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Updated Interim Report:
Case studies and Scenarios

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

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This basic report exists only in an electronic version.

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1 Executive summary

This report presents the results of the scenario exercise in the ReRisk project and consists of four key-activities: a structural analysis, a questionnaire survey, four case studies and the creation of four scenarios through morphological analysis. The goal of the scenario-building activity is to create four plausible scenarios that illustrate the likely impact of rising energy prices on regional competitiveness and cohesion for 2030. The task also seeks to identify regional development opportunities and policy options available to regions to better cope with this challenge.

The structural analysis resulting from Workshop I not only reveals the drivers of regional competitiveness and energy development, but also shows the strong dependencies between these two fields. The drivers of competitiveness are identified as the innovation capacity, the economic robustness given by the diversity of the regional economies, the internal and external markets, the spatial characteristics, and the governance of the regions. Moreover, the hierarchy of these elements is dependent on the time-perspective in which regional competitiveness is viewed; namely short term and long term competitiveness.

In the context of regional competitiveness, energy is seen as the provision of a resource that keeps the economy running, provides quality of life for the inhabitants of a region, and accordingly, is a critical asset that is transformed, distributed and commercialized locally as well as internationally. In energy development the innovation capacity appears as the main driver alongside the availability and price of energy resources and the economic specialization of regions. Closely related to innovation and another central factor is the availability of technologies both for energy production and for achieving energy efficiency. Two other important elements in energy development are governance, which sets local, regional, national and international regulations on the use of different energy sources; and consumer behaviour, which relates to cultural perceptions on how the energy is consumed.

The case studies provide concrete examples of different approaches to energy vulnerability by specifically investigating wind and biomass power generation, energy efficiency in the residential sector, and energy savings and recycling through industrial symbiosis. The studies of the Municipality of Samsø in Denmark and the Region of Navarra in Spain exemplify two different approaches to renewable energy deployment. While in both cases the respective national governments acted as a provider of policy frameworks and support mechanisms for wind energy, completely different forms of participation by various actors took place at the regional and local level. In the case of Samsø the citizens were engaged as investors, together with the municipality and private companies, in the planning process of both the land and off-shore wind energy projects. This has resulted in the creation of renewable energy as an integral part of the local energy supply and the process has turned out to be a source of best practices in renewable energy deployment. This is in contrast to the region of Navarra, where the Regional Government and some private companies were the main actors of wind energy development. Furthermore, the strong involvement of the private sector wind energy development in Navarra has resulted in the creation of their own renewable energy industry that positions the region as one of the world's leaders in renewable energy technology. Accordingly, the case studies also showed that different natures of wind energy development and their impact on the local economy are rooted not only in the availability of natural resources but equally important in the regions' socio-economic characteristics.

Similar to the two previous cases, federal authorities in Germany have provided a solid energy and building policy framework whereby proactive standards and support mechanisms actively promote renewable energy and efficiency development in Freiburg. At the same time, it was discovered that local authorities, in concert with NGO's and local firms, have had a significant impact by integrating ambitious environmental goals with their overall development policies. The origins of this local approach on renewables and energy efficiency were partly motivated by the rejection of nuclear energy development by the local communities in the 1970's. Additional factors include the relatively high innovation capacity of the local economy and their specific focus on developing the environmental economy. Also, it is shown that Freiburg's comprehensive environmental movement – which their green housing development is largely based on – has had a pioneering role in the creation of transnational municipal networks that diffuse environmental technologies and best practices for local governments around the world.

The case study of Industrial Symbiosis (IS) in Kalundborg also exemplifies a bottom-up initiative. However, in contrast to the other case studies, IS in Kalundborg was a response from private companies to strengthen regulations on water protection, resulting in important energy efficiency solutions. The case illustrates how companies can adapt towards resource depletion and find new business opportunities by sharing information, services, by-products and waste materials. The case study also demonstrates the fundamental role of networking and commitment between the actors in IS development. This observation is confirmed in the case of Landskrona where the outcomes of IS are still very limited due to the slow process in consolidating networks between local companies.

In order to identify the roles and interactions between different administrative levels in terms of energy development a web-based questionnaire was conducted among 41 European regional energy agencies.

The results show that while energy policy is generally concentrated at the national level, differences exist between the national and regional level regarding the character of emphasis on energy policy. Specifically, security of supply is usually emphasised at the national level while energy efficiency and environmental protection are emphasized slightly more at the regional level. Similarly, the questionnaire also reveals some interesting differences regarding the emphasis on different energy sources between the two governance levels.

The questionnaire also reveals that international agreements on GHG's and environmental protection are one of the most important drivers for renewable energy deployment and energy efficiency at the regional level. In terms of fomenting cross-sector energy efficiency awareness it is also revealed that national governments, and to minor extent the regional governments, have an overarching role in relation to all sectors, while local governments, with the exception of the residential sector, have a minimal role. Further, the regional involvement in this regard corresponds to those regions with a higher emphasis on renewable energy.

The result of the questionnaire also shows that economic growth is tied to increased energy consumption in most regions and significant changes in consumption habits will only be considered when oil prices exceed USD $200 per barrel. Also, the respondents indicated that high energy prices will impact energy consumption predominantly in the residential sector, which they also consider this sector as possessing the greatest energy saving potential and opportunity. In contrast, the transport sector is seen as facing the greatest challenges for reducing energy consumption.

1.1.1 Scenario 1

In scenario 1 global agreement on more ambitious GHG quotas have been reached and global emissions trading schemes are operational in several sectors. The European economy is characterized by continued growth dominated by the knowledge and service industry. A significant level of decoupling between economic growth and energy consumption has also taken place.

The increase in the share of renewable energy has been most significant followed by a modest increase in the share of fossil fuels. At the same time, energy supplied by nuclear reactors has been reduced significantly.

The overall innovation capacity in Europe has continued to increase significantly and renewable energy and energy efficiency technologies are developed in Europe and exported. Energy efficiency technologies are available and affordable for industries and households. This availability allows for energy production from medium and small scale producers, such as households.

New economic activities have appeared in rural areas, especially considering new opportunities for renewable energy production, while urban areas also continue to witness social and economic growth. The share of public transport, especially railways, trams and metros has increased and there have been decreases in the share of private car transportation.

1.1.2 Scenario 2

This scenario offsets a decrease in energy produced by nuclear reactors with a high increase in the demand of fossil fuels and a moderate increase of renewable energy. Following this, a number of factors imply that there has been an overall shift toward progressively heightened energy efficiency in Europe. Clean energy technologies are assumed to be available to all energy producers and consumers, there has been be marked reductions in the energy intensity of European economies, and international agreements on carbon quotas have been set, even though some of the most energy producing countries will not participate. Also not forgotten is the fact that the energy prices are high - approximately $200USD – thereby making clean energy technologies economically more competitive.

It is assumed that Europe is experiencing balanced economic growth in all sectors and socio-economic growth is evident in both urban and rural areas. Moreover, rural development particularly emphasizes the private car as a favoured mode of transport. Lastly, global competition from other rapidly developing countries means that some energy technologies are imported from overseas, thereby implying that Europe's innovation capacity has been moderated.

1.1.3 Scenario 3

In this scenario nuclear energy is the main priority for energy development in Europe. Renewable energy deployment has also witnessed significant growth, but not to the same degree as nuclear. The demand for energy from fossil fuels has been reduced as nuclear energy and renewables have replaced coal in the industrial sector and oil in the residential sector. Additionally, priorities on climate change policies prevail in Europe despite the fact that the most energy intensive countries have not signed global agreements on GHG emissions.

Centralized and large scale renewable energy technologies continue to be common, but the development of micro-scale solutions has been largely restricted to remote and isolated areas. Energy efficient technologies have also become less competitive due to a decrease in electricity price in the 2020's.

The European economy will be characterized by the domination of manufacturing and primary industries, though these sectors will go through a process of modernization. The innovation capacity of Europe has been moderated as the R&D spending has been reduced. Due to the growth of manufacturing, primary industries and overall population, energy consumption in Europe has increased.

Urban areas, especially the capital cities, will continue to witness continued social and economic growth as well as some rural areas with vast natural resources will face economic grow. Investments in both public and private transport have been significant as progressive efforts to electrify the transport system have been made, but the balance between public transit and private car use from early 2000's has been maintained.

1.1.4 Scenario 4

Scenario 4 is characterized by a significant increase in fossil fuel consumption, a moderate increase of renewable energy production and recession of the economy. At the same time, energy demand from nuclear reactors has been reduced. Low decoupling between economic growth and energy consumption has led to high energy demand and clean energy technologies are expensive, thereby only available for large scale producers.

Globally, new carbon quotas are set, but the most energy intensive countries are not part of the agreement. Europe is characterized by a balanced presence of all sectors, though the most energy intensive industries have gone through a process of modernization, while others have been slowly displaced. Innovation capacity in Europe has decreased, which has led to a reduction in the export of technologies and services.

Economic growth has continued to be concentrated in urban areas, while depopulation has taken place in rural regions. Furthermore, the private car transportation has increased.

2 Outline of methodology

The scenario building activity in ReRisk is based on explorative prospective that aims to shed light on multiple images of possible futures, which are constructed on the notion of past and present conditions of the studied system. Therefore, the four scenarios created in this exercise are not prognoses or forecasts, but instead they are plausible visions of the future that shed light on the implications of different development trends on a system. This implies the identification of the drivers determining the evolution of both energy and regional development, and, in this connection, the identification of different development paths to be taken by possible actions and their consequences.

This exercise complies with the four key principles of prospective scenario building: relevancy, consistency, likelihood and transparency (Ritchey, 2007-2009). The approaches applied for the scenario building process are:

- Exploratory; by using past and present trends leading to the description of likely futures. This includes using data analysis and the case studies carried out within the ReRisk project as point of departure for building the scenarios.
- Anticipatory; by analysing predetermined visions of the future. In this case, four distinct hypothetical visions of the future under high energy prices for year 2030.

The method behind the scenario building exercise has its bases mainly on the General Morphological Analysis (MA) originally developed by Fritz Zwicky, which is a qualitative method for structuring and investigating the total set of relationships contained in multi-dimensional, non-quantifiable problem complexes by using the technique of Cross Consistency Assessment (CCA) (Ritchey, (2007-2009). Accordingly, the scenario building exercise is comprised of two phases: the construction of the scenario bases, which consists of the identification of the drivers, the actors and trends in the studied system; and setting out the four scenarios, which consists of the definition of the hypotheses, CCA and the selection and validation of the scenarios as illustrated on page 666.

2.1 Construction of the scenario bases

When analyzing the options for structuring scenarios in relation to future energy dependency, it was also necessary to identify the role of energy planning and development at different administrative levels, their actors and the interactions between them. Also it was necessary to identify the trends in energy supply and demand as well as the current policy regarding energy development, regional competitiveness and cohesion. This was achieved by utilising multiple research contributions - qualitative as well as quantitative - that enable triangulation between each approach to provide well-supported rationales for the scenarios. Accordingly, these contributions were obtained from:

- The inputs obtained from Workshop I (structural analysis)
- The inputs from two questionnaires
- Four case studies that provide a synthetic analysis of energy systems, their actors in the deployment of alternative energy solutions.
- A study on the policy target from the EU Energy and Climate Change Package and the Lisbon Treaty (presented in Annex VI). These policy targets served to define the policies target in which the scenarios were based.

The trends on energy supply and demand in Europe were identified by using three available reference studies:

- European Commission 2007. *Energy, Transport and Environment Indicators.* EUROSTAT pocketbooks.
- European Commission 2008. *European Energy and Transport: Trends to 2030- Update 2007.* Directorate-General for Energy and Transport.
- International Energy Agency (IEA) 2008. *World Energy Outlook 2008*.

2.1.1 Structural Analysis

The objective of the structural analysis was to set the bases for the scenarios by providing a better understanding of the interdependencies of regional spatial/structural characteristics, energy production and consumption. This included:

- Identifying the internal and external elements/factors in energy and spatial systems (System delimitation)
- Identifying the mechanisms of change and adaptation in terms of the energy sector and regional competitiveness (retrospective).
- Selecting the drivers to be used in the morphological analysis by analyzing the relationships between elements of energy and spatial systems.

The structural analysis was carried in Workshop I. The basis for this workshop was built through a preparatory workshop with specialists from Nordregio and series of interviews with the independent experts who participated in the workshop. While the preparatory workshop served to identify the issues to be discussed during Workshop I, the interviews helped to collect individual perceptions of these issues. The result was a set of questions that were used in Workshop I to initiate and structure the input from the experts.

In order to identify the elements for energy supply, energy demand and regional competitiveness during Workshop I, a version of Creative Problem Solving (Parnes, 1992) was used. This led to a phase which aimed at a degree of consensus on the most relevant, salient and viable drivers (the convergent mode). Ultimately, Workshop I not only resulted in the identification and analysis of the drivers, but also four test scenarios that shed light on how these drivers related to each other.

2.1.2 The case studies

The case studies present four concrete examples of different approaches to managing energy vulnerability. The aim was to identify the drivers and mechanisms of change in energy systems, the relationship between the public and private actors, and the relations between different governance levels in terms of the development of energy production, consumption and distribution. The case studies also shed light on different strategic decisions in energy development and their consequences on regional competitiveness.

2.1.3 The agency analysis (The questionnaires)

While the case studies show concrete examples of energy approaches, they do not show the distribution of perceived and actual responsibility between different levels of governments. Therefore, the *Agency Analysis* provides us with information regarding the distribution of these responsibilities between different levels of governments. In this connection the first step was a web-based survey among representatives from at least one regional energy agency from all EU member states providing us with insight into the distribution of authority and responsibility between three governmental levels: State – Region - Local. This provided an initial overview over the relationship between the local, regional, and national responsibilities which has served as an important input to as well the initial scenario tests, the analysis of the case studies and the structural analysis. In a second phase, after Workshop III, a series of in-depth interviews with selected representatives from the regional energy authorities will provide additional information needed for the outlining of the final scenarios.

A two-step model was used in connection with the questionnaires. The first step involved the creation of a rather detailed draft questionnaire that was tested by obtaining responses to a total of 45 questions from 21 regional agencies. The results from this preliminary version were combined with the results from Workshop I to produce a much simpler questionnaire with 23 questions. The revised questionnaire was submitted to a number of representatives from different European regional energy agencies and a total of 41 responses were received.

2.2 Setting out the scenarios

This phase consisted of three steps. The first step consisted of three working group sessions and one preparatory workshop where experts from Nordregio defined several hypotheses (values) for each of the drivers (variables) identified during the structural analysis, questionnaire and case studies. While the hypotheses were being defined the same groups carried out the cross-consistency analysis, which compared, pair-wise, each of the hypotheses in the morphological field. This helped reduce the morphological space through further elimination of less-dominant drivers and the identification of inconsistent pairs of hypotheses. The context in which the cross-consistency analysis was carried out was: The scenarios were given for 2030; The scenarios were at a European scale; Energy prices were at a "high" level, which has caused structural changes in regional economies (for example, an oil price of $200USD per barrel); Policies on climate change, regional competitiveness and cohesion have prevailed in 2030.

This exercise resulted in a cross-consistency matrix that was used as the framework for the morphological analysis.

During the second step, the hypotheses, exclusions and preferences indicated in the cross-consistency matrix were entered in the Lipsor-Morphol software to visualize and select different plausible scenarios. This resulted in subset number of scenarios that were further reduced to four based on conditions of internal consistency, plausibility, uniqueness (clearly distinguished from the outset), likelihood and relevance for European regional policy. During this process the different scenarios were further evaluated against the results of Workshop I, the case studies, the questionnaire survey, as well as the objectives of the project.

The scenarios were further evaluated and reconfigured during a second project workshop (Workshop II) that included the participation of all project partners. This exercise was complemented with further recommendations from the project partners. For example, one of the scenarios was modified by having its point of departure based on decreased economic growth and increased fossil fuel dependency in order to illustrate the vulnerability of regions with high energy expenditures under extreme conditions.

In step 3, the invited external experts to Workshop III further analysed and rationalised each scenario. This provided further details and examples of early events that can cause each scenario to happen in Europe by 2030. This also included outlining the causalities between the hypotheses within each scenario. After the scenarios were validated during the first day, the groups discussed the impact of the scenarios and identified different sets of policy options that may enhance regional competitiveness and regional cohesion under the given circumstances for each scenario. The remaining step here will be to send the scenarios to the experts for a last round of consultations and validation.

Please consult Annex I for a detailed graphical outline of the scenario process in task 2.3.

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3 Structural analysis

This section presents the results obtained from Workshop I, thereby providing an overview of the most important internal and external elements and drivers of regional competitiveness and energy development, and the interdependencies between them. In the presentation below only the main characteristics are outlined while details regarding the in-depth definitions are available in Annex III.

