys' (proposed by Böhme, Doucet et al., 2011) as possible thematic issues that ETC could tackle.	Low	
Key determinants of success in territorial co-operation		
Strengthening the wider participation of actors in ETC, assuring availability and sustainability of ETC funding, allowing different forms of co-operation at different stages of co-operation (from easy to more advanced), and providing a wide range of domains for ETC (within a restricted range of issues) would be appropriate actions to generate more effective ETC policy.	Med	Ensuring wider participation should be a standard objective of transnational programmes, and in particular SMEs might be a particular group of stakeholders to focus on in delivering energy projects. Different forms of cooperation may be more difficult to implement within Interreg projects, but clustering could allow for some stakeholders to take on different roles over the lifetime of a project. As before, the range of domains and issues covered by the Programme are a more strategic matter.

Table 8 Continued: Recommendations from TERCO

Recommendation	Relevance for NSS	Comments
Governance structures and good practice in territorial co-operation		
New TC support structures could promote collaborative forms of policy formulation and delivery.	Low-Med	This recommendation talks specifically about partnerships of the State, private sector and civil society and the importance of such partnerships in peripheral regions where multiple support mechanisms are needed to support entrepreneurial activity – such partnerships are also to be encouraged within the North Sea Region.
Co-operation of sustainable partnerships, rather than mere projects, should be a target of multi-annual support.	High	This is a key challenge for ensuring the legacy of Interreg projects – the recommendation suggests supporting the creation of new networks to assist private and social entrepreneurs. Such networks could be formed through project partnerships or clusters of projects, but would require additional financial support over the longer term.
Continuity and consistency of co-operation in TC must be supported as key factors of its efficiency.	Med	The North Sea Region Programme cannot provide continuous funding (as proposed in this recommendation) to support long term projects, but should try to encourage greater private sector involvement in project implementation or in communicating project results to lever in additional financial resources. Providing more opportunities for exchange between projects (e.g. through clustering) can promote continuity of ideas.
A change in focus within TC opportunity structures	Low	This recommendation suggests that "civil society networks and local-regional co-operation are prioritised and eligible for more generous and specifically targeted support". However it may not be possible to steer the composition of project partnerships in such a specific manner.
Policy recommendations by TC types - Interreg B		
Extending the eligibility criteria	Low	This recommendation specifies regions that could benefit from being included in more than one cooperation area within the Interreg B programme. It is not the purpose of this project to redefine the boundaries of the North Sea Region.

Table 9: Recommendations from Territorial Trends of Energy Services and Networks and Territorial Impact of EU Energy Policies (ESPON 2006)

Recommendation	*Relevance for NSS Projects*	*Comments*
Availability of statistical data	Low	The availability of comparability across Member States is a problem we have encountered as well, and beyond the scope of NSS to do anything about.
Local energy agencies	Low	The establishment of local energy agencies is an interesting idea, and would provide greater continuity for some of the activities already being undertaken by North Sea Region projects with regards to informing energy efficient behaviour and promoting local renewables, however funding this is beyond the scope of the current Programme. In addition to this, the need for a transnational approach can be questioned given that such organisations would have to be integrated with country or region specific governance structures and energy markets.
Local versus national policies	Low	This is a within country issue rather than a transnational issue or concern, although national or regional variations inevitably shape the take up of energy efficiency/lower carbon energy production processes.
Renewable energy development	Low/Med	Potential for capital projects is limited within the Programme, though enhancing skills and developing SMEs that service the renewables sector could be a more realistic aim for projects.
Flexibility in price policy	Low	Pricing policy issues are beyond the scope of this project, although flexibility in pricing will inevitably have influences on demand and supply.
Promoting full costing of energy use	Low	This is largely shaped by national and international markets.
Promote R&D on energy efficiency and use of renewables	Low	Large scale R&D into these areas more likely to be funded by bigger European research programmes such as Horizon 2020
Need for an integrated approach to energy policy	Low	This recommendation focuses on large scale and strategic matters to be dealt with at European and national scales. Since its proposal, the EU has developed a number of policies aimed at a more integrated policy: ‘Energy 2020: A Strategy for Competitive, Sustainable and Secure Energy’ (CEC, 2010) and the ‘Energy Roadmap 2050’ (CEC, 2011) and the provisions within the Common Strategic Framework represent examples of the efforts being made in this regard.

Table 10: Recommendations from ESPON CLIMATE

Recommendation	Relevance for NSS Projects	Comments
For metropolitan/urban regions, high impact, but strong resilience and adaptive capacity, with spatial planning needing to promote greater resilience in various ways	Low	Fairly generic, limited relevance beyond contextual information.
Coastal Regions: high impact due to sea level rise and potential for increased tourism in the North	Low	Fairly generic, limited relevance beyond contextual information.

Within the ESPON Climate project, recommendations associated with metropolitan/urban and coastal regions have the greatest pertinence to the North Sea Region, however their specific relevance from an energy perspective is limited. Within metropolitan/urban regions, “Efficient spatial structures” would undoubtedly help increase energy efficiency but such ambitions require large scale actions that may not be possible in existing urban settlements. In relation to coastal zones, these are becoming increasingly important sites as for energy production and storage, however the Climate project also highlights the potential vulnerabilities of infrastructure in such areas and this should be taken into consideration when designing future North Sea Region Programme energy projects.

D.5. Conclusions on the Use of Existing ESPON Results

This review of projects has provided the opportunity to select the most relevant territorial evidence and tools for supporting transnational cooperation that ESPON can offer to support the work of the North Sea STAR project. Alongside the main stakeholder sparring, case study and synthesis activities being undertaken by the North Sea STAR project, these additional insights can help the North Sea Region Secretariat in the development of energy projects as it moves into the programming period for Interreg Vb.

The ESPON maps presented in this review complement the data collection work already undertaken by the North Sea STAR project team in providing additional contextual material, showing the energy situation and potentials that exist in the North Sea Region. Whilst there is good data on (land based) wind and photovoltaic potentials for the region there are still some gaps relating to other renewables such as hydroelectric and biomass which may need to be tackled on a country-by-country basis in order to provide adequate detail. There is still also a lack of detailed, up to date information on energy production and consumption at a sub-regional level that must be tackled in the same way. The applications developed by the TranSMEC project can be used to generate more data based on energy projects under the Interreg IVb project that may aid future decision making, but without more comprehensive energy production/consumption data these tools may be limited to focusing on the spatial, financial and institutional distribution of projects and have a lesser role in monitoring project achievements against broader energy indicators.

The typology maps presented here reflect to a large extent what is already known about the region and its energy performance in relation to self-sufficiency, or in the case of the CLIMATE project the factors which may affect energy performance in the future. Overall it appears that increasing energy efficiency is the measure that is most greatly emphasised in order to help regions maintain self-sufficiency and minimise the risks of exposure to rising energy prices, whilst the further deployment of renewables may also assist those regions that are less self-sufficient.

With regards to the recommendations offered by the different ESPON projects, many of these recommendations are aimed at national and European policy makers or attempt to tackle issues that must be resolved at a strategic level beyond the capacities of the North Sea Region Programme Secretariat, for example in relation to capital investment, energy pricing policies and infrastructure planning. However a number of recommendations suggest activities that could be the focus for new projects to be supported by the next Operational Programme, including:

- Investigating the feasibility of renewables deployment in urban settings, e.g. solar and wind use,
- Raising consumer awareness of alternative energy sources,
- Education and training related to renewable energy/energy efficiency,
- Expanding eco-innovation/energy services in industrial parks.

In addition to suggestions for projects, the recommendations provide some points to consider about partnership building and ensuring long-lasting impacts of Programme (or project) activities. While the North Sea Region Programme is unable to fund long term networking, the process of partnership building and clustering projects could support the creation of new networks with the capacity to and resources to continue transnational cooperation. As suggested by the TERCO project, developing synergies with other projects and funding streams that enable the upscaling of pilot projects could also support this. Providing opportunities for inter-programme initiatives, whether this is merely dissemination of project results and exchanges of best practice, or developing joint projects and themed project clusters could also help to increase the impacts of projects, but to some extent the formation of such arrangements depends on the political will of project partners and funding bodies to facilitate this type of joint working.