3.1 Drivers of regional competitiveness

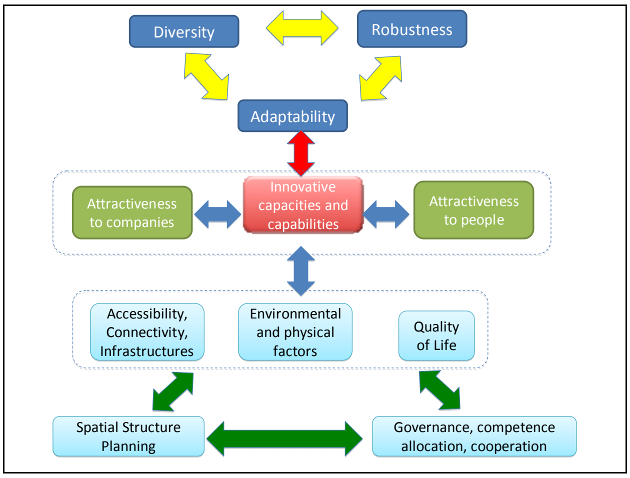

Figure 1 Elements of regional competitiveness and their interaction. See Annex III for details

Regional competitiveness includes “a range of factors from measures of income and prosperity to economic creativity and innovative ability that describe the performance of one economy relative to others”. Furthermore two different perspectives should be emphasized: Short term competitiveness as the capacity of a region to maintain a high level of economic performance in a short term (5 to15 years) perspective, and long term competitiveness as the capacity of a region to maintain a high level of economic performance in a long term (15 to 25 years) perspective. Long term competitiveness chiefly relies on the adaptive capacity of a region, which in turn is dependant on economic robustness, but also the diversity of the regional economy.

3.1.1 Innovative Capacity

Innovative capacity as *“the capacity of generating new ideas”* reduces economic vulnerability because it diversifies economic structures by fostering the creation of new industries and products. The capacity to create new ideas is determined by three factors; the openness of the society towards new thinking, the knowledge capital, and the accessibility to this knowledge. Knowledge accessibility includes the availability and quality of the education bringing in new sources of knowledge and fostering new ideas through R&D. Social, physical and financial infrastructures are needed, just as regional densities of scale are important because it helps to promote a collective commitment among individuals on attaining competitiveness. The networking capacity is another important factor allowing the exchange of information and experiences necessary for both the creation of new services and technologies and the formation of trans-boundary cooperation between regions, firms and research institutes. Similarly the accessibility to qualified labour force plays a central role, and in this regard education not only serves to build the social capital of a region by forming young professionals, but also attracts both students and professionals from other regions. Finally access to financial resources is important because it provides the bases for public and private investments in R&D, education and entrepreneurship.

3.1.2 Attractiveness

Aspects of attractiveness are closely linked to the innovative capacity of regions as living conditions and highly-developed business environments attract and retain skilled workers and high-tech firms to the region. Skilled labourers seek good living conditions, and more specifically, good quality of life determined by cultural perceptions of achieving lifestyle ideals and opportunities to develop. This includes efficient and affordable internal and external transport, accessibility to the social, natural and built environment, accessibility to health services and affordable and available housing.

3.1.3 Robustness of regional economy

Economic robustness as *"the ability of a region to withstand fluctuations in the markets"* is generally determined by the presence of territorial capital: economic, social and resource capital, as well as diversity in the region's economic structure. In order to attract companies and labour force a region is also dependent on the region's economic robustness. In the long term the innovative capacity becomes central as it generates flexibility in the regional economies by stimulating new industries and services. Here, energy is seen as a resource that serves the region's economy.

3.1.4 Governance

In order to promote and sustain the innovative capacity of a region political stability and good governance is required by means of well-functioning authorities and the creation of proper policy frameworks for innovation and entrepreneurship. Governance puts forward the framework conditions and the directions in which the internal and external factors of competitiveness may interact proactively.

3.1.5 Spatial characteristics

Spatial factors include on one hand environmental factors related to the quality of the environment for living and performing economic activities, such as clean air and water, food and land, and on the other hand to physical factors including the nature of the residential, transport and communication infrastructure, as well as infrastructure for energy and water distribution. Spatial factors are also internal factors of competitiveness as explained above.

3.1.6 Internal and external markets

Competitiveness is a balance between import and export of tangible and intangible resources between regions. Tangible resource flows are goods while intangible resources flows are represented by knowledge and services. The competitiveness is influenced by three elements; *where* the served markets are located, *what* products and services are offered by a region, and *how* these offers are presented and delivered to the markets. The acceptance of new products and services will be determined by consumer openness towards new products and the availability of those produces. The availability hinges not only on the physical presence of the products, but equally decisive are price factors - the economic capacity of consumers to pay for a particular product or service - and qualitative factors such as ideologies, life styles and behaviour.

3.2 Drivers of energy development

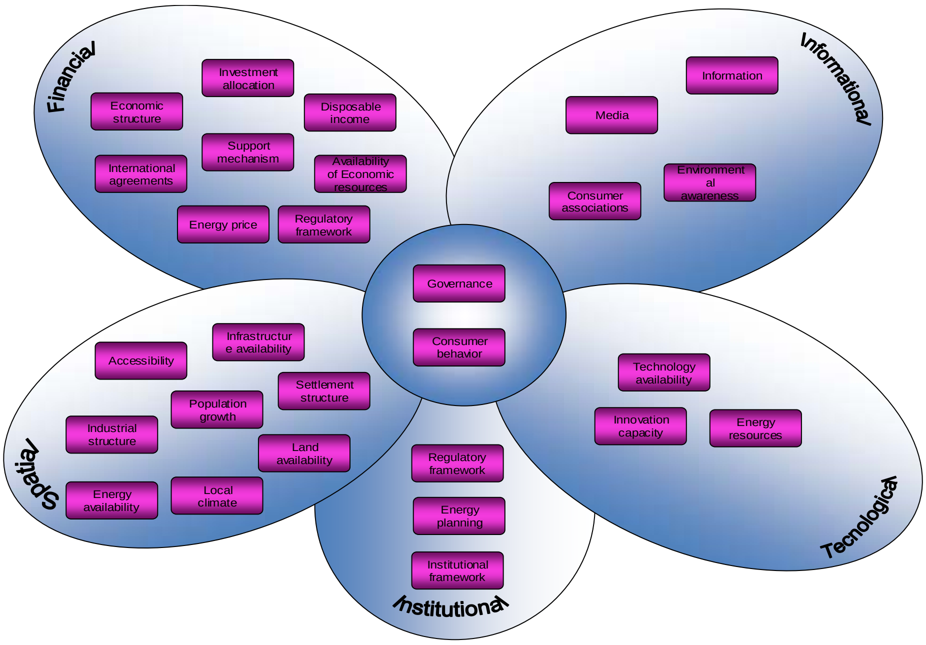

Figure 2 Clustering model for energy development. See Annex III for details

Energy development as *"the endeavour to provide sufficient primary energy sources and secondary energy forms to fulfil societies' needs involves both deployment of already available energy technologies as well as research, development and deployment of new technologies".* Traditionally it includes security of supply, energy efficiency, natural resource management and environmental impact. The results from workshop I show that energy development comprises a large number of elements that can be grouped into clustered loops that are mutually dependant: institutional, financial, spatial, informational and technological loops. In addition two elements are intimately related to each of the loops: governance and consumer behaviour.

3.2.1 The institutional loop

Institutions can be governmental, non-governmental and commercial, they can be centralized or decentralized, which is both important factors in terms of policy orientations and energy development decisions. Regulatory frameworks encompass legislations regulating production, transmission and consumption of energy, and assigns governing powers to authorities in the energy sector. The regulatory framework also steers the exploitation of energy sources and sets limits such as building restrictions, caps on GHG emissions, etc. Depending on the institutional framework energy planning sets the directions for the development of the energy sector and serves the interests of national, regional and local actors.

3.2.2 The financial loop

While energy production and transmission are essential elements, they implicitly raise the question of availability of economic resources for investment. The significant elements in this regard are listed in the following table:

Market price for energy: influencing the investment choices of energy consumers, and plays an important role in determining which energy sources are exploited. Prices of traditional energy sources act as drivers for the exploitation of new alternative sources.
Profitability: determines the choice of energy source exploitation for producers and whether or not new sources of energy will need financial support.
Availability of economic resources: has a direct impact on investments in new technologies as well as the allocation of investments such as development of alternative sources and infrastructure deployment.
Disposable income: determines the price that consumers are willing to pay for energy.
Financial system: determined by the legal and policy frameworks for the finance sector.
Support mechanisms: are widely used by governments as market based instruments to subsidise renewable electricity, usually through two categories of support schemes: *investment support* playing a role during development stage and market introduction of renewables, and *operating support* such as support per unit of electricity produced.
International Agreements on GHG emissions: create commitment towards common goals on caps for emissions and help to internalize the externalities of energy production from fossil fuels. Often tied to emissions trading schemes providing economic incentives for achieving reductions in the emissions of pollutants. It is a quantity instrument because it fixes the overall emission level (quantity) and allows the price to vary.

3.2.3 The spatial loop

Settlement structures affect energy consumption patterns with two elements being particularly important: *The distribution of living and working places*, related to *distances* between living and working areas (the distance, ICT and transport mode), as well as *time* for transportation and commercial activities associated with everyday life (the spatial arrangement of cities and regions), a*nd accessibility to commercial and living areas* relating to energy demand through the availability of infrastructure and technologies enabling energy efficient modes of transportation both for passenger and goods.

The availability of, and accessibility to, infrastructure define peoples' transport patterns to-and-from work despite the availability of different working arrangements today. Similarly the size of population affects total energy as reduced per capita energy consumption can be achieved through greater population densities because due to denser living arrangements and increased transportation opportunities.

Economic Structure shapes the energy mix and intensity of a region mainly in the short term. Regions with heavy industries will consume more energy relative to regions with high proportions of the economic mix dominated by the service sector. The accessibility to energy is also important because energy independent regions have little pressure emphasize structural changes in the economy.

In centralized energy systems settlements and industries will rely on long distance transmission infrastructure for electricity and gas, while decentralized energy systems provide locally produced energy that is transmitted over short distances. Centralized solutions may fit well in areas lacking energy resources while areas rich in energy resources are able to generate energy in situ. Land availability plays a fundamental role for the use of renewables. For wind energy for example, vast areas exposed to suitable wind conditions are needed and the conflict between landscape conservation and wind energy development is well established. Also local climates also play a significant role in the ways energy is consumed and generated. Seasonal cold and heat periods, and extreme weather events increase energy demand in order to maintain comfortable temperatures of homes and workplaces.

3.2.4 The technological loop

The nature of technology availability is delineated between domestic development and imported technology. Access to technological solutions helps facilitate the shift towards utilization of alternative energy sources and makes these sources competitive in markets. Technologies are tied to the availability of endogenous energy resources. Innovation Capacity is a central driver in energy development by providing technologies on energy efficiency and renewables. Specifically, regions exposed to fluctuations in energy markets due the lack of domestic energy sources can find ways to reduce their dependency though the creation of innovative solutions on energy production and efficiency. And innovation enable energy-rich regions to further this by exporting excess energy created by a reduced internal demand and increased energy production from alternative energy sources.

3.2.5 The informational loop

Environmental awareness is part of the culture, but can also be inculcated through information and education programmes. Information influences consumer's habits by creating awareness of benefits or negative consequences of irrational use of energy and use of unsustainable energy sources. The media works as the link between information sources and energy consumers, determining how consumers perceive the information. Consumer associations have proven to promote environmental awareness among both the general public and government institutions.

3.2.6 Governance and consumer behaviour

Governance relates directly to all the loops by setting the institutional, policy, legal and planning framework for production, transmission and consumption, as well as for regional development. The governance style has impact on the Institutional Loop in terms of the regulatory framework and structure of energy prices. Therefore, the Governance Loop reflects the particular actions and their respective actors that are embedded within the overall governance style of energy development. Not least, governance styles have a fundamental role in setting up taxation and trade schemes, reaching international agreements, allocating investments and promoting the future development of the economy.

Consumer behaviour is crucial for supporting a transition in energy development. Consumers have impact on energy consumption through behavioural changes on energy use as well as through their purchase by selecting energy efficient technologies for households and transport. As explained in the Informational Loop section, consumer behaviour tied to cultures and dependant on the level of awareness not only on the negative effects of excessive energy consumption or the use of fossil fuels, but also on how to apply these technologies and consume less energy through behavioural changes.

4 Case Studies

The following case studies illustrate multiple aspects, priority issues and implications of energy generation from wind energy as well as energy efficiency through green housing and industrial. Furthermore, the following case studies also provide a picture of top-down and bottom-up development processes and the relation between the public and the private sector in relation to energy supply and demand.

4.1 The development of wind energy on the island of Samsø, Denmark

4.1.1 Spatial characteristics of the island of Samsø

Samsø is an island and a municipality located in proximity to the east coast of Jutland. At the time when the sustainable energy project was initiated, Samsø was part of the county of Aarhus, which since the local government reform in 2007 has changed to the Region of Central Denmark. The island covers an area of 114 km², the length of the island is approx. 26 km, and its maximum breadth is 7 km. As it is also the case for other small island communities, there are limited education opportunities on the island for young people after they finish secondary school. Therefore, Samsø struggles with a falling population, as most young people move away, and only a few returns to the island. Thus, in 1997 there was a population of 4366 persons which in 2005 had fallen to 4124. The occupational structure on Samsø is dominated by the agriculture and tourism industries. (PlanEnergi, 2007)

4.1.2 Planning system

The Danish Planning, which originates from the 1970s, has three main characteristics. First, it involves a decentralised planning system meaning that extensive decision making power is left to municipalities. Second, it involves the principle of framework management which entails that different levels of physical planning, i.e. regional, municipal and local planning, are subject to a hierarchic implementation structure that aims to ensure that due attention is paid to national interests, political objectives, etc. Third, the importance of transparency in the planning process is emphasised through legal requirements stating that the public shall be engaged in the planning process. The Danish planning system comprises a system of plans at both national, regional, municipal and local levels, and a zone system which divides the country into three categories: summer cottage areas, urban zones and rural zones. Another significant part of the Danish planning system is the Environmental Impact Assessment (EIA) which is carried out before certain activities are initiated and serve as a basis for decision making.

4.1.3 Danish Wind Energy Policy

The overall focus of national energy strategies has changed since the 1970s, when the first national energy strategy was launched in Denmark. Thus, from 1990 the overall goal of energy policy shifted to focus on promoting sustainable energy development and complying with commitments to reduce greenhouse gas emissions. Both the energy plans from 1990 and 1996 strongly pursue the development of RES and the expansion of electricity generation based on RES, especially focusing on wind power. There is a high acceptance of wind turbines in Denmark, partly due to the fact that a majority of windmills are owned by private households based on neighbourhood cooperatives. In 1992, the government introduced a feed-in tariff for private wind power producers. It was fixed at 85 % of the utility production and distribution costs. In addition to the feed-in tariff from the utilities, the private wind power producers received a “tax refund” of 0.27 DKK (3.7 eurocents) per kWh. This policy has changed gradually, as the focus of national strategies has also changed. Today wind power is produced cheaper as the technological development of wind turbines has entailed that they have become larger and more efficient. Thereby, the feed-in tariff was mainly an incentive which was provided to private investors during the 1990s. (Meyer, 2004)

4.1.4 Deployment of wind power on Samsø

The development of wind energy on Samsø has taken place on the basis of a competition launched by the Danish Ministry of the Environment in 1996 which this municipality won. The purpose of the competition was that a local community during a period of ten years from 1998-2008 should demonstrate that it was possible to convert an entire local community to renewable energy supply. At the project’s initiation only 5 % of the island’s electricity consumption was generated by local windmills, whereas in 2005 locally generated wind power covered more than 100 % of the island’s electricity consumption.

Through the renewable energy project, eleven land based wind turbines were established on Samsø. Before the project was initiated a few land based windmills were already in operation on the island. They were owned by local farmers and as neighbourhood cooperatives. The planning phase of the land based windmills, which were to be established as part of the energy project, was difficult, as the island’s citizens and the planning authorities of respectively the county and the municipality were in disagreement on the placement of the windmills. Especially issues of preserving nature and heritage sites were prevalent in the discussions. Eventually agreement was reached on three sites that took into consideration nature and heritage issues. The acceptance of the public was referred to by the interviewees as being very much in line with the local ownership of the turbines. Thus, according to both national and local tradition, the eleven windmills are owned by farmers and two of them are owned as neighbourhood cooperatives. The generation of power from the land based windmills covers the local electricity consumption which is possible due to the relatively small population size of the island.

The renewable energy project also included the establishment of ten offshore turbines. The establishment of offshore windmills was made possible by the energy project and the investment from the Ministry of the Environment. It implied the construction of a connection from the offshore turbines to the national grid. The introduction of offshore turbines further strengthened the supply of wind power on the island and, through its export of power, it compensates for the transport area which has not been transformed to RES. In terms of ownership, one turbine is cooperatively owned, three are owned by investors from Samsø, one is owned by a financing company and the remaining five are owned by the municipality. The municipality decided to take a loan of 25 million DKK in order to invest in the off-shore wind turbines. The municipality's investment was approved by the county, and in order to limit the responsibility of the municipality, the Ministry of the Interior demanded that the investment should be based in an independent public limited company. Thus, the company Samsø Offshore Wind Co. was established. The planning of the offshore wind turbines took place after the feed-in tariff was eliminated with the Energy Act in 1999. However, in February 2002 a political agreement was reached to guarantee a minimum price of 43 øre/kWh in a period of ten years. During December 2002 and January 2003 the ten off-shore windmills were established and connected to the national grid. (Hansen *et al.,* 2007)

4.1.5 Policy implications

The main influencing factor which made the development of wind power possible on Samsø was the national policy framework in the 1990s which was focused on the development of RES. The fact that the Ministry of the Environment organised the competition which Samsø won was a precondition in terms of including wind power in regional and municipal plans. The feed-in tariff provided to owners of windmills further supported the development of wind power as it served as a solid economic incentive to invest in wind power. At the regional level the county's planning department was involved in the planning process and ensured that environmental considerations were taken in connection to the establishment of wind turbines. At the municipal level, the planning department was involved in deciding the location of the wind turbines. Moreover, the municipality was a main investor in the offshore wind turbines. At the local level the citizens of Samsø were engaged in the planning process and as investors in the wind turbines. In order to take into consideration the local level involvement, two organisations were established on the island: Samsø Energy Company which ensured the technical part of the RES implementation, and Samsø Environment and Energy Office which dealt with the public participation and involvement. These organisations and their combination of technical and citizen concerns have been significant at the local level throughout the project. Finally, in accordance with Danish planning traditions, NGOs were also influential in the planning processes of the land based and offshore turbines.

4.1.6 Impacts on regional competitiveness

The renewable energy project was initiated in 1998. One year later the local slaughterhouse, employing 100 local residents, was shut down. This closure was expected to have a tremendous impact on the economy of the island, as already, Samsø was a municipality with a low per capita income and an increasing number of people moving away from the island. The municipality in cooperation with the regional development department of the county of Aarhus saw the energy project as an opportunity for regional development. Thus, the county produced a development plan which placed the energy project in the centre. The idea of the plan was that the energy project was seen as an opportunity to restore balance on the island and it would serve as an addition to the two dominant industries, agriculture and tourism.

The main impact of the renewable energy project on regional competitiveness is the increase in tourism which has come as a consequence of establishing Samsø Energy Academy, which was opened in November 2006 as an independent organisation. The background for establishing the Energy Academy was to combine Samsø's experience with implementation of renewable energy in a local community and the future challenges which the island faced in further developing the project. The opening of the Energy Academy has led to an increase in tourism with a new group of 5-6000 professional tourists visit the island every year. The international professionals come to the island to learn from Samsø's experiences and to exchange experiences with the academy's employees. The Energy Academy also participates in European projects. The regional development department perceives the energy project to be a good example of regional development, using the case of Samsø in its marketing of the region, communicating that the case of Samsø is a good example that the region cares about the peripheral areas of Central Denmark.

Another way in which the energy project has strengthened regional competitiveness is through competence development. Different elements of the implementation of initiatives of the energy project generated employment for craftsmen, especially in establishing district heating systems. Moreover, the decision to establish Samsø Energy Academy proved to be of significance for job creation and competence development, especially for the local smiths. The building of the Energy Academy was designed on the notion that local craftsmen should be employed in the project. The head of Samsø Energy and Environment Office, as a strong communicator, was a significant actor in terms of engaging the local workforce, convincing the local smiths to become certified solar heat installation contractors. Subsequently, the smiths and other craftsmen were engaged in constructing the ecological smart house that became the Energy Academy. Thereby the local craftsmen have gained new competences, and thus companies involved in the construction of the Energy Academy are now consulted by companies in the rest of the country in terms of smart house construction. Moreover, the services of the craftsmen have expanded to also include installation of solar panels and water pumps.

4.2 Wind energy in Navarra, Spain

4.2.1 Spatial characteristics

The Autonomous Region of Navarra is located in northern Spain and covers a total area of 10,391km^2, approximately 2.1% of the entire country (Faulin *et al.*, 2006). Similar to its small absolute size, Navarre has a total population of 578,210, only 1.3% of the national population; and accordingly, has a population density of just 55.65 inhabitants/km^2, well below the national average of 80 (Faulin *et al.*, 2006). Pamplona is the largest municipality in Navarre (total population: 195,769) and is the only city with a population over 35,000 inhabitants (Government of Navarre, 2009). Navarre is characterized as a small, predominantly rural region with only a few urban agglomerations and good access to natural assets. The size, however, has not stopped it from contributing more than its share towards the Spanish economy. In 2006, with a GDP per capita of €30,900, Navarra continued its trend of being well ahead of both the Spanish national average (€24,600) and EU27 average (€23,600) (Government of Navarra, 2009). This currently positions Navarra in second place in Spain and 34th (out of 271) in Europe in terms of GDP per capita, and the region also exceeds the average per capita income in Spain by 30% (Belarra,2009). Furthermore, Navarra's unemployment rate in 2008 stood at 5.7%, compared to the national rate of 8.3%, and is below the EU average (Government of Navarra, 2009).

Economic production in Navarra is generally attributed to the growth of its industrial sector beginning in the 1960's, diversifying the economy away from the dominating agricultural employment. The industrial sector in 2007 accounted for 28.5% of the Gross Value Added (GVA) in Navarra, which puts the region well above the national average of 18% for the country as a whole. Within the industrial sector, a large part of production is characterized by cutting-edge, high value-added technology where car manufacturing, machinery and equipment production are most dominant.

Energy performance in the region of Navarra

Until 2003, Navarra was characterized as being dependant on imported sources of energy because the region has no source of traditional primary energy sources such as oil, coal or natural gas. Today, this situation has changed dramatically considering that by the end of 2008 renewables provided 65% of the electricity consumption of the region and wind accounted for 70% of total energy produced from renewables (Belarra, 2009). In terms of renewable energy sources the table below outlines the breakdown of overall production levels of each renewable electricity source in Navarra for 2007, as well as the 2010 targets for renewables stipulated by *The Energy Plan 2005-2010*.

Table 1 Energy production from renewables in the Navarra region (Moreno, 2007)

Renewable Type	2007 Production	Production details 2007	Forecasted target 2010
Small hydroelectric dams (<10MW)	157 MW	-111 installations -Average installation production level: 1.41 MW 10.8% of electrical consumption in Navarra	225MW 30.2% growth between 2007 and 2010
Large hydroelectric dams (>10MW)	18MW	1 reservoir El Berbbel's water reservoir	98MW 81% growth through construction of two new reservoirs
Biomass	25MW	4.3% of electrical consumption	40MW before 2010 37.5% growth
Solar photovoltaic	15.33MW	Combination of solar farms and individual installations	30MW 49% growth
Solar thermal	967 Toes	Still early in the development stage	10MW
Wind power	936MW	16 locations and 38 wind farms. 64% of electrical consumption in Navarra	1400MW

4.2.2 Planning system

There are four levels of government that exist in Spain each characterized by their different spatial planning responsibilities: the State; the regions, consisting of 17 Autonomous Regions and 2 autonomous cities; the provinces, consisting of 50 individual provinces within the delineated borders of the regions; the municipal level, consisting of 8,109 local municipalities. While the Spanish political model is very similar to the federal model, the approval of the Spanish Constitution in 1978 has resulted in a historical process of political decentralization. One result of this is that Autonomous Regions have exclusive competency of spatial planning policy (Dasi & Gonzalez), just as they are responsible for energy-related planning issues such as authorization of energy installations including power stations, the energy network and feed-in tariffs when the tariff is only operated in a limited number of regions (IEA, 2005).

4.2.3 Energy policy

The Government of Navarra has the main competence on energy policy for the region. Specifically the Department of Innovation, Industry and Employment is responsible for the formulation and coordination of energy policy in the region. The development of the current energy plan is based on the work of various sessions, which included representation from the municipalities of Navarra.

Energy policy in Navarra aims at reducing external energy dependency, expanding best practices in renewable energy resources, promoting energy efficiency and contributing to the national environmental goals in terms of international energy and climate change commitments of the *Kyoto Protocol*. These policy goals crystallized in the *First Regional Energy Plan 1995-2000 (FEPN)*. The development of the renewables was also considered in the plan as strategic decision to develop a new industrial sector with good potential for export. Following the FEPN, Navarra continued developing the energy sector under the framework of *The Energy Plan 2005-2010.* The mid-term goal of this plan was to make Navarra the first region in Spain to become independently from foreign electricity supply, and produce 100% of their electricity from renewable energy sources. Whereas wind energy is still the fundamental driver of Navarra's renewable energy policy, the goal is to produce over 75% of the region's total electricity demand from wind energy by 2010. (Fairless, 2007)

National polices have also played a important role in the development of wind energy in the region, specifically by internalizing global commitments in energy and climate change in the national policy, setting goals on renewables and the introduction of both investment and operational support for renewables. Most central documents in this regards were among others the Royal Decree on electricity produced by hydro sources, cogeneration and RES established in 1994, the Law of the Electricity Sector established in 1997, the Plan for the Promotion of Renewable Energy in Spain 2001-2010 and the Renewable Energy Plan enacted in 2005. The introduction of feed-in tariffs initially issued by the national government through the Law of the electricity sectors has been considered significantly important as it contributed in making generation of renewable energy a profitable economic activity. More recently the *Royal Decree 436/2004* introduced two tariffs that subsidized energy production from wind and solar energy.

4.2.4 The deployment process and policy implications

The success of the wind energy industry in the region of Navarra has been regarded as the consequence of three factors; namely a well established energy policy fully supported by the region's authority, the region's historical development of the industrial sector dominated by the automobile industry and the active involvement of the private sector. (Pintor Borobia et al, 2006)

Navarra's renewable energy boom is directly linked to the creation of the Hydroelectric Energy Corporation of Navarra (EHN) by late 1980's. The objective of the EHN was the to promote the development of renewable source of energy, initially funded by public and private investors; the regional government and its dependant Savings Bank contributed 48% of the capital, the local utility company Iberdrola contributed 37% of the funding along with 15% from the company Cementos Portland. (De Miguel Ichaso, 2000). The interest for wind energy grew mainly as EHN could not further expand the hydro electric infrastructure since new sites for the construction of dams were unavailable. As a response of the Government of

Navarra and the EHN built wind measuring stations to investigate the potential of wind energy in the region, leading to the construction of the first wind turbines on the outskirts of Pamplona in 1994. This development was further stimulated by the national regulation on renewable energy as distributors became required to give priority to electricity from wind farms as well as by the introduction of feed-in tariffs on wind and solar energy.

Once the EHN began developing plans for wind energy in Navarra, the Danish turbine manufacturer Vestas was contracted to construct the first turbines to be situated in Navarra. The first industrial factory for renewable energies was a joint venture between the Gamesa Eólica (51%), Vestas (40%) and the government of Navarra (9%). Gamesa Eólica subsequently expanded and now has three manufacturing plants in Navarra, seven throughout Spain and accounts for over 55% of the Spanish wind power sector (De Miguel Ichaso, 2000). By 2003, over 50 companies were active in the renewables sector in Navarra and the steady progress of EHN was enough to attract the attention of the Acciona group, who, by 2005, had entirely taken over EHN in an effort scale the progress of the Navarrese firm to the international level. (Fairless, 2007)

An important factor in the success on the deployment of wind energy was the implementation of the *First Regional Energy Plan 1995-2000 (FEPN)*. This made Navarra the first Spanish region to invest in renewable energy sources, with the wind industry being its primary focus. The regional energy policy in Navarra has been financed by EUR 400 million from the Government of Navarra. The particular focus of this funding, like the aims of overall energy policy, has been towards wind farms and solar farms as well as biomass production. Generally, these investments have originated in the form of tax credits and subsidies. Additionally, the Government of Navarra helped private companies by granting direct subsidies of 20% of total investments to attract renewable energy firms between 1994 and 1999, and increased this amount to 30% since 2000. (Faulin *et al.*, 2006)

In 2001, Navarra was already the second ranked Spanish region in terms of electricity production from wind energy and by 2002 Navarra had already surpassed the EU goal for renewable energy sources as a share of energy production (CENER, 2007). The result of this process has been 38 wind farms in the region, consisting of 1,100 turbines installed and enough power to cover 100% of the regional electricity demand during three months of the year (Belarra, 2009). In 2004 the Government stopped the approval of proposals for new wind farms due to concerns of landscape impacts of wind farms causing conflicts with the public. Whereas the last development of wind farm was culminated in 2005, the installation of experimental parks to test new turbines is still allowed. Further expansion of wind energy in Navarra relies now on improvement in performance and efficiency of the mills and by the so-called repowering, i.e. through the replacement of old mills with modern ones. Being the initial production capacity of wind mills 0.5 MW the new wind mills manufactured by Acciona and Gamesa will produce between 1.5 to 3 MW. (Belarra, 2009)

Alongside with the establishment of public and private partnership the deployment of wind energy in Navarra has also resulted in important R&D initiatives. Most notorious was the National Renewable Energies Centre (CENER) established in 2000 as a foundation venture called CENER-CIEMAT. Accordingly, the CENER was funded mainly by the Government of Navarre (37%), the National Research Centre for Energy, Environment and Technology (CIEMAT) (27%), the National Ministry of Education and Science (18%) and the Public University of Navarra (9%). CENER acts today internationally, nationally and regionally as an institution dedicated to the research, development and promotion of renewable energy. Furthermore, CENER has cooperated with the government of Navarra in the creation of regional energy plans and making specific contributions to the development of wind power in the region (CENER, 2007). In order to ensure the presence of trained technicians and specialists in renewable energy in the region's labour market the Centre for Training in Renewable Energy (CENIFER) was established by the Government of Navarra. CENIFER provides training towards different target groups. The institution also participates in collaborative programmes to train technicians from other countries. (CENIFER, 2009)

4.2.5 Impacts on regional competitiveness

To some extent the wind energy sector in Navarra has followed a similar development to the automobile, namely new technologies have been adopted and further developed, resulting in the fabrication and assembling of high value products for export. Today, wind energy sector has become an exporting industry covering today 16% of global demand for wind turbines. It is also evident that the development of wind energy in Navarra has laid down the bases for the further technological development of new technologies on solar power and bioenergy, not leas by considering that the same companies originated from the wind industry are now developing these other technologies. (Pintor Borobia et al, 2006)

The development of the renewable energy sector has resulted in approximately 6,000 employees of which approximately 4,200 correspond to the wind energy industry (Belarra, 2008). While the absolute numbers of employment are impressive, the nature of the jobs created are equally important. First, the spatial distribution required by wind energy production resulted in the creation of jobs in rural areas leading therefore to a process of decentralization of the region's economy. Second, the employees of the renewable energy firms are comparatively young, with over 46% of them under the age of 30 and 86% under the age of 40. Third, there has been a strong demand for highly-skilled and specialized workforce in companies in

Navarra engaged in renewable energy technology as these involved only 9% unskilled labour force (Faulin et al., 2006). Considering that part of the production of wind turbine components from Gamesa Eólica has been allocated outside the region, the lack of specialized labour force has also represented an important constraint in the further development of this sector whiting the region (Erro Garcés, A. & García Barneche, L., 2006). Nevertheless the success of the wind energy industry in Navarra has resulted in regular visits by delegations from around the world interested in learning more about these developments in particular wind energy and the transboundary cooperation on renewable energy deployment with other regions of in Spain and Europe, as well as with countries in other continents, most recently Brazil and Chile. (Belarra, 2009)

4.3 Industrial symbiosis in Kalundborg and Landskrona

4.3.1 Kalundborg, Denmark

Kalundborg's industrial symbiosis (IS) network has evolved over a period of 25 years and today it comprises partnerships in some 25 projects. The IS is built as a network cooperation between seven companies and the municipality of Kalundborg's technical department. The projects concern recycling of water, transfer of energy and recycling of waste products between the independent symbiosis partners. The IS developed as a "bottom-up" initiative in an attempt to exert good management practice and to improve environmental performance.