Lastly, the broadening out of partnerships to engage SMEs and facilitate entrepreneurial activity needs to be carefully considered in future programming activities. Whilst complex administrative requirements for European funding programmes can be a disincentive to private sector involvement, Interreg programmes could provide valuable learning experiences and opportunities for economic development in relation to innovation and low carbon/renewable energies. In the context of the current economic crisis, private sector partners may become more attractive as the ability of local and regional government actors to co-finance projects is diminished, and thus ensuring the right administrative support is in place to help SMEs participate in Interreg is crucial.

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Annex E – Energy Scenarios for 2050

This Annex prvides further details of the elaboration of the energy scenarios described in Chapter 3 of the Interim Report.

E.1 Scenario 1 - Implementation of Recent Policies

This scenario envisions that current ambitious energy and climate goals will be achieved. For each of the ten criteria the following impacts can be anticipated.

Energy Production – The North Sea Region is a core region of the EU's energy transition where the total power capacity installed in Europe will reach more than 1,200GW by 2050. Renewables will represent more than half of newly installed capacity, requiring an investment of around €2 trillion (at 2005 prices) for the period up to 2050. In the North Sea region, power generation will rise by more than 20% until 2050, with renewables representing 55% of total generation by 2050. Of this, 35% will come from onshore wind, approx. 30% from offshore wind, and 15% from solar. Bioenergy will also contribute significantly to the energy mix, while renewable energies from geothermal sources and marine sources (tidal, currents, waves) will contribute small shares. Nuclear's share of energy production will not change considerably. The share of solid fuels in the electricity mix will be cut by half by 2050. In some regions, remaining coal fire plants are converted to cofire generation[12] and fitted with carbon capture and storage (CCS). Since the mode and localities of power generation will change considerably in the next decades, investments are needed to adjust the grid infrastructure onshore and offshore and to improve the reliability of aging energy infrastructure.

Energy consumption - In accordance with existing national and European energy strategies the regions around the North Sea invest in insulation and energy savings measures. Financial incentives, regulations but also slightly increasing market prices for energy are drivers for this process. Progress in savings is mainly made in housing, industry and agriculture. In contrast road traffic and aviation lead to increasing energy consumption which is partly compensated by savings in other sectors. On-going regional and European integration processes as well as advancing globalisation lead to more passenger traffic and goods transport. Energy consumption is a broad mix of different energy types. Natural gas plays an increasingly important role on the way towards more renewable energies. District heating is available in all urbanised regions. But also energy consumption by oil products continues to play a dominant role, especially in the transport sector. Electricity consumption is to a large degree based on renewables, mainly wind, biomass and photovoltaic. Migration mainly from rural areas causes a slight decrease

[12] Cofiring means that power stations are able to burn two fuels simultaneously.

in population which contributes to stable or slightly shrinking energy consumption patterns.

Energy efficiency - In all parts of the North Sea Region new buildings and buildings undergoing renovation have to meet energy codes and minimum energy performance standards. Progress in achieving better insulation and efficient building equipment and appliances is slow but continuous. Energy production, industry and transport become more efficient due to technological progress, market benefits and incentives. Research comes up with technological innovations and concepts for better integration of various elements in the energy system. But strong progress in achieving better energy efficiency is hampered by disintegration. Monitoring, enforcement and evaluation of cross-sectoral energy efficiency strategies is not fully implemented.

Energy costs - Excluding hydro, the costs of all renewables will decrease. By 2050, wind will be the lowest-cost renewable, at €0.04–0.05 per kWh (offshore will be slightly more competitive than onshore). Solar costs will drop nearly 80% from €0.44 per kWh in 2010 to €0.09-0.11 kWh, but solar energy is projected to cost almost twice as much as wind and hydro in 2050. Bioenergy costs will be slightly higher. The potential for increasing the supply of new hydro or bioenergy are limited. Wind and solar have much greater potential and benefit from technological innovations. Both factors are main drivers of cost reduction. Regarding non-renewable energy, energy costs tend to increase. An increase is also projected for the market price for fossil and nuclear fuels. In 2050, non-renewable energy is expected to cost twice as much as wind energy. Electricity trade via international grids favours the massive integration of renewables. The main effects of this trade are decreases in the need for back-up installed capacities and for large-scale storage technologies. Related infrastructure in the North Sea region and neighbouring regions will also buffer market fluctuations in energy prices.