4.3.2 Spatial characteristics of the municipality of Kalundborg

The municipality of Kalundborg is based in the region of Zealand in Denmark approximately 100 km from the capital, Copenhagen. It covers an area of 604 km^2 and holds a total population of 49,743. The population density is 82 per km^2 which is lower than the national average which is 126 per km^2. Approximately 35 % of the municipality's citizens live in Kalundborg which has a population of 17,600, while 14 % live in smaller towns and larger villages of between 200 and 2,000 inhabitants. Finally, approximately 29 % of the population live in the open land or in small villages. Due to the latter the municipality of Kalundborg is designated as a rural. Concurrently, Kalundborg is an industrial municipality with international and high technology companies placed in the town. During the period 1997-2007, the municipality has had an increasing number of industrial workplaces, unlike Zealand as a whole where there has been a decline in the number of industrial workplaces. Kalundborg is distinct in a national context due to its high occupation in the fields of industry, construction, and agriculture. Kalundborg has a coastline of 160 km with significant nature and culture-historical qualities which attract both tourism and settlement, and which also entails a challenge for the town in terms of maintaining the sustainability of the coastline. (www.kalundborg.dk)

The IS exchanges that have been established between the seven companies involved in the network in Kalundborg have developed around physical conditions that are unusual in Denmark. Thus, Kalundborg is characterised by large processing industries situated within relatively short distances. The industries are diverse, not competing and in a situation where they have been able to utilise each other's by-products and waste materials. The location of the power plant in Kalundborg has further strengthened the opportunities for exchanges, notably in terms of the energy savings in the network, and the connection to the district heating system of the town. Consequently, the power plant is a key to a number of energy, water and by-product exchanges. Moreover, the involvement of the technical department of the municipality is characteristic for the network. In the case of Kalundborg, similarly to other Danish municipalities, the municipality is the distributor of water from the local lake, and district heating for the municipality. Water from the lake is a key element to the water processing industries in town. The construction of pipelines and other costs connected to establishing IS exchanges have been commercially negotiated between the parties involved in each individual project. Public funding has thereby only been involved in connection to the projects that involve the municipality.

4.3.3 The industrial symbiosis exchanges

There are three types of projects in the IS network: exchange of energy (6 projects); recycling of water (12 projects); and recycling of waste products (8 projects). The power plant produces 10 % of the total electricity consumption in Denmark based on coal. Excess heat from the power plant is applied as central heating for the town of Kalundborg. Moreover, the company provides excess heat from the electricity production as process steam to Statoil, Novo Nordisk and Novozymes. This use of excess heat is equivalent to more than 75,000 family households' annual electricity consumption and equivalent to 240,000 tons CO^2. Today, total energy savings through the IS exchanges amount to approximately 20 %.

Treated wastewater is pumped to the power plant for use in flue gas treatment. Water is reused 3 to 4 times between the Statoil refinery and Asnæs Power Plant. The reuse of cooling water as process water, delivery of deionised water and steam, and the final use of treated water in the flue gas treatment process lead to high efficient water usage. Thus, the recycling and reuse of water between the companies saves 3 million m^3 of water from nature. The annual intake of new water is today reduced to 7 million m^3 each year.

More than 98 % of the sulphur in the flue gas from Asnæs Power Plant is removed in the desulphurisation process. The by-product industrial gypsum is produced by adding calcium and recycled treated waste water and delivered to the plasterboard company Gyproc where it replaces natural gypsum. Used plasterboards are collected at Kara/Novaren's collection sites and returned for reuse at Gyproc. In total, these exchanges entail that gypsum equivalent to more than 15 million m^2 plasterboards replace natural imported gypsum at Gyproc. Another example is the insulin production of Novo Nordisk where one of the by-products from the yeast fermentation producing insulin is converted into yeast slurry. The yeast slurry replaces approximately 70 % of the traditional soy proteins in traditional feed mixes, and the feed is produced by adding sugar, water and lactic acid bacteria to the yeast. Novozymes treats industrial waste water, and after inactivation and hygieniation of the water, the approximately 150,000 tons of spent biomass is converted to the fertiliser NovoGro which is delivered to more than 600 farmers on Zealand, thereby replacing up to 60 % of the fertiliser needs depending on the crops produced. The company RGS 90 is treating 250,000 tons of oil and chemical polluted soil in their facility in Kalundborg by using sludge as nutrient to the bio-remediation process. After treatment the clean soil is utilised as filling material at various construction sites on Zealand. Finally, Kara/Noveren, the biggest waste company on Zealand, collects waste from households. The waste is incinerated at the combined heat and power plant in Roskilde. Household waste from more than 150,000 families is providing heat and electricity to more than 1/3 of these families. (www.symbiosis.dk)

4.3.4 Deployment process and policy implications

The county of Western Zealand played a key role as a catalyser for the first initiatives for IS exchanges in Kalundborg. At the time, in Denmark, the county's planning department was responsible for overseeing and ensuring adherence of industry to environmental regulation on issues relating to groundwater.[1] In the beginning of the 1980s, the county of Western Zealand put in force that due to the strain on the groundwater, there could be no further expansion of industrial activities in Kalundborg. The planning and establishment of the initial IS exchanges were carried out by the directors of three large processing industries in Kalundborg: Asnæs Power Plant, the pharmaceutical company Novo, and the oil refinery, Statoil, all familiar with each other and their companies. The trust existing between the parties was an important factor facilitating the development of the network, which in turn severed as the base-line for reaching agreements between partners. The municipality's technical department also joined the IS network as a partner in a number of exchange projects. The initial three

[1] This structure has changed with the local government reform in 2007. The regional level is no longer involved in environmental and planning issues at the municipal level.

directors however, based on the case study analysis, have been the main driving forces in terms of developing the network.

4.3.5 Impacts on regional competitiveness

The focus of the companies from the initiation of the IS network was to find a solution to the environmental regulation in order for the industries to be able to expand their activities. If they had not found a solution, based on the fact that some of the companies were planning to expand at that time, one can assume that a possible solution for companies would have been to move their production to another region or another country. Statoil or Novo moving from the region would have entailed loosing a high number of work places and consequently it would have caused implications for the rural municipality. Moreover, the environmental regulation would have stopped potential new companies from setting up production in Kalundborg. The fact that some of the companies are multinationals has also had an impact on the development of the network, especially Novo Group. Thus a story about the IS in Novo's magazine first caught the attention of the international press. As a reaction to the increasing international interest the IS was further institutionalised with the Kalundborg Symbiosis Institute which was established to coordinate the activities of the network. The establishment of the institute entailed that the municipality's development department also became involved through the institute's board of directors.

The international reputation of the IS network took speed in the 1990s, and since 1996 the requests from various international entities, mainly universities and public authorities, have been coordinated by the Symbiosis Institute. Universities and leading researchers in the field of industrial ecology from around the world have shown interest in the IS network, and visited the IS in Kalundborg to learn from their experiences. Through collaboration with Yale University the symbiosis has become a member of the Industrial Ecology Society, which further strengthens the presence of Kalundborg in the international academic community. Research and development activities are thus carried out in other countries based on the experiences of Kalundborg. The IS network was from the start developed merely as a practical collaboration and by some of the member companies it is still considered as such, and therefore the companies, through the boards of directors, do not agree on the further development potential of the IS. Varying perceptions of the companies involves the alleged role of the network as an international role model. Some companies do not think that the Institute should exploit the potential further opportunities for providing counselling, e.g. to planning authorities that consider establishing similar systems. The municipality's development department has begun using the IS as an asset in terms of dialoguing with companies that consider setting up production in Kalundborg. The municipality uses the IS in a similar manner in its EU office in Brussels. Through this forum, the development department also finds that there is an interest from planning authorities in other countries, giving opportunities to provide counselling to municipalities, e.g. in Poland. Since spring 2009 each partner has been allowed to freely use the IS in Kalundborg in their corporate branding. In September 2009 the regional climate strategy for the region of Zealand enters into force. Increasingly, the region sees IS as relevant in relation to the climate debate, and strategies to implement IS on a regional level have thus been included in the five year climate strategy. The strategy aims to encourage the inclusion of measures for IS in municipal plans. The region of Zealand considers the development of IS as a tool for advancing the development of peripheral regions.

4.3.6 Landskrona, Sweden

The International Institute for Industrial Environmental Economics (IIIEE) at Lund University took the initiative to develop industrial symbiosis in Landskrona. Landskrona Industrial Symbiosis Programme (LISP) is the first IS programme which has been established in Sweden. It started with a consultation period in 2002. Some synergistic connections between companies were already in operation at this time. However, LISP aimed to identify further collaboration options by following a systematic approach and facilitating their realisation. In May 2003, the formal LISP was initiated including over 20 companies and three public organisations. The duration of the project was 18 months. LISP was financed by the national authority, the Swedish Business Development Agency (NUTEK).

4.3.7 Spatial characteristics of the municipality of Landskrona

The municipality of Landskrona is based in the region of Skåne in the South of Sweden approximately 90 km from the Danish capital, Copenhagen. The municipality of Landskrona covers an area of 141 km^2 and holds a total population of 40,860. The population density is 289 people per km^2. The municipality of Landskrona is dominated by industrial activity, and the number of industrial workplaces in the municipality is above the national average. (Statistics Sweden, 2009)

The municipality of Landskrona has similarities to Kalundborg with its domination of industrial activity and its location by the sea, but the processing industries of Landskrona are smaller in size than the multinationals which initiated the IS network in Kalundborg. Meanwhile, the industrial composition of Landskrona was considered appropriate by LISP coordinators for developing IS. Another reason why this municipality was selected was that a number of companies approximately 15 years earlier participated in a project with the municipality's environmental department and the coordinating institute, IIIEE. Through this project companies had already made internal environmental improvements was considered necessary before IS exchanges could be established. In addition, the municipality of Landskrona has a district heating system in.

4.3.8 Deployment process and policy implications

Academic knowledge about developing IS combined with practical experience from IS initiatives in the UK served as the basis for the initiatives of the IIIEE coordinators in the 18 months project. The coordinators first contacted the head of the municipality's environmental department who assisted in contacting the companies in town. Following, respectively the municipality's technical and business development departments became involved in the project. The technical department was involved as a supplier of district heating to the municipality. At the national level, funding was provided by NUTEK and an employee from the national agency participated in LISP meetings. 20 companies in Landskrona decided to participate in the project, each contributing with in-kind funding. The participant companies belonged to a diverse range of sectors such as chemicals, waste management, metals processing, recycling, agricultural seeds, printing, transport and logistics. (Mirata *et al.,* 2005)

During the course of the project, the coordinators regularly organised meetings, as well as seminars and study tours with the participating companies. They used a participatory approach entailing that companies were encouraged to look for opportunities for IS exchanges themselves supported by academic input from the IIIEE coordinators. It was necessary to convince and engage the companies to see the opportunities themselves. Especially a number of breakfast meetings and tours at participating companies' plants opened up new opportunities and led to discussions between companies. Some companies opted out of the project relatively quickly in the process as they found no opportunities for collaboration. In some cases linkages between companies were rejected because companies did not find them economically feasible. The networking that took place between the companies through the project was essential for the process, since the managers and middle managers did not know each other and each other's companies very well in advance. Previously there had been no natural forum for exchange of experiences and networking, but this was facilitated by LISP.

Actual IS exchanges that came out of LISP were limited, and thus there is only one example of IS collaboration established between a car glass manufacturer, a chemical company, and a wastewater treatment plant. The packaging company have solvent from their production which they send to the producer of car glass. The car glass producer mix this with their cooling water thereby reducing the solvent. Finally, ethanol generated by this process is transported to the wastewater treatment plant using it in its processes. A more collective mindset between the local companies was developed during the course of the project just as internal environmental efficiency solutions were found. During the course of the project, the IIIEE coordinators were the main actors in terms of facilitating and pushing the process of developing IS exchanges. However, after the closure of LISP, IS activities have stopped in Landskrona, and there is no one pushing for further development.

4.3.9 A comparative perspective on IS development

This section summarises and discusses main findings of the two cases aiming to point to elements that facilitate the development of IS networks.

The original drivers for establishing IS exchanges vary between Kalundborg and Landskrona. In the former case environmental regulation regarding the consumption of groundwater in the local industries was the catalyser for the development of the first IS exchanges. In the latter case, academic knowledge on Industrial Ecology (IE) and IS and practical experience from the UK were the main drivers behind the initiative of the IIIEE coordinators to establish IS. The case of Kalundborg and research carried out on the development of IS in the UK point to the fact that *environmental regulation* can serve as a strong incentive for IS collaboration. Thus, in the case of Kalundborg, companies were forced to limit the consumption of groundwater, and in the UK companies were forced to institute more efficient waste management. In Landskrona companies did not experience the same pressure to collaborate to find solutions.

According to academic literature, economic and social factors are of importance in the development of IS exchanges (Gibbs, 2008; Deutz *et al.,* 2008; Jacobsen, 2006; Jacobsen, 2007). Throughout the development of the approximately 25 commercially negotiated IS exchanges in Kalundborg there has been economic viability in the collaboration projects. One of the findings in the Landskrona project was that some companies lost interest in the project because they did not find economic viability in establishing IS connections. The reason for this may be connected to the fact that with the initiation of LISP there had not previously been a forum for networking or exchange of experiences in Landskrona. In Kalundborg it was found that in some cases the economic gain from projects were minor, and collaboration was established more due to the level of *trust* which existed between parties. In Kalundborg, a number of local informal forums existed in the 1980s through which managers and middle managers knew each other on a personal level, whereas in Landskrona in the beginning of the 2000s when LISP was initiated, the companies, managers and middle managers did not know each other. LISP facilitated the initiation of a forum for exchange of experiences and networking. Literature points to the fact that trust should develop before companies develop IS exchanges, especially if they have no legal requirements or other pressure to do so. This process of building trust between companies was initiated through LISP. In conclusion, based on the two cases in question, one may propose that *social factors* are equally important as *economic feasibility* when developing IS networks.

The two cases distinguish themselves by the way they have been developed. Kalundborg IS network was developed “bottom up” by the companies involved. The LISP was neither a directly “top-down” or “bottom-up” managed project. The project in Landskrona was inspired by the academic knowledge in the field of IE and IS, and along with others Kalundborg was used as an example in the introduction of the concept of IS to the companies involved in Landskrona. The IIIEE coordinators used a voluntary and participatory approach to engage the companies in the development of IS.

One cannot evaluate whether one approach is better than the other based on the two cases studied, however one can argue that the study points to strengths in both approaches. The *“bottom-up”* approach applied in Kalundborg implies a high level of commitment from the companies, as they have entered into commercially negotiated collaboration projects, and in that sense they have “ownership” of the network. The *academic knowledge* approach in Landskrona entailed that companies were able to receive professional counselling based on academic research regarding their opportunities for IS collaboration. In this case, some companies were inspired to find internal solutions instead of collaboration, but nevertheless the academic guidance led to environmental efficiency solutions.

The IS network in Kalundborg is characterised by the commitment of two of the initial “inventors” of the IS network which have been essential in pushing the development of the network and creating and maintaining the international reputation of Kalundborg, not least through their contacts to key persons in the international IE society. In Landskrona on the contrary clear leadership in terms of further developing IS exchanges here, and this may also help explain why the development in Landskrona has been limited.

Finally, the case study indicates that IS deployment demands time. The development in Kalundborg has taken approximately 25 years. The IS project in Landskrona was first initiated in 2002, where there were no existing networking forums for the local companies. Hence, IS Landskrona can be also seen as in its initial state when companies are becoming more aware of the advantages of establishing IS networks.

4.4 Green Housing in Freiburg, Germany

4.4.1 Spatial Characteristics of Freiburg

The City of Freiburg is located within the State of Baden-Württemberg as one of nine independent cities and 35 districts. The city has a population of 216,300, which amounts to a population density of 1,421 inhabitants/km^2 and is well below the region’s capital city Stuttgart, with a population of over 600,000 residents and a population density of 2,894 inhabitants/km^2 (City of Freiburg, 2009). The largest reason for population density anomaly is based on the fact that over half of the total area of Freiburg (153.06km2) is conserved within the Black Forest national reserve.

Baden-Württemberg is known as Europe's leading region in terms of economic performance and innovation. The state leads Germany in terms of GDP per capita – EUR 33,293 compared to a EU average of EUR 27,601 - and in percentage of employers in high-tech sectors - 18% of all employed persons (BW, 2009). Consequently, Freiburg is identified by its prevalent local knowledge economy. In 2005, Freiburg's GDP was EUR 7.6 billion, of which manufacturing and service provision accounted for 27.7% and 71% respectively (City of Freiburg, 2009). Dominating the service sector are the twelve tertiary education institutions located in Freiburg; namely, the University of Freiburg, which has an annual enrolment in excess of 28,000 students (City of Freiburg, 2009).

The urban structure of Freiburg is distinguished by its clearly defined centre, called the 'old city', and a mixed-use periphery. The new building stock in Freiburg has resisted a tendency to generate a sprawling urban structure of differentiated land uses and suburban residential communities, and increased housing demand has been met by the redevelopment of brownfield sites already within the confines of the city's urban configuration. These medium-density mixed-use communities have been constructed to an environmental standard well above the requirements of the federal state and are the focus of the green housing solutions described in this case study.