Technological Innovation - Development and rapid implementation of innovations in the fields of energy delivery and energy efficiency are key to transitioning to an affordable, predominantly renewable energy landscape. Reliability of currently available renewables (wind, solar, geothermal, bio and hydro) will increase in the coming years as a result of technological improvements, i.e. better efficiency and lower materials use. For the same reason, costs for infrastructure will decrease. Installations will benefit from economies of scale effects resulting from increased production. Improvements to energy storage and low-loss transmission capacities will be expanded in concert with renewable electricity generation capacities. Technological innovations in the energy distribution infrastructure are also challenged by the stepwise balancing of interests of different parties participating in the European energy market. The North Sea Region will continue to be an energy exporting region, but needs to develop and to invest in appropriate infrastructure. The implementation of super-smart grid infrastructure is also a crucial aspect which challenges information and communications technologies (ICT) in the North

Sea offshore grid. Innovative new solutions will also be made and those renewable energy technologies (hydrogen and marine (wave-tidal-currents)) which are currently in the early stages of development will become mature.

Societal Partners - Reform of existing carbon and electricity markets will be crucial in achieving the emissions reduction goal, and the cost internalization of greenhouse gases. This need challenges all societal parties to develop and establish well-functioning markets as the energy transition progresses. A diverse set of alliances will subsequently emerge. The alliances will focus the regional energy production and consumption chains. Stakeholders entering the energy market as new partners due to developments in renewables become easily accepted partners of the chains. Formal and informal approaches to planning and management of energy strategies will be accompanied by shifts of national budget priorities and acknowledge the importance of investing in an intelligent energy economy. Entrepreneurial activities are promoted by an intense public-private dialogue and the formation of multi-sectoral clusters on a sub-regional scale.

Social changes - Technology and social structures involving individuals, groups and institutions change over time. With respect to the North Sea Region, energy technology and society evolve and improve simultaneously and in balance. This co-evolution arises from the interactions of the involved actors and their informed decisions. The dynamics of the North Sea Region population is not impacted by demographic changes or shifting economic preferences. The energy transition will promote the human well-being in both urban and rural areas. New approaches to energy production and consumption will, in a stepwise manner, help to improve the socio-cultural conditions in marginal areas of the North Sea Region. It still seems inevitable that better coordination of energy policy, spatial planning and land-use regulation issues are needed. This requires the establishment and/or improvement of integrated planning structures at the national and regional levels and the re-design of subsidy schemes. The closer adjustment of land development plans to energy efficiency and sustainability criteria, and the fostering of increased cooperation across municipal and county lines remain an objective for the future.

Policy making – Ambitious energy policies have existed since the turn of the millennium. Climate change and secure energy supplies in times of rising energy prices have been intensively discussed. The general messages from this time are still valid but are not an important part of national policies anymore. For regions and municipalities, however, the topic is still a central part of the- regional development strategies. With this change in policy level from the European and national sphere to lower levels possibilities of steering energy efficiency and of renewables actions becomes weaker. In addition, the synergy of research, innovation and good governance is difficult to create at lower levels. The major ambitions, therefore, stay unchanged and are slowly implemented by regional and lower governments and private stakeholders. The national level missed the opportunity to develop the necessary legal framework for the implementation of a new energy infrastructure which is needed to link renewable energy producers and consumers. Legal ambiguities lead to various court cases which establish the necessary legal framework in a stepwise manner. However, this is time consuming and slows down the implementation of new energy infrastructure.

Economic development - With the global economic crisis from 2008 and a subsequent recovery the price of crude oil has been stable for several years. With the return of world growth, to slightly below pre-crisis rates, the price of Brent crude increases to far above early-2012 levels by 2020. Before this increase European and also North Sea Region´s economy has suffered from higher energy prices in comparison to the United States. From 2020 onwards, greater independence from global energy markets and imports turns into a benefit for economy in the North Sea Region. Some firms heavily benefit from the trend towards more renewables and more efficient technology. Major companies in the energy sector gain about half of their revenues from energy-saving and green technologies. Coastal areas particularly benefit from the economic development and the economic growth at a national level is not hampered by the energy transition process.

Social learning - Creating a radical energy transition requires an awareness of complex learning processes. Such processes involve a multitude of actors and levels such as energy providers, policy actors consumers, social networks, and broader societal contexts. The energy transition shapes up as a catalyst for system innovations. The profound change requires the re-configuration of technologies and modified institutions (e.g. regulation; informal norms such as professional cultures and cognitive paradigms). Social practices (e.g. use patterns, lifestyles), as well as cultural norms and values will shift to more collaborative approaches. The active political and social action taking is benefitting from shared visions of the energy system and from continuous adaptation of innovations.

E.2 Scenario 2 - Zero Carbon society

In scenario 2, the shift from fossil to renewable energy sources is proceeding even faster and with more socio-ecological benefits than expected. Impacts on and for the criteria can be envisaged as follows.

Energy production – The North Sea region is successful pioneer in the energy transition. In 2020, 35% of the energy production will be related to renewable sources which will become the sole source of energy production by 2050. Power generation will rise by less than 10% until 2050. Of this, 30% will come from onshore wind, approx. 30% from offshore wind, 20% from solar and 15% from bioenergy. The share of geothermal and marine sources (tidal, currents, waves) will become more relevant in the last decades before 2050. The decommissioning and, wherever possible, adaptation of the fossil energy infrastructure will be harmonised with the build-up of a modern renewable energy based infrastructure. Mode and localities of energy production are driven by the needs of the consumers. This decarbonisation of the power sector will require investments in renewables and their large-scale uptake in the electricity system. Investments in smart grids are also needed, with a particular focus on transmission and distribution structures.

Energy consumption - The building stock is renovated towards modern standards in all parts of the North Sea Region. The North Sea Region specialises on the export of their fossils and spends part of the profit of these exports for a quick and innovative change towards a carbon free society. Individual transport will stay important in large areas of the often rural North Sea Region. But cars and trucks will operate on biofuels for long distance journeys, while for shorter trips electric drives dominant. Both techniques may be joined in hybrid cars. Also shipping and aviation will turn towards more biofuels by 2050. In addition gas is used in transport with increasing shares of biogas instead of natural gas. Heat available from industry and biogas plants is used for district and production heating. Solar heat and heat pumps are the dominant heating systems in detached houses. A smart grid is established and major consumers become even more flexible in using and storing energy when it is cheap while they reduce their consumption during more expensive periods. The use of natural gas and gasified methane becomes an important transitory technology. The carbon emissions resulting from these are compensated by carbon capture and storage techniques where carbon is stored e.g. in former gas fields. This scenario requires energy savings of 15%.

Energy efficiency -Transport is organised in the most energy efficient way. Long distance travels, for example, are as far as possible done by train instead of flights or individual traveling by car. Deteriorated energy infrastructure is without exception replaced by modern and efficient technique supporting a mix of renewable energies together with selected fossils (mainly natural gas). Gasification of electric energy (Power-to-Gas), e.g. from wind farms, is established not only in pilot projects but also on larger scale. This technique is yet not too efficient by itself but allows a quick transformation into a zero carbon society by using existing infrastructure, e.g. pipelines, storage facilities and heat systems for natural gas. Industry and SMEs have an energy management in place implementing highly efficient industrial equipment and systems. Energy efficiency has become a core interest of regional and national governments as the mid-term economic benefit has been clearly understood and is publicly accepted.

Energy costs - Renewable energies will become the major source of energy in a short period of time. By 2050, renewables deliver energy in an affordable and reliable way. Existing infrastructure from the fossil and nuclear phase of the energy production, distribution and consumption will be re-used and adapted wherever possible and economically feasible. This approach contributes to keep the consumer´s contributions to investments in grid and storage infrastructure low. Effective energy installations are crucial in decreasing costs for all renewables. By 2050, wind will be the lowest-cost renewable, at €0.03–0.05 per kWh (offshore will be even more competitive than onshore). Solar costs will drop to €0.08-0.11 per kWh. Bioenergy costs will be slightly higher then. While the potentials for further cost reduction or the integration of additional resources of hydro or bioenergy are limited, wind and solar will benefit from significant technological innovations in conversion efficiency and robustness both being main drivers of cost reduction. Before the turn to renewables only is completed several years before 2050, the energy costs of non-renewable energy tend to slightly decrease as it is projected for the market price for fossil and nuclear fuels. In 2050, energy trade via international grids favours the massive integration of renewables. Related infrastructure in the North Sea Region and neighbouring regions will also buffer marked fluctuations in energy prices.