4.4.2 Green Housing in Freiburg

To achieve an energy specific definition of Freiburg's green housing, performance should be evaluated based on a structure's total energy requirements measured in kilowatt-hours per square metre per year ($kWhm^2a$). Therefore, three distinctions can be used to objectively analyze the green housing stock in Freiburg. First, to be considered a green home, residential structures should at least meet Freiburg's Low-Energy standard, which involves a maximum energy demand of 65 $kWhm^2a$, approximately 50% of the maximum permitted in Germany (Siegl, 2009). Second, the Passive House Standard was first developed in Germany in 1990 and requires that total energy demand not exceed 40 $kWhm^2a$ and total demand for energy for heating and cooling not exceed 15 $kWhm^2a$ (Sperling, 2002). Third, the Plus-Energy House Standard is met when a house generates more energy over the course of a year (through some sort of microgeneration technology such as solar photovoltaic panels) than it consumes. To varying degrees, each of these concepts has been employed in Freiburg.

The development of green housing in Freiburg has predominantly taken place in the Districts of Rieselfeld and Vauban. Rieselfeld is a 70ha land plot located 6km from the city centre and when completed in early 2010 will provide 4,000 residential units for 10,000 residents. Completed in 2006, Vauban is a 40ha land plot that is located only 2km from the city centre and encompasses 2,000 units that are home to 5,000 residents. The complete package of energy solutions realised in these developments - from the use of Passive House and Plus-Energy House techniques to community CHP installations - unanimously implies a spatial decentralisation of energy solutions where a close spatial connection between the given solution and the end point of consumption is evident.

4.4.3 Planning System

In Germany, the federal government is primarily responsible for passing legislation on energy and building policy, while the Länder - the sixteen regional states of Germany - are responsible for the administrative implementation of national legislation. At the national level, the Ministry of Economics and Technology is responsible for developing the German energy policy, but they receive considerable support from the Ministry for the Environment, Nature Conservation and Nuclear Safety for implementing policies pertaining to the development of renewable energies and all environmental regulation that affects the energy sector. At the same time, the Ministry for Transport, Building, and Urban Affairs is responsible for spatial planning in Germany as well as being responsible for the application of all climate change, renewable energy and energy efficiency policies relating to the building sector.

The energy policies concerning the residential building sector are defined by relatively strict and progressive national legislation and regional governments are not responsible for drafting binding policy that governs the residential building sector (PL). In reality, the state acts as an intermediary between the federal government's national policies (which can be further concretised at the regional level) and their implementation at the municipal level (SM). State responsibility for governing certain acts and not others is determined on an individual policy basis depending on the scope and nature of each policy.

In terms of the residential and commercial building sectors, the responsibility to institute national energy and building legislation rests on the municipal governments, which possess relative autonomy within spatial planning and building and land-use planning (HK). It is at this scale where building development plans and local land-use plans are created, thereby allowing municipal governments to strengthen binding national policies with their own local standards. Freiburg's comprehensive energy and environmental approach, which was produced by the Freiburg Environmental Protections Agency, and the land-use and building plans forwarded by the planning department have therefore been the chief motivators for the green housing developments in the District's of Vauban and Rieselfeld.

4.4.4 Policy Developments for Green Housing

By 2008, Germany already had a 14.8% share of its total electricity supply coming from renewables the German government have set targets to reduce GHG emissions by up to 40% by 2020 and to double its energy productivity – a measure of economic output per unit of energy – between 1990 and 2020 (BMU, 2007b) (IEA, 2007). To meet these targets, a number of energy and climate change policies have been enacted by various departments in the German government. *The Integrated Energy and Climate Protection Programme (2007) and the National Energy Efficiency Action Plan (2007)* were developed with specific tools designed to focus on reducing GHG emissions in the residential sector (BMU, 2005). Within these programmes, it was determined that the residential sector would be responsible for reducing total GHG emission by 120 million tonnes per year between 2008-2012 (BMU, 2005) (BMU, 2007b). The following policies specifically relate to the residential sector:

- *The Energy Savings Ordinance (EnEV):* Under the EnEV, the maximum energy demand has been tightened on September 1st 2009, by 30% (from 160 kWhm²a for new residential constructions in Germany. (BMU, 2007b)
- *The Renewable Energies Heat Act (EEWärmeG):* This act is binding since January 1st 2009 and mandates that new homes must cover a certain percentage of their thermal energy demand through the use of renewable energies (IEA, 2008).
- *The Renewable Energy Sources Act (EEG):* The EEG obliges operators of regional power grids to purchase all available energy from renewable sources at prices above market value (IEA, 2007). The price for energy from each renewable production method is fixed for 20 years, with annually depreciating subsidy rates dependant on the renewable energy production method that is used (SM).
- *The CO_2 Building Redevelopment Programme*: Based on the fact that 73% of the current housing stock was constructed prior to the first thermal insulation standards in 1978, the programme provides direct grants alongside the loan variant for energy renovations to residential buildings. Funding is earmarked at EUR 1 billion through at least 2011 (BMVBS, 2009).

At the municipal level, in 1996 Freiburg City Council passed the *Climate Protection Concept*, which called for a 25% reduction in CO_2 emissions in 2010 compared to 1992 (HK). Just recently, council approved the follow-up programme called the *New Climate Protection Concept,* which has an even loftier target of 40% less CO_2 emission by 2030 (HK). Freiburg's

Environmental Protection Agency has suggested that the city move forward with their new targets since the national policies for climate protection have been significantly improved in the past year and it has been Freiburg's mission to continually lead Germany's environmental movement. To achieve these targets, specific measures are outlined in the *Climate Protection Concept's 12-point Action Plan,* which highlight priority areas for urban climate change policy and specifically influence green housing (Breyer *et al.,* 2008).

- *The New Energy Standard for Buildings:* In light of the improved national energy standard for houses (e.g., EnEV) and further technical improvements in the building sector, Freiburg's city council has just approved an enhanced new energy standard. Under the new agreement, all newly built houses and apartments must reach near the energy efficiency standards of Passive Houses (HK).
- *Support Programme for Energy-conscious Renovations:* Beginning on January 1st 2009, this support programme promotes the reduction of energy consumption in residential buildings. Grant assistance is a voluntary benefit for any resident of the city who can seek up to EUR 12,000 for insulation improvements, energy advice or the optimisation of heating systems in their home. (City of Freiburg, 2009)
- *Public Awareness Campaigns:* Awareness campaigns offer targeted information on how people can reduce their carbon footprint based on personal and residential consumption habits. (City of Freiburg, 2009)

4.4.5 The Deployment Process and Policy Implications

The proliferation of Freiburg's green housing movement is the result of several factors. First, historical events over the past 35 years have embedded and engrained a heightened environmental approach to city governance and policy development. Following from this, harmony exists between the goals of the national and municipal government, there is an active network governance mix operating in Freiburg, and also, a mutually beneficial relationship exists between economic development and environmental stewardship in Freiburg.

Freiburg has had a long and storied conflict over the proliferation of nuclear energy. During the early 1970's, the State of Baden-Württemberg pursued plans to construct a large-scale nuclear power plant only 30 km from Freiburg to meet the increased energy demand of the region (Solar Region Freiburg, 2009). The local agricultural community triggered opposition to the prospect of increased reliance on nuclear energy and resistance quickly spread to the Freiburg's student community and the general public (ECA, 2009). This resistance initiated major protests and widespread civil disobedience, and culminated in 1975 with the State of Baden-Württemberg's withdrawal of plans for nuclear development (Solar Region Freiburg, 2009).

The termination of plans for the nuclear power plant in Baden-Württemberg had two direct consequences: first, engagement in the protests significantly raised the environmental awareness of Freiburg's citizens, and second, the Baden-Württemberg region was left with a major hole in their future energy plan. This hole was filled by an environmental approach to energy development that new ecological and participatory approach to local politics and decision-making. The result has been that nuclear dependence in Freiburg has been reduced from over 60% to less than 23% and will continue to decrease as the national and regional governments continue their nuclear phase-out programme. Furthermore, over 80% of the electricity consumed in the city is generated by co-generated heat and power (CHP) plants and domestically produced renewable energy. Thus, although Freiburg will fall just short of their target for a 25% reduction in CO_2 emissions from 1992 to 2010, their renewable energy and energy efficiency developments are commendable in light of a simultaneous phase-out of nuclear energy. (HK)

Also, by tracing policies and decision-making that have influenced the development of Rieselfeld and Vauban through the national, regional and local governance structures it becomes evident that Freiburg's environmental governance strategy is partially nested within a traditional multilevel governance typology. This assertion is evidenced by the scaling of binding energy, climate change and building policies from the federal level down to the municipal level, which identifies a top-down notion of policy governance. At the same time, a local environmental focus and relative autonomy over spatial planning and building and land-use plans is clearly a focal driver of Freiburg's green housing initiatives (HK). The focus on local conditions for the development of these systems implies the necessity for a coordinated approach to energy planning that empowers the authorities most in touch with the local environment. This approach, which is highly evident in Freiburg, recognises that while national policy is necessary for establishing binding standards, funding tools and market conditions, it is local administrations that spearhead the development of green housing (Keirstead, 2008). Thus, the growth of green housing in Freiburg has been driven by national energy, climate change and building policies at one end and local policies in the same areas at the other end.

At the same time, the essence of the local environmental movement is also deeply rooted in the non-state institutions within the local environmental economy and non-governmental organisations. One instigator of the non-state movement was in 1981 when Fraunhofer Institute, Germany's leading applied science research institution with over 15,000 staff in 40 locations, opened a research institute for solar energy systems in Freiburg (HK). This was the first solar institute in Europe to operate independently from a university and it has played a key role in local governance of Freiburg's environmental movement by being a central actor in cultivating Freiburg's environmental economy (HK). Freiburg's environmental sector is now comprised of over 1,500 firms that employ over 10,000 people and these firms generate over EUR 500 million annually for the local economy (Breyer *et al.,* 2008). Thus, Freiburg's economic structure is characterised by the tremendous harmony between the environment and economy where the environmental economy has become the leading business sector in the city.

The strong standing of Freiburg's local governance network has motivated the city to pursue new arenas for acquiring the tools and expertise to lead the fight of cities against climate change. This has led to a second sphere of network governance in Freiburg; the growth of transnational municipal networks (TMN) as globally-local or 'glocal' networks. TMNs aim to realise the full potential of local actions for mitigating global environmental issues by scaling up local environmental governance directly to the transnational level. This example of bottom-up governance adds a new global dimension to governing the local environment and creates a new context of multilevel governance for fighting energy and climate change. Considering the strong environmental movement in Freiburg, it comes as no surprise that the city is considered to be a European hub of TMNs. Freiburg is the home of the International Council for Local Environmental Initiatives' (ICLEI) European Secretariat and the International Solar Cities Initiative, is a model city of the ICLEI's Local Renewables Initiative and is a regional base for the Energie-Cités Association. Although the two environmental governance typologies clearly identify two different ways of governing; the role of government and the hierarchical approach bound by the nation-state on one hand and the growth of horizontally oriented network approach on the other hand; the analysis of green housing in Freiburg has shown that both forms are evident. The result is a mix of state and non-state actors that draw from complimentary scales and spheres of governance simultaneously to reach an advanced level of environmental governance, which is exemplified in part by the pioneering green housing developments in Freiburg.

4.4.6 Impacts on Regional Competitiveness

Considering that the residential sector is responsible for 25-30% of regional energy consumption throughout Germany, the development of green housing is a means toward achieving regional competitiveness in itself because of the overall impact it can have on reducing energy consumption, improving the use of local renewable energy and transitioning the region towards a low carbon future. Furthermore, many of the drivers of green housing simultaneously act as stimulators of regional competitiveness, and therefore, the issues pertaining to the overall governance strategies and innovative capacity of Freiburg can also be seen as indicators of competitive regions.

Freiburg's environmental governance strategy puts the region at a competitive advantage in two ways: First, it helps to cultivate the socio-political framework and labour force needed to transition the residential stock towards low-carbon energy consumption habits, which will contribute directly toward the goal of regional competitiveness by securing domestic energy sources and reducing overall energy consumption. Second, regional competitiveness and green housing share a mutual dependence on the environmental economy and innovation sector and Freiburg's strong environmental governance initiatives have been important for attracting environmental firms to the city.

Freiburg's extensive education sector paved the way for the city's strong innovative capacity and has provided the knowledge base for a rapidly growing environmental sector, which has helped ensure a diverse and flexible economic base. Furthermore, Freiburg's green housing is representative of the technologies and innovative systems that have been developed by local firms and local populations, and co-operation between the high-tech environmental sector in Freiburg and the energy technologies deployed in Rieselfeld and Vauban has been well-documented. This shows that while the residential developments benefit from the locally bound innovation, these firms use the residential sector in Freiburg to test, display and diffuse their innovative accomplishments. It has also been laid out that Freiburg's green housing, its environmental sector and the local economic development strategy benefits from network interaction between government and non-government institutions at numerous political scales. The fact that the City of Freiburg and the firms based there play central roles in a number of transnational environmental networks means that Freiburg is well-positioned to benefit from it's networking capacity in terms of promoting/diffusing its technological developments as well as obtaining local and regional best practices from abroad. In depth study of Rieselfeld and Vauban has shown this to be the case; the two districts have been exhaustively used to promote the achievements of the City of Freiburg and market the energy technologies of the local environmental firms.

5 Questionnaire Results and agency analysis

This section presents the results of the web-based questionnaire that was distributed to representatives from at least one regional energy agency from each EU member state. The aim of the questionnaire was to get an understanding of the distribution of perceived and actual responsibility of energy management between different levels of governments. Both issues are crucial in order to understand details of the dynamics of changes to the energy structure. The question of actual responsibility enables the identification of the governmental level that is permitted and obliged to make decisions and take action in relation to changes to the energy structure. In contrast, the question of perceived responsibility identifies potential bottlenecks in relation to potential changes. The tables indicated in this section are available in Annex V.

5.1 Policy measures in relation to the 3 pillars of energy policy

The first set of questions were directed towards the division of labour between national and regional energy policies in order to see to what extent differences in policy measures may apply generally, and if there are sub-national variances amongst different regions. The focus is on the 3 pillars of energy policy - security of supply, energy efficiency, and environmental protection - and the level of authority is indicated through values from 0 - indicating no emphasis, to 5 - indicating highest emphasis. As shown in table 1a of Annex V, the state is perceived as being the government level that places the most emphasis on security of supply (avg. 4.1) while the level of responsibility is considered lower in relation to energy efficiency (avg.3.5) and environmental protection (avg. 3.1). Further, the role of the national policies in relation to security of supply and energy efficiency are much more concentrated in levels 4 and 5, while environmental protection is much more diverse with a fairly evenly spread of values between 2, 3 and 4. While the state appears to emphasize security of supply, the regional responses are much more varied, as shown in table 1b. In the case of security of supply close to 60% of respondents indicated a high emphasis (levels 4 or 5), while a relatively large group are at level 2 (22%). In relation to both energy efficiency and environmental protection, a majority of the regions emphasize relatively high values for the role of regional policies. At the same time, the character of emphasis of regional policies appears to favour energy efficiency concerns (avg. 3.78) relative to environmental protection (avg. 3.56) and security of supply (avg. 3.54).

5.2 Prioritized energy sources

The responses to the previous questions indicate a marked division of labour between the national and the regional energy policy level. This division is made even clearer when it comes to prioritizing energy sources in national and regional energy policies, as shown in table 2a and 2b. With percentages ranging from 37% emphasizing Nuclear and 39% emphasizing Coal, to 54% emphasizing Natural Gas and Renewable Energy, national energy policies are clearly identified as treating each energy source with relative importance. Comparatively, the regional involvement is much more concentrated on the Renewable Energy (66%) and Natural Gas (41%) relative to Coal (24%) and Nuclear (10%). In all likelihood this is strongly connected to the previous table showing the national policy with focus on strategic resources in order to generate energy security, while the regional focus is much more on questions in relation to energy savings and environmental issues.

5.3 Drivers of renewable energy and energy efficiency

The importance of regional perspectives in relation to environmental protection become even more clear in table 3 where this response gets the second highest score. Furthermore, energy price and security of supply score much lower as drivers in relation to the development of renewable energy and energy efficiency. What it most surprising, however, is the highest ranking given to international commitments, indicating that international agreements and international relations are the main drivers behind both renewable energy deployment and energy efficiency at the regional level. This connection is quite interesting and should be looked further into in relation to this question in the scenario building.

5.4 Energy policy development

As shown by table 4, while state institutions have been identified as the determining level in relation to national energy policies in the previous questions, the state is also identified as being crucial in relation to the development and governance of energy policy at the regional scale. While some kind of regional authority seems to have been delegated to the region, 68% of respondents still perceive energy policy development and governance as being a national obligation, which may be considered surprisingly high. In this respect, regional autonomy in terms of energy policy seems to be relatively limited in 2/3 of the regions. The regions in this group are, to a relatively large extent, representatives of situations where strategic energy planning seems to be dominating, while the other group representing 1/3 of the regions are dominated by regions where the renewable resources have been developed more than average.

Based on the previous response in table 4, the result of question 5 on the ability of regional governments to implement binding policies beyond standards set at the national level is quite surprising. While the state is considered to be in charge of the energy policy development by 2/3 of the regions, 41% of them are still able to implement binding policies beyond the standards set at the national level. This puts the question above regarding regional autonomy in relation to energy development issues in another perspective, and accordingly, should be scrutinized further. Another question in relation to policy development has to do with responsibilities for communicating information and the development of awareness in relation to energy efficiency (i.e. turning policies into practical action). As options for the responses, the following sectors are highlighted: The industrial sector, the energy sector, the transportation sector; and the residential sector. Table 6 shows the results and indicates several interesting patterns. A clear result is the fact that the national governments have an overarching role in relation to all sectors – generally from around 1/2 to 2/3 of the cases - while local governments have minimal roles outside the residential sector (which includes general concern regarding the consumption patterns among the population). It is quite obvious that the role of the local governments in almost all the municipalities is limited to this sector. The only exception is a slightly higher involvement in the transportation sector, compared to the industrial and the energy sectors. In contrast, regional governments are indicated to be responsible in approximately 1/3 of the regions, and as already mentioned, the involvement of the regions seem to be closely connected to regions with a high emphasis on renewable energy development relative to traditional strategic resources. Delegation of responsibility is in this connection is clearly related to the overall policy goals defined at the state level.

The question regarding the quality of dissemination of energy efficiency awareness to the population is outlined in table 7. Only a limited number of regions consider the present spread of information to be sufficient, while the majority - 49% - consider current dissemination levels to be acceptable only in some sectors, and 22% consider it to be generally inadequate. When looking into details regarding which regions are satisfied with the dissemination level there seems to be connection to the regions where this responsibility has been delegated to regional authorities. In this way, there seems to be a close connection between regional responsibility and regional energy efficiency in this respect. While the question of responsibility in relation energy policy has already been determined as a national responsibility in question 1a and 1b, the actual inclusion of this aspect in the energy policies are reflected in table 8a. The inclusion of this policy at the national level is quite obvious with a score of 4.32 out of 5. Surprisingly, however, the inclusion of the security of supply aspect at the regional level is also quite clear, as almost 60% of the regions have emphasized this with a score at least 4 out of 5. With that said, there are still regions where this aspect is more or less absent.

As an addendum to the security of supply perspective in table 8a, the role of renewable energy solutions - and especially the question of decentralized compared to centralized solutions - has been put forward in table 8b. While none of the regions consider decentralized energy solutions as insignificant, only 14% consider it as a top-priority (level 5) and only 41% have it as priority 4 or 5. The key perspective in this connection, however, is the question of centralized versus decentralized solutions. Even though one can think of renewable energy solutions in relation to small scale and decentralized conditions, most regions view the development of these renewables in connection to centralized decisions. Therefore, the answer appears to be more or less the recognition of the status quo.

5.5 Renewable energy development

Only 17% of the regions state that investments in non-renewable energy resources are prioritized over investments in renewable energy technology (table 9a). This clearly shows that renewables are emphasized as a priority for most regions. When comparing the types of regions represented in this connection it is quite clear that combinations of all types of renewables exist, and there are vast differences in the level of involvement depending on the type of renewable resource is exploited as the top priority. Similarly, Table 9b shows that three out of four regions have established operating support instruments to help the development of renewable energy technologies. This distribution shows that the regions providing these instruments utilise many combinations of renewable and non-renewable energy systems in parallel. Consequently, the main energy systems chosen by governments are not shown, in general, to influence the option of looking for renewable alternatives.

5.6 The economics of energy sources

Two questions have specifically focussed on the relationship between economic development and access to energy resources. The first, table 10, relates to the linkage between energy consumption and economic growth. Here, 51% of the respondents consider economic growth in their region as dependant on energy intensive sectors. Furthermore, it is interesting to note that 22% of the respondents are either undecided or unaware of the nature or extent of the linkage between these two variables. Both findings indicate that the process of de-coupling economic growth from energy consumption should be considered a major issue. As a consequence of the previous question, table (11) looks into the potential impact of higher energy prices on consumer decisions and energy demand. Three levels of future oil prices have been suggested: USD$100, $150, and $200 per barrel. In the first case only 12% view the price level as having serious and/or very serious impact on consumer decisions and energy demand, and in the second case only 20% consider a price of $150 as having very serious impact. However, almost 70% of the regions consider an oil price of $200 per barrel to be very impactful, while less than 10% consider it to be of limited or moderate importance. Accordingly, there is a close connection between the choice of basic energy system and oil price development, where the regions with high emphasis on renewable and other alternative energy resources are those least worried about substantial increases in energy prices. Also, most of the regions believe the effects of such price increases will provide a strong impetus for change in specific sectors of the economy, as indicated in the table 12.

5.7 Development perspectives

In relation to the question of reacting to changes to energy prices it is quite clear in table 12a that the effect on the residential sector and consumer choices is predominant. With a score of 2.76 it appears that residential sector *expectations* towards energy efficiency are greater than each of the other sectors (energy sector: 2.56, transport sector: 2.44, industrial sector: 2.24). In sum, there seems to be a relatively close relationship between two components in this connection. First, the issue of relatively high adaptability of private/individual consumption versus the relatively low adaptability of public/business relations is reflected in the energy consumption pattern; which likely affects the abilities and complexities of adjusting to consumption pattern changes. Second, the practical experiences with policy development in the regions seem to indicate that it is easier to develop *and* implement policies targeting the individual consumers relative to those targeting the public and business sectors.

In relation to the previous, the role of the residential sector and lifestyle perspectives is also identified as the sector with the greatest *potential* for energy savings. Here, 41% of the regions emphasize this sector as having the highest savings potential, while the transport sector is the closest follower at 27%, followed by the industrial sector at 20% of the regions. Lastly, the expectations of the energy sector are viewed as having the greatest savings potential by only 7% of the regions. In relation to energy savings *opportunity*, the residential sector is again the clear leader with 59% of the regions viewing it as having the most straightforward path to higher energy efficiency. However, what is somewhat surprising is that the industrial sector is ranked second at 17% while the energy and transportation sectors are valued equally at 10%. In terms of *challenges* 41% of respondents view the transportation sector as providing the greatest obstacle for regional energy savings. This is an important indication of the recognized need for changes to transportation systems and the realization of the need for more efforts directed towards developing efficient transport solutions. Following the transport sector, 34% of the respondents emphasized challenges related to the residential sector, while both the industrial and the energy sectors are ranked quite low.

5.8 Information availability

Due to the nature of the ReRisk project the question of access to relevant information regarding energy consumption has been an important issue. Accordingly, this is addressed in table 13. In Contrast to our own experiences in accessing energy consumption data, 61% of the respondents emphasize that this type of statistical information are currently gathered, while 29% indicate that it is not, and 10% do not know whether they keep this type of data. In relation to future planning of energy dependent relations at the regional level it is crucial to stress that while access to this type of detailed information is already of great importance, it will be even more crucial in the future.

6 The scenarios

This section presents the four scenarios resulting from the scenario building activity. It is important to point out that the scenarios resulting from this activity are only a small sample of a large number of very complex plausible visions of the future that aim to show likely impact of rising energy prices on regional competitiveness and cohesion. As explained in the methodology the scenarios consist of hypotheses that were identified by the results of the analysis completed in Workshop I, the questionnaires, the case studies and the policy review. Furthermore, as the hypotheses were being defined during an internal workshop at Nordregio, the cross-consistency assessment was carried by the same groups using the matrix presented in Annex IV. The resulting scenarios from the morphological analysis were further evaluated and four scenarios were selected in terms of their internal consistency, plausibility, uniqueness, likelihood and relevance for European regional policy. The scenarios have yet not been further revised by the expert in a final round of consultations. This last step is ongoing at the present moment, so the scenarios with therefore be adjusted in accordance with the responses obtained from the experts.

6.1 Scenario 1: Green High-tech

6.1.1 Energy mix: *Emphasis on renewable energy*

In this scenario the utilisation and development of renewable energy technologies is a top priority in Europe in 2030. Considerable economic and demographic growth has prevailed in Europe, which entails that there has been an overall increase in energy consumption. The demand of renewable energy will grow extensively while increases in the demand of fossil fuels become rather modest. The demand for nuclear energy is on the contrary decreasing progressively, as phase-out programmes have been introduced and old nuclear reactors have been closed down.

A long-term goal in Europe is to transform to a non-fossil fuel economy and this is an ongoing process in 2030. In connection with the gradual phase-out of fossil fuels, there is a particular emphasis on integration of energy systems, i.e. integration between fossil fuel and renewable energy technologies. A growing implementation of district heating systems is an example of integration which also provides a solution for energy waste management. The application of renewable energy technologies is being adapted to the specific needs and characteristics of different territories, as well as potential hazards that may affect the performance of these. Moreover, the supply of energy, i.e. centralised vs. decentralised, is adapted to different territorial needs across Europe.

A liberalisation of the energy market has been carried out, and this has facilitated the utilisation of renewable energy sources. Energy markets are comprised of many actors as individuals have better opportunities to invest in energy production. Accordingly, within the limits of the legislative framework, individuals are permitted to own their own energy production systems, which are generally considered to be reliable market investments. Further, public participation in planning processes is stressed and, in general, local communities are active in developing initiatives for local energy solutions.

6.1.2 Energy demand: *High decoupling between economic growth and energy demand*

There is a wider diversification of economic sectors in European regions in 2030. Despite an overall increase in energy demand by 2030, energy efficiency in manufacturing industries and private households is lowering the energy intensity of energy consumers. Generally, the awareness of both industries and private households in terms of utilising renewable energy sources and energy saving measures is increasing resulting in further energy savings. The design of energy efficient products is focused on making products attractive for consumers according to changing trends of the market. The general public awareness is also linked to the fact that public participation in energy planning processes is increasing. Gradually, the involvement of individuals in associations or cooperatives that manage renewable energy systems is proliferating.

6.1.3 International agreements on GHG: *Enforced international agreements on GHG emissions*

New GHG emissions quotas have been agreed globally and a global emission trading scheme is functioning. Global ICT solutions have been developed to facilitate the trading of emission rights and monitoring emissions for all countries. Climate change issues in Europe are managed top-down from the EU to ensure enforcement of international targets. In addition to international GHG agreements, there is also an international agreement in place to conserve water. Accordingly, interregional cooperation is an increasingly adopted measure to save water resources, as well as in relation to the provision of waste management activities.

6.1.4 Technology availability: *Clean energy technologies available to most producers/consumers*

Renewable energy technologies are available and accessible to large, medium and small producers, including households. Similarly, energy efficiency technologies are available, accessible and affordable to most industries, households and for transport. A number of renewable energy and energy efficiency technologies are being utilised in 2030. First, an efficient technology for storing wind energy and PV energy has been developed and is widely implemented. Moreover, common European standards for PVs are established, thereby encouraging further utilisation of these technologies. Second, virtual power plants, comprised of clusters of distributed generation installations, such as wind turbines and small hydro that are collectively controlled by a central entity, are in operation. Third, new and more efficient grid technologies have been developed, and the grid parity of renewable energies in comparison to oil is cost efficient. Finally, the deployment of geothermal is increasing. As a consequence of the development of clean energy technologies, information campaigns, education and training programmes are available to both industry and private households. This encourages both energy producers and consumers to adopt new technologies and provides them with the appropriate competences to do so.

6.1.5 Innovation: *High innovation capacity*

In Europe, there is generally a high capacity to create, develop and export new products and services. There are increasing public investments in higher education and research and development programmes. As a consequence, the average education level in Europe continues to increase and awareness of saving energy and renewable technologies is integrated in education programmes. This facilitates general public awareness and a gradual change in behaviour in terms of reducing energy consumption. Education for actors such as craftsmen and architects, directly involved in implementing energy efficient solutions, is cross-sectoral, thereby facilitating a common understanding and approach to energy efficiency and renewable energy.

6.1.6 Economic development: *Higher presence of the service and knowledge economy*

Continued economic growth in 2030 is dominated by the service sector and the knowledge economy thanks to increased competitiveness in technological development, consulting and high-tech manufacturing. Taking into consideration higher transportation cost due to high oil prices from outside Europe along with climate change implications, manufacturing industries are still present in Europe. This development has progressively resulting on stronger emphasises on self-sufficiency and local production in many regions.

6.1.7 Settlement patterns: *Urban and rural growth*

European countries are experiencing economic and social growth in both urban and rural areas. A shift away from the traditional divide between urban and rural areas towards a new notion of urban and rural integration is developing, partly due to the increasing utilisation of renewable energy technologies. Thus, collaboration between urban and rural areas in terms of energy production and consumption is increasing, and there is no longer a clear distinction between them. The liberalisation of the energy market entails that networks of “energy communities” are developed across rural and urban areas. The networks are organised as cooperatives which are the owners of wind farms and other renewable energy establishments. The general improvement of the ICT infrastructure has facilitated this process along with the improvements in grid technologies for renewable energy sources. The fact that there is social and economic growth in rural areas is partly due to the diverse opportunities for virtual commuting that are utilised. Also, the concept of second homes, which involves keeping a home in an urban and rural area, is commonly used. This is connected to the fact that face-to-face contact is still important in relation to most jobs, and by keeping a home in the city, individuals can commute between homes. Another commonly used concept is the establishment of meeting forums in rural areas, where professionals sharing common business interests can meet and exchange ideas on regular basis.

6.1.8 Transport: *Emphasis on public transport*

European countries experience growth in the use of public transportation relative to the use of private cars. This is mainly a consequence of high oil prices and taxation on private car use. However, the increasing awareness of climate change and a general change in behaviour of individuals in terms of saving energy are also influential factors. Both public and private modes of transportation partly run on fossil fuels, electricity is increasingly used as a fuel for transport. Due to the predicted global impacts of climate change and population growth, agricultural land is no longer used for biofuel production. Instead, organic waste materials are used for producing second generation bio fuels. The structure of public transport networks demonstrates a mix between private and public ownership, and private individuals are, to a higher extent, involved in the transport planning process. Generally, public transport networks are improving in urban and rural areas, along with the establishment of connections between them. Moreover, networks of highly developed bicycle and walking paths are common in urban areas.

6.2 Scenario 2: Energy Efficiency for a future Europe

6.2.1 Energy mix: *Emphasis on fossil energy*

Energy demand from fossil fuels continues to increase significantly as Europe is operating under the assumption that these continue to be available in the medium to long term, and the environmental externalities of its production and consumption will be reduced. While the development of renewable energies has helped to offset the energy supply lost from the phase-out of nuclear energy, improvements in energy efficiency, clean fossil fuel technologies, and lack of available land for large-scale renewable energy production, have clouded out the possibilities to further expand renewable energy as the future of Europe's energy supply. In terms of fossil fuels, the access to secure supplies of natural gas is critically important, along with the infrastructure for its dispersal throughout regional energy grids. Combined heat and power (CHP) systems have been installed in both urban and rural areas and district heating systems are commonplace. New ways of harnessing and using waste energy produced by fossil fuel conversion are now economically viable, which improves efficiency from fossil fuels. However, the uneven distribution of access to natural resources for producing energy has motivated greater integration of energy markets at the European level. In terms of renewable energy, the development of large scale sources is constrained by new rural functionalities implied by balanced economic activities and rural development. For example, wind energy is preferred over energy crops because it can be situated among food-producing agricultural areas to create new notions of rural multi-functionality. Conversely, small scale renewable energy – solar PV, geothermal, solar thermal, etc. – have become important energy producers in Europe.

6.2.2 Energy demand: *High decoupling between economic growth and energy demand*

The energy intensity of the European economy is reduced in large part because high energy prices have resulted in the "commodification" of energy. This has motivated energy producers to invest in efficiency improvements, especially in terms of energy production and transmission, and energy consumers have invested in efficiency across all sectors. While industrial spatial development emphasizes the improved efficiency achieved through industrial symbiosis, the efficiency potential of the industrial sector is relatively low, so other sectors have picked up the slack to reduce overall energy intensity. The efficiency improvements of the building sector have been especially pronounced, but due to slow turnover rates in the building sector it will take many decades before low-energy buildings are predominant in Europe. Further, the size and packaging of consumer products has been reduced significantly, along with new technologies that reduce energy consumption of all electric appliances through developments of standby functions and intelligent energy systems.