Technological Innovation - The next decades breed successful implementation of significant innovations in the fields of energy delivery and energy efficiency. Technological barriers in all the sectors of renewable energies will be un-locked for several reasons. New materials will markedly improve the efficiency of solar even by 2020. The up-scaling of wave and tidal and hydrogen from pilots to large scale installations including the embedding in the energy infrastructure is a success factor for regional sustainable developments. New mobility technologies lead to increasing efficiency and reduction of carbon dioxide emissions. Feed-in of biogas instead of natural gas will promote increasing application of electric and biofuel powered engines in the expanding transport sector. Innovations to low-cost and low-loss grids help to further optimise the distribution of electric energy, heat and gas for various purposes. The positive impact of technological innovation will be maximized by innovations in the socio-technological realm. Related positive effects can be observed in the field of energy efficiency and cover all forms of producer-consumer alliances.

Societal Partners - New social and organisational structures are recognized as being of high importance in re-shaping the socio-economic energy landscape in the North Sea Region. A first step towards a more sustainable energy system is involving more social actors. In order to get these systems to work in practice, social actors from research, technological development, planning as well as architectural and political fields manage to organize themselves soon and successfully. Close cooperation with investors and on-site users prove to be essential in that respect. The transfer of good practice and appropriate local participation models enable societal partners to establish sound policies and frameworks. The implementation of innovative settlement showcases and business clusters are steps towards a more sustainable energy future. The new societal partnerships are capable of compensating for barriers due inconsistent government policy.

Social changes - Although it is of course not possible to predict which innovations or new concepts could arise and be successful, the harmonious evolution of the socio-ecological and socio-technological spheres is a key feature of the significant progress in the decarbonisation as priority field of the NSR. Of importance here is the positive impact of energy transition measures in coping with the challenges of demographic changes, disparities of urban and rural areas and economic crisis. Many individuals and most of the societal groups can benefit from resilient social structures which are strengthened or emerge from a more renewable, multi-modal and decentralised approach to the energy sector. Vice versa, the energy sector is becoming more robust with respect to regulatory uncertainty as the uncertainty for the developer in receiving the required permits for energy infrastructure. Regional governance approaches are an additional instrument for the strategies of involved groups of actors in timing and locating infrastructures in line with interest of the public in sustainable development from the local to the NSR level.

Policy making - Public awareness of climate protection and sustainable energy policy is high and part of election campaigns and public discussions. Governments therefore develop strong frameworks for energy efficiency and accelerate implementation by stimulating investment, monitoring, evaluation and enforcement. The expansion and conversion of energy grids is prioritised by legal frameworks. Research and development are heavily involved in developing a holistic energy concept and the necessary technologies. Regions around the North Sea cooperate intensively and contribute to a stable and climate friendly energy mix. Sophisticated governance initiatives achieve a movement towards political structures that enable more negotiation between contending interests, rather than the imposition of one interest over others. Major energy suppliers and industry still have a large share in energy production, transformation and storage. But at the same time many within the population are also engaged and hold shares in energy facilities. This is true not only for small scale facilities such as photovoltaics, but also for large energy systems. Energy production has become much more democratic which again raises awareness and interest of people. Renewable energy is mainly sold by direct marketing and subsidies are limited to a few elements of central importance, e.g. selected storage technology.

Economic development - On a global level the world order is held together by nationally disembodied, economic relationships. There is a drive to open national borders, underpinned by a belief in market efficiency. Economic growth helps developing countries to close the gap with developed countries, which also achieve further growth. This new world order leads to a significant increase in prices for fossil energies. Because global natural gas production growth is more modest than anticipated, prices, which remain regionalised, are strong in regions of relative scarcity. Resource stresses become severe. High prices and periodic crises stimulate strong demand-side attention to increase utilisation efficiency, which in turn further increases the focus on adaptation to the effects of climate change. For those regions which have no or nearly no access to fossils it becomes financially attractive to save energy and to produce renewable energy within a stabilising North Sea Region wide network. For other regions around the North Sea, which have access to oil or natural gas, increasing energy prices make it more attractive to sell fossils instead of using them by the regions itself. Initially high costs for a quick transition towards a zero carbon society on North Sea Region level show now in their revenue.