6.2.3 International agreements on GHG's: *Weakly enforced international agreements on GHG emissions*

The most energy intensive global economies have not signed a unified global agreement on GHG emissions, which has limited the ability for European economies to proactively develop renewable energy technologies while simultaneously remaining economically competitive globally. However, due to the phase-out of nuclear energy and important new rural functionalities, political commitment towards environmental protection is highly-focussed on energy efficiency. Further, this commitment is dependent on governing structures that draw out the roles and responsibilities of the public sector at each administrative level as an integrated and concerted energy and climate change approach.

6.2.4 Technology availability: Clean energy technologies available to most producers/consumers

Thanks to high energy prices new energy efficient technologies as well as renewable energy technologies have become more competitive. Specifically, consumers will prefer these technologies because of significant opportunities for cost reductions in energy consumption. For large producers this has implied that clean technologies for large-scale energy production are prudent investments. Further, economic stimulants and taxation policies directly have also contributed in increasing the availability and attractiveness of these technologies. Awareness regarding the consequences of energy consumption and the potentials for reducing energy expenditure will be diffused through a variety of media types in new and creative ways. Also, development of new human resource positions, such as energy auditors and consultants, emphasize the benefits of improved energy efficiency.

6.2.5 Innovation: *Moderate innovation capacity*

The innovation capacity in Europe has been moderated due to economic regionalization that has placed new emphasis on more traditional economic sectors. The innovation capacity of other countries such as China and India has increased significantly relatively to Europe. Therefore, many of the technology adopted in the European energy sector has been developed abroad. Public investments on R&D have also decreased due to an increasing social spending resulting from a rising demand from social assistance for aging populations. The effect of higher energy prices, EU climate change policies, and the importance of energy for economic competitiveness means however that innovation will put emphasis on energy technologies especially related to efficiency. Further, the importance of innovation in terms of spatial planning and its integration with energy, land use and urban planning is also emphasized.

6.2.6 Economic Development: *Balanced economic growth by all sectors*

The general trend of globalization has been challenged due to high freight transport costs and increased wage rates overseas. This has led to a more balanced and regionalized economy that has replaced the predominant growth of the service sector in Europe. This regionalization process has been most influential for the agricultural and industrial sectors. In terms of the agriculture, the sector has benefitted from technological development and has made important efficiency improvements. Some industrial production will return to Europe, but many energy intensive industries will remain overseas or in European regions with abundant natural resources for producing energy. The new industrial mix in Europe is highly efficient as its rationale for being located in Europe is based on the inferred energy and cost savings that result from reduced global freight transport. Industry will be made more efficient through automated and scrutinized production methods, thereby implying the demand for highly trained and skilled workers across all sectors.

6.2.7 Settlement patterns: *Urban and rural growth*

Urban socio-economic growth in Europe is unavoidable due to the importance of agglomeration in the service sectors. In lieu of this it is increasingly important that urban spatial and land-use planning is integrated with energy planning to produce spatial arrangements and built environments that meet an improved energy standard. Accordingly, city planning now includes binding energy and environmental protection policies that governs energy consumption across multiple sectors. This integration has motivated urban growth as polycentric, mixed-use and dense urban environments that reduce energy dependence, especially in the building and transport sectors. If rural areas have experienced socio-economic growth it is realistic to assume that they will not continue to experience depopulation. Therefore, effective policies for retaining skilled workers in rural areas have been implemented. Also, the regionalization of global economies has created new rural functionalities that have increased the diversity of jobs available in rural areas. Similarly, ICT developments allow more people to live predominantly in rural areas and commute to urban areas for work on a more periodic basis.

6.2.8 Transport: *Emphasis on private car transport*

In this scenario the dependence on the private car is related to the growth of rural environments that do not have the populations of scale to rationalize public transit infrastructure. Cars are also popular because of the perception of freedom they imply, especially for residents of rural areas. At the same time, the higher costs associated with car ownership has motivated new perspectives for what it means to own and drive a car. For example, urban and rural transportation networks now promote high-occupancy commuting by providing the necessary infrastructure and incentives. Car sharing and co-operatives have also become commonplace, but this is limited to urban areas that suitable population densities exist. Due to high oil prices hybrid and electric cars are now economical and the appropriate infrastructures - car-charging at parking lots and battery exchange stations - have reduced the burdens of hybrid car ownership. Consequently, these vehicles now represent a significant share of all car purchases in Europe. At the same time, combustion engines continue to be produced as relatively profound innovations have greatly improved efficiency and the availability of biofuels from waste materials. New technologies such as intelligent driving systems and exhaust recycling systems have also been extensively developed.

6.3 Scenario 3: Nuclear energy but for big regions

6.3.1 Energy mix: *Emphasis on nuclear*

In this scenario nuclear energy is the main priority for energy development in many European countries. These countries have deployed nuclear energy programmes during the last 15 years. Nuclear phase-out programmes in have been shelved and replaced by new programmes on the construction of nuclear reactors. These programmes have resulted from the decision-making of national governments coupled with intensive information campaigns aimed at creating public acceptance towards nuclear energy, which emphasised on the benefits of cheap electricity and the importance of climate change mitigation. Following national decision-making, the planning and construction of new nuclear reactors started in the early 2010's have taken at least ten years to materialize. While the infrastructure for nuclear energy was under construction between 2010 and 2020, renewable energy deployment witnessed a significant expansion, primarily large-scale renewable energy systems such as wind and solar farms and CHP. Further, renewables encountered a phase of stagnation after 2020 due to increased competition from operational nuclear reactors and lack of available land and decreased innovation on these technologies. While the overall energy network has been gone through a process of centralization, a new balance between centralized and decentralized energy systems is also apparent. This is not only due to the presence of renewable energy, but also because technological developments in nuclear energy allow smaller reactors to generate electricity from nuclear waste (cascading). The demand for fossil fuels has been reduced in 2030 as nuclear energy and renewables have replaced coal use by industries and thermoelectric plants. Also, the use of oil for heating has almost been entirely replaced by electricity, biomass and district heating. Consequently, the transport sector, primarily freight and the airline industry are the primary consumers of fossil fuels in 2030.

This scenario also presupposes a high expansion of the electrical grid for whole Europe. The energy sector is dominated by few big producers, partly as consequence of the large investments required for the construction and maintenance of nuclear rectors, distribution grids and waste storage facilities. The dependency of large investments has also had other important implications; namely, the reduced availability of economic resources for renewable energy development. The overall vulnerability of these large scale energy systems towards financial crises, especially during the construction phase of nuclear energy infrastructure is also a notable implication. Initially the high presence of nuclear energy in Europe has created a gap between oil and electricity prices, but has increased due to higher demand of uranium world-wide. Uranium is primarily imported from Australia and Canada, and to a minor degree from the Middle East and Russia.

6.3.2 International agreements on GHG's: *Weakly enforced international agreements on GHG emissions*

Despite the fact that some of the most energy intensive countries in the world have not signed proposed global agreements on GHG quotas, Europe has maintained its energy and climate change goals. Most importantly, however, nuclear energy has become a widely accepted measure for climate change mitigation.

6.3.3 Energy demand: *Low decoupling between economic growth and energy demand*

Due to overall population growth and the relative growth of manufacturing and primary industries, energy consumption has increased significantly in 2030. Moreover, as the nuclear plants became operational in the beginning of 2020's, persistent energy efficiency improvements became difficult to achieve because the lack of incentives and technologies available to consumers, and abundance of cheap and reliable electricity from nuclear reactors. This has resulted in significant increase of energy consumption per capita which in turn starts putting again pressure on energy prices. The transmission of electricity from nuclear plants through long distances has also resulted into important energy losses.

6.3.4 Technology availability: *Clean energy technologies are available to few producers /consumers*

Due to its cost and low availability the development of micro-scale solutions - roof-top wind mills, household PVs, fuel cells is largely restricted to remote and isolated areas. Since energy sector investments in many European countries have been related to nuclear energy, renewable energy technologies have not been benefitted from effective national support mechanisms. The decrease in electricity prices after 2020 has further hampered renewable energy technologies' ability to compete in urban regions since cities have been the first to be connected to the nuclear plants. Energy efficient technologies have also become less competitive in response a decrease in electricity price between 2020 and 2030. Therefore, the only way of promoting further energy efficiency will be through directives. However, this has implied that many technological developments have fallen outside specified support mechanisms and therefore have not been able to reach consumers.

6.3.5 Innovation: *Moderate innovation capacity*

The innovation capacity of Europe has been moderated relative Asia. Gained competitiveness in manufacturing and primary industry has thus resulted in less political emphasis on innovation. While overall R&D spending has been reduced, nuclear energy R&D has received extensive funding. Consequently, many renewable energy technologies are imported from abroad. This has also resulted in increasing import of foreign technology.

6.3.6 Economic development: *High presence of the primary and manufactory industry*

While Europe has faced increased competition in high-tech and service sectors from Asia, high prices on raw materials, oil and food, as well as high costs for transport coupled with a relatively low electricity price from nuclear has opened the possibility for growth in the electricity-dependant manufacturing and primary industries in Europe. This process has been accompanied by reduced production costs due to modernization and automation of industrial processes. This situation has opened opportunities for recycling industries which now collect various solid materials; mainly metals, but also organic waste materials that can be converted into solid fuels for CHP or second generation biofuels for the transport sector. The result is an increase of the manufactory and primary sectors and regional development policies supporting the expansion these industries. The high degree of automation in these industries growth in employment is lower level than expected.

6.3.7 Settlement patterns: *Urban and rural growth*

Immigration and economic growth has continued to be concentrated mainly in urban areas. Most of the new industries are located close to the urban centres and high population densities coupled with industrial concentration has had the potential to cause competition on land and water resources. Rural regions have also witnessed increased agriculture activities performed exclusively by large and specialized farms that have displaced small ones. This situation implies that the agriculture sector has become less labour intensive despite of its economic expansion, and therefore contribution on the growth of the rural population have been modest. The exceptions are rural regions rich on natural resources where the primary industry has flourished. While regions in the pentagon as well as industrial regions have benefited most from nuclear energy supply, remote and isolated regions, especially insular regions, will continue to be dependant on renewables and fossil fuels because they cannot be connected to the main electric grids of Europe. Also, while nuclear waste has accumulated quickly during the last 10 years, inter-regional disputes have increased as decisions on which regions may process and store nuclear waste has become tenuous. However, this situation is dependant on the capacity of national governments to allocate economic resources for infrastructure to manage and store nuclear residues. Accordingly, regions in countries that lack these economic resources will continue to face serious conflicts, which might necessitate external intervention.

6.3.8 Transport: *Emphasis on both public and private car transport*

Due to high oil prices progressive efforts are made to electrify the transport system, especially in urban areas. However, the current balance between public and private car transport is maintained as developments on public transportation are still insufficient for reducing car dependency; especially in urban areas where the population is still growing. The availability of cheap electricity and high oil prices has also motivated the construction of high speed trains that connect the main urban nodes in Europe. For private car transportation, high oil prices and climate change policies have resulted in some adaption toward new energy sources. In particular, hybrid and electric cars are commonplace. However, high oil prices have created a significant burden for users who cannot afford to buy new energy efficient cars. Similarly, the freight and air transport will continue to be heavily dependant of fossil fuels and will face significant challenges.

6.4 Scenario 4: Business as usual?

6.4.1 Energy mix: *Emphasis on fossil fuels, mainly coal and natural gas, moderate increase in renewables, decrease in nuclear power*

In this scenario, there is only moderate transition to renewable energy sources, and the renewables that are exploited are large scale, centralised solutions. Coal use in electric generation has gone up. Relative availability, plus promotion of the belief that “there is coal for 230 years” has driven the movement. Central Asian and Russian/Arctic gas deposits have now become major sources of energy. This has meant major capital investment in pipelines and especially in LNP production, storage and transportation systems, such as harbour facilities. The fear of the cost of nuclear waste storage, of uranium shortage, and of the cost of decommissioning nuclear plants – combined with public skepticism – have all contributed to a reduction in the share of nuclear power. Therefore, large scale gas and coal are dominant, but already in 2030 we see the exhaustion of few of the fields and a production decline in others.

The emphasis on “big energy” has reduced the number of actors able to invest, and their effective lobbying has managed to pervert the market for small-scale alternatives. Now multi-national energy corporations dominate the field more than ever, despite the efforts of several European countries to emplace protectionist schemes. For example, Gazprom is still nationally owned, but is now an international player. User resentment due to the high cost of energy is high. Large-scale production has meant that the use of waste heat (in district heating, for example) has not been developed to any great degree, and is instead a pollution problem, but the fly-ash problem from coal plants has been ameliorated to a degree due to bi-production (such as gypsum board) and sale of what would be a pollution problem.

6.4.2 Energy demand: *Economic growth and energy demand still strongly coupled*

Although there some increase in energy efficiency, the reduction of energy requirements is offset by the reduction of GNP due to the burden of high energy costs. Therefore, the ratio of GNP/energy output has remained stagnant. Modernisation in industry and freight transport has given marginal efficiency gains, but increase in auto-use has offset this.

6.4.3 International agreements on GHG: *International agreements on GHG emissions not significant*

The efforts to reduce GHG emissions have been hindered by the lack of initiative and participation from the USA and China. The backlash in the USA after President Obama has resulted in a reversal of willingness to cooperate internationally, and China has responded with an "I won't if you don't" attitude. This has made other countries hesitant to make too large concessions in times of no economic growth. The motto seems to be "Ruhr coal for Ruhr workers", and wherever possible, protection of local jobs has taken precedence over climate control.

6.4.4 Technology availability: *Clean energy technologies available only to a few, large producers and consumers.*

The general slowness in economic activity has resulted in little adoption of new, clean technologies. What is available is expensive, and lack of a large market means that investment in R&D that might have brought down costs has been slow. The general lack of free capital at the meso and micro scales has resulted in very slow retro-fitting of existing building stock to make it more energy efficient, and there is relatively little new building due to the downturn. The subsidies that some countries have created to encourage investment in retrofitting and energy efficient building have been unsuccessful: they were too short-term, and therefore those who needed them most (private housing and small scale cooperatives, for example) simply could not afford the investment, in spite of the subsidies.

An ageing population is proving to be resistant to change and long-term efficiency investment, but is, in fact, more willing to invest in conveniences (elevators, heated driveways) that are *adding* to energy consumption. The feed-in tariffs that were tried in Britain and Germany early in the century have just not caught on. Public trust has been too little, and too late. Now only a few big actors with venture capital are investing in high-tech solutions: small scale actors have found it too risky. The attempts at cooperative schemes from the early 'teens failed due to insufficient access to revolving credit. Large scale solutions are also hampered by public resistance to wind parks, and only those with patient capital and money for lawyers are still in the game. Adding to this are the concerns with terrorism that have limited the location of energy production to sites that can be access-controlled and protected.

6.4.5 Innovation: *Low innovation capacity*

The stagnation of GNP growth has been mirrored by a lack of investment in R&D. The best brains are now moving to China, India or Brazil, where income possibilities are much better. Smaller companies that closed after the 2008 crisis never reopened, and their workforces went into unemployment rather than contributing their tacit knowledge to development. Now, very few companies can afford to invest in development, and public stimulation schemes are few and under-utilised. Education has received neither attention nor investment, and students in general are doing less well on international comparative tests. Universities cannot attract top students or faculty, and a downward spiral in quality is becoming increasingly apparent. The regions of Europe, in their protectionist stance, have failed to pool resources and to learn from one another. Now Europe, once the centre of knowledge economy, has become a net importer of technology.

6.4.6 Economic development: *Balance, but no growth*

It seems that the economy in general has never really recovered from the financial crisis of 2008, but that a more pervasive, structural economic problem – rooted in dependency on costly energy – has hindered any dramatic recovery. There has been no significant reorganisation of the importance of the various sectors, but this is due to a lack of any real change or innovation. Industry is hampered by outdated infrastructure and rising prices for scarce raw materials, lower buying power hampers the development of private services, and a lack of investment results in stagnation in public service sectors. It seems that social dumping and eco-dumping were strategies that Europe abandoned far too late: the emerging economies were learning fast, Europe wasn't.

Start-ups are failing at too high a rate due to lack of affordable venture capital and poorer frame conditions. The "buy local" movement from the early years of the century has truly taken hold, but now the motivation is protectionist rather than environmental. One sector is blossoming, however, and that is the second-hand market, as more people choose cheap used options rather than the high prices of new goods. Incomes have stagnated and governments have to address the issues of public dissatisfaction and unrest, rather than have a proactive stance toward development. Lack of public tax revenue for social support (retirement, security) contributes to this unease. Protectionism is also apparent in immigration policies which have become increasingly restrictive. There is still immigration, but only from very poor countries, and most of it illegal.