Social learning - The energy transition of the North Sea Region is a worldwide recognised blueprint. The related social learning processes promote the sustainable development of the North Sea Region and its sub-regions. Sectors, groups of individuals share differing knowledge and experiences involving the revelation and integration of different and often contrasting participant viewpoints. In addition to local to national structures, strong transnational settings have been established in the North Sea Region. The interplay of many societal partners has improved the ability of the North Sea Region to innovate. The energy sector is a major driver for societal inclusion and making the North Sea Region a frontrunner in all respects of sustainable development. Improvement of integrated planning structures at the national and regional levels, the re-design of subsidy schemes, the closer adjustment of land development plans, and an improved urban/rural cooperation are prominent outcomes of social learning at all relevant levels. The rapid expansion of renewable energy resources, the societal generation and the transfer of knowledge enables (i) regional structures to be re-built in a way that matches available resources to the existing demand for energy services as closely as possible and (ii) political and legal competences to be re-allocated across and beyond the existing political administrative structures.

E.3 Scenario 3 - Obstacles in Energy Transition

Scenario 3 focuses on factors which inhibit the implementation of intended energy measures and the region´s development in general. The consequences for the criteria are:

Energy production - The North Sea region is confronted with an un-easy process in shifting the energy production to renewable sources. This is documented by a slight increase in overall energy production in the whole region. In 2020, 25% of the energy production will be related to renewable sources. This share will slightly increase to 35% in 2050. Onshore wind will be the main source of electric energy from renewables, while the contribution from offshore wind will increase only slightly due to difficulties in the acquisition of investments. The share of bioenergy will be constant as consequence of fading acceptance in bioenergy. Due to high production costs, solar energy will not be competitive. Small budgets will be available for technological developments to realise significant contributions from geothermal sources and marine sources (tidal, currents, waves). Fossil and nuclear will stay the main pillars of energy production. Nuclear’s share will not change considerably. The share of solid fossil fuels in the electricity mix will cut by half until 2050 and be replaced by fossil gas. In some regions, remaining coal fire plants are converted to co-fire generation and fitted with carbon capture and storage. Overall, the energy landscape in terms of infrastructures and producer-consumer relationships will not change fundamentally.

Energy consumption - The recent re-urbanisation trend continues. Within urban areas an increasing share of public transport leads to decreasing energy consumption in inner-urban transport. But at the same time, people tend to have more than one home. Long distance commuting between home and work, weekday’s and weekend’s home as well as a significant increase in flights lead an overall increase in consumption by transport. Individual and goods transport are further based on fossil fuels. Heating systems are mainly based on oil and gas. Especially detached and semidetached houses are not insulated according to modern standards in large parts of the North Sea Region. Consumed electricity comes to a large degree from natural gas and coal. The fact that consumers further stick to fossils is partly caused by missing alternatives as the different levels of the energy system stay largely unchanged in comparison to 2010. Increasing living standards lead to an overall increase of energy consumption of 5% by 2050.

Energy efficiency - Energy efficiency is not a major part of public discussion or governmental action. Progress is solely achieved by technological innovations and the replacement of obsolete appliances and equipment. The North Sea Region has failed to achieve earlier goals as property owners hesitate to invest into insulation and more energy efficient appliances. High initial costs, unsolved problems with inaccurate installation of insulation and limited functionality of energy efficient cars or equipment slow down efficiency improvements. Fossil fuels and the related technologies are still recognised as the most reliable and most convenient technique. Transparent information on the benefits of higher energy efficiency is not for all stakeholders available.

The same is true for technological information of how to apply and use highly efficient equipment. Some parts of the North Sea Region benefit from this development and see no need for more ambitious energy efficiency yet as this might be a misdirected investment.

Energy costs - Non-renewable energy will be the main factor for energy prices to be paid by the consumers. The energy costs tend to increase sharply as it is projected for the market prices for fossil and nuclear fuels. The energy costs will also be high. By 2050, wind will provide the lowest-cost renewable energy, at €0.05–0.07 per kWh. Offshore will be a less competitive than onshore due to continued technological difficulties. Solar costs will drop to approximately € 0.20 per kWh in 2050. Bioenergy costs will be similar. Within the North Sea Region, the tariffs continue to differ on a sub-regional scale. The electricity trade via international grids is hampered due to lacking investments in the integration of renewables.

Technological Innovation – due to market and policy failures, low public interest as well as a consequence of decreasing efforts in research and technology, the further improvement of renewables technology is proceeding slowly. Marine renewables including off-shore remain a hardly exploited potential. Development of bioenergy and further wind generation, both on and off shore, stalls after 2030 while small scale wave and tidal projects help to maintain the contribution of energy generation from renewables. Despite a coal revival by 2020 with the commercialization of affordable and efficient carbon capture and storage technology, an increase of the efficiency of fossil energy plants remain an unresolved technological problem.

Societal Partners - The next decades will bring long term economic and energy crises. This results in significant quality of life losses and an increase in distributional inequalities. Less pressure on the energy system is related to a reduced economic growth. Increase in renewable energy resources is driven exclusively by economic interests of powerful investors. Sub-regions of the North Sea region with already strong economies and access to traditional energy resources and related infrastructure can benefit from this in economic terms, but some regions will face social problems as economically marginalized sub-regions as well. The degree of collaboration of the sub-regions will subsequently become less. Sectoral interests of certain groups are driving decision taking processes on the local up to the transnational level. The process of fragmentation will also impact the marine and terrestrial ecosystems and result in a socio-ecological decline.

Social changes - Changes of the societies interacting with energy behaviours and policies are constricted by market crisis and socio-ecological impacts over the decades to come. An aging population tends to continue economic preferences. This also sustains traditional approaches to the energy sector both in terms of the fossil sources and market partners.

Policy making - Renewable energies are important for electricity production. However, the region has not been able to make further progress yet. After a euphoric phase the energy transition concept lost its attractiveness for policy makers. The population is divided into winners and losers of the new energy concept. In public perception industry and farmers benefit from renewable energies while the man in the street has to pay increasing energy prices and tolerate new overhead power lines in his neighbourhood. Therefore conflicts instead of consensus are dominating public discussions. Single politicians stoke uncertainties about retroactive cuts in subsidies for renewables. This makes investors feel insecure and slows down the transition process. Network expansion is also slowed down as no interregional agreement on detailed routes was achieved yet and affected population opposes to new infrastructure facilities. As therefore consumers and producers cannot be linked also the development of offshore wind farms and infrastructure lags behind official strategies. For the core issue of energy storage no sound large scale solutions have been found or implemented. Furthermore, the different parts of the North Sea Region follow their own agenda and a region wide energy concept is not actively pursued. National governments focus on a traditional concept of safe energy supply which is to a large degree focused on own and imported fossil energies.

Economic development - Europe emerges from the crisis of the early 21st century weaker than before. Economies in other regions of the world are doing better than Europe. Some regions across the globe benefit from shale gas, cheap coal and the availability of natural gas while Europe suffers from policy disintegration and high energy prices. Around the North Sea Region this leads to a slowdown not only of the economy but also the take up of green energy. Areas with access to hydrocarbons still do relatively well while others suffer from the economic depression without having alternatives at hand, such as production and maintenance of renewable energies. As the transition towards greener energy was started with subsidies and feed-in-tariffs these obligations are still to be paid by private and industrial consumers. But as the energy transition stays incomplete consumers suffer from these payment obligations without getting the benefits.

Social learning - The energy transition of the North Sea region turns out to be a troublesome process. A low status of public awareness and interest in energy topics inhibit group interactions on the needs and appropriate steps of the energy transition. Lacking or discontinued interaction of individuals and groups blocks social learning processes being essential for socio-technological innovations and their implementation. The fundamental disaggregation of social structures into separately acting sectors and individuals hampers the flow of ideas, information about promising experiments and the pooling of intellectual and physical resources. Severe consequences are (i) a low success rate of research and development projects, (ii) less qualified and trained people and (iii) no profound institutional improvement.

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