6.4.7 Settlement patterns: *Urban growth – rural stagnation*

The protectionist stance is also apparent in the attitudes of cities and regions. Cooperation is weak, attempts to compete, strong. In spite of the decline in the quality of urban life due to unrest, poverty, crime and homelessness, the urban areas represent the only economic opportunities now available, and therefore, are still growing. Consequently, the rural exodus that once characterised outlying areas of Europe has become a general phenomenon. The hardest hit are the tourist-dependent areas far from major population centres. These simply cannot compete for the fewer tourists that still have the money to travel, while mass-tourist traffic decreases each year. The only rural areas that are doing well are those with recreational amenities that are quite near large population centres, as short vacations replace international trips.

Urban planning has stagnated, and the response to growing populations is inadequate. There are some attempts to retro-fit the city, but new building is not keeping pace, so crowding and sprawl to the immediate environs are apparent. Of course, there are some “islands” of wealth and innovation, but these are not integrated into the metropolitan fabric, but are “outposts” of international companies. Income and price levels are de-coupled: some consumer goods are cheaper due to lack of demand, but food and other transported goods are expensive due to transport costs, regardless of the ability of consumers to pay.

6.4.8 Transport: *Emphasis on private cars and trucks*

A lack of investment in good, competitive public transportation options has resulted in increased use of cars, despite what consumers might wish. There are not sufficient alternatives to provide alternatives to cars. Economic stagnation has also meant that the car-park is older and pollutes more than ever. Hybrids are an increasing part of the mix, as fuel costs offset their greater initial cost. The shift to electric cars that seemed to be in the offing some years ago has not materialised due a lack of public investment in the charging stations and other infrastructure that might have stimulated their adoption. Batteries are still expensive and hard to recycle.

More cars and trucks providing transportation, combined with urban growth, has resulted in more cities having to deal with the “all-day rush hour” – with traffic jams and slow-downs, and the concomitant pollution increase, as the new norm. The rise of the “local vacation” (short private travel to local resorts rather than flying to distant venues) also adds to the metropolitan traffic picture.

7 Further proceeding towards the Draft Final Report

The main task left for finalising the scenario activities are:

- The scenarios will be sent to the experts participating in Workshop III for a final round of consultation. The goal of this exercise is to not only validate the scenarios produced during this activity but also eliminate possible inconsistencies.
- Based on the outlined scenario dimensions generated in Workshop III a series of in-depth interviews with selected representatives from the regional energy authorities will be carried out. This will provide important input in relation to explaining response patterns, differences and inconsistencies between the grouping of the responses from the questionnaire and the result of the cluster analysis in task 2.3. Consequently this will provide important information needed for the outlining of the final scenarios, and eventually for the policy recommendations.
- The policy recommendations provided during Workshop III will be outlined.
- The potential impact of the scenarios on the regional typologies produced through the clustering analysis in task 2.3 will be identified, just as the regional typologies produced during Workshop III will be used to relate the scenarios to the results from the clustering analysis.
- Based on the above the final structure and characteristics of the scenarios will be decided on, outlined, described and tested in relation to the regional typologies.

8 Annex I. References

8.1 Structural analysis

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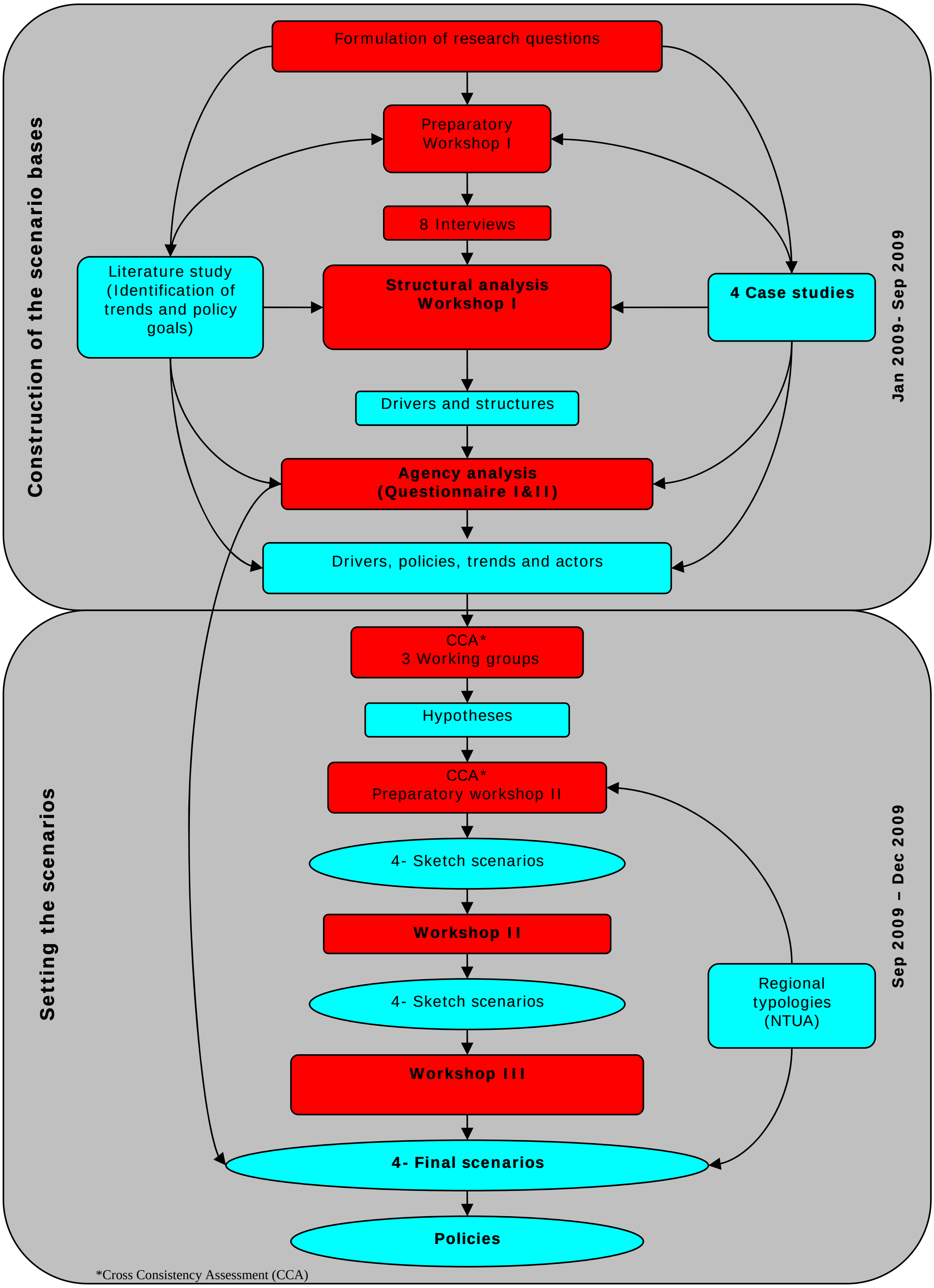
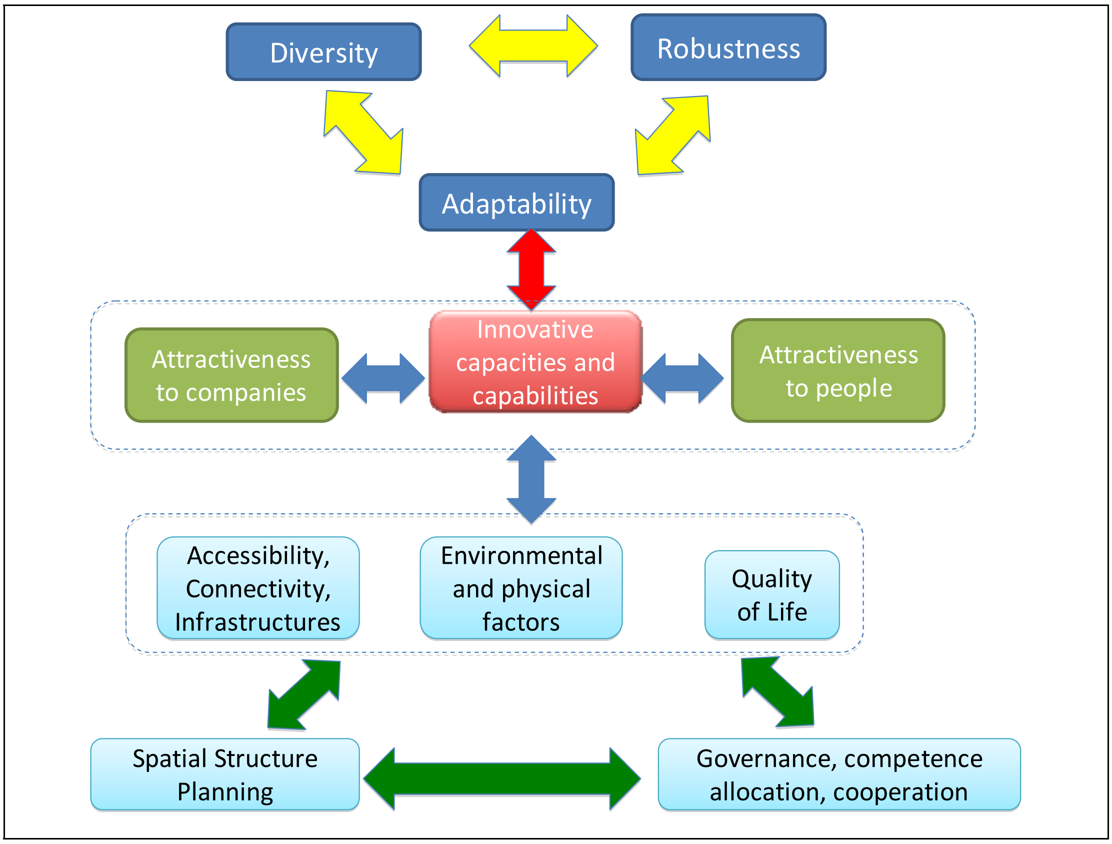
9 Annex II. The scenario process



The diagram outlines the scenario process in task 2.3. Activities are marked in red and their deliverables are marked in blue.

10 Annex III. Definition of drivers

Below are the more detailed definitions of drivers of regional competitiveness and energy development from Workshop I.



10.1 Drivers of regional competitiveness

Regional competitiveness can be defined as *"a range of factors from measures of income and prosperity to economic creativity and innovative ability that describe the performance of one economy relative to others".* Furthermore, regional competitiveness can also be defined from two different perspectives:

- Short term competitiveness: is the capacity of a region to maintain a high level of economic performance in a short term perspective (in a 5 to 15 years perspective);
- Long term competitiveness: is the capacity of a region to maintain a high level of economic performance in a long term perspective (in a 15 to 25 years perspective). Long term competitiveness chiefly relies on the adaptive capacity of a region, which in turn is dependant on economic robustness, but also the diversity of the regional economy.

10.1.1 Innovative Capacity

Innovative capacity was defined as *"the capacity of generating new ideas"*. The innovative capacity of a region reduces economic vulnerability because it diversifies economic structures by fostering the creation of new industries and products. The capacity to create new ideas is determined by three factors; the openness of the society towards new thinking, the knowledge capital, and the accessibility to this knowledge.

Knowledge accessibility is comprised of the availability and quality of the education system needed to transfer knowledge to new generations, bring in new sources of knowledge and to foster new ideas through R&D. In order to allow these factors to adequately materialise social, physical and financial infrastructures are needed. Moreover, regional densities of scale are an important factor for innovation because it helps to promote a collective commitment among individuals on attaining competitiveness.

The networking capacity is also an important factor for achieving and maintaining innovation capacity. It allows for the exchange of information and experiences necessary for both the creation of new services and technologies and the formation of trans-boundary cooperation between regions, and the firms and research institutes within them. The accessibility to a qualified labour force also plays a central role in the short and long term. In this regard, education not only serves to build the social capital of a region by forming young professionals, but also attracts both students and professionals from other regions. The access of financial resources is also important because it provides the bases for public and private investments on R&D, education and entrepreneurship.

10.1.2 Attractiveness

Aspects of attractiveness are closely linked to the innovative capacity of regions, which fundamentally relies on good living conditions and highly-developed business environments to attract and retain skilled workers and high-tech firms to the region. As the core driver for innovation, skilled labourers seek good living conditions, and more specifically, good quality of life, which are inevitably determined by cultural perceptions of achieving lifestyle ideals and opportunities for individuals to develop. The most commonly cited factors determining quality of life are: efficient and affordable internal and external transport, accessibility to the social, natural and built environment, accessibility of health services and affordable and available housing.

10.1.3 Robustness of regional economy

Economic robustness is *"the ability of a region to withstand fluctuations in the markets"*. Economic robustness is generally determined by the presence of territorial capital, namely economic, social and resource capital, as well as diversity in the region's economic structure. The ability of regions to attract companies and labour force is also closely dependent on the region's economic robustness, and therefore these two factors are closely interrelated. In the long term, especially during market changes, the innovative capacity becomes central as it generates flexibility in the regional economies through generation of new industries and services. Here, energy is seen as a resource that serves the region's economy.

10.1.4 Governance

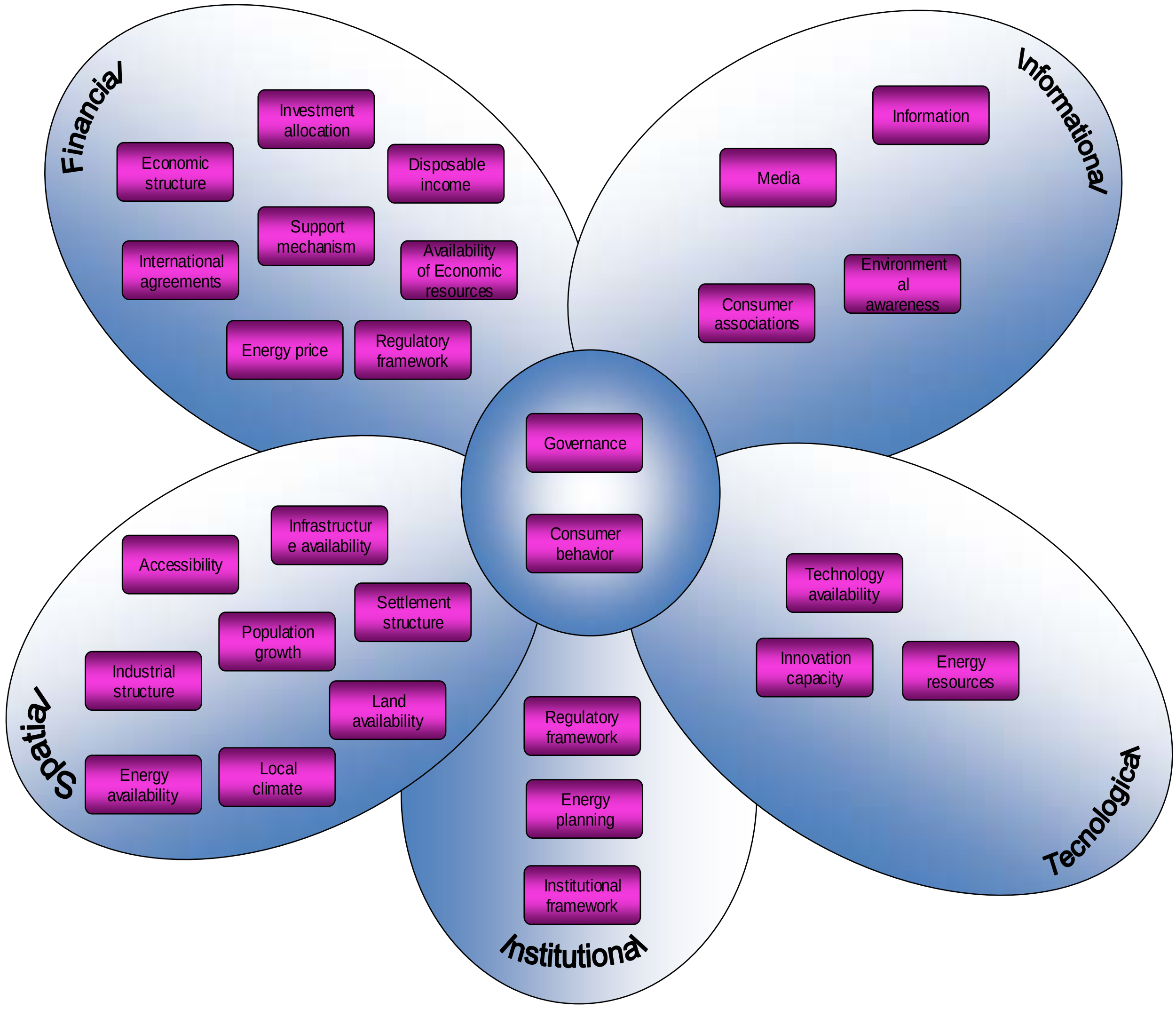
In order to promote and sustain the innovative capacity of a region all factors should be embedded within political stability and good governance. This is performed by well-functioning authorities through the creation of proper policy frameworks for innovation and entrepreneurship. Thus, governance puts forward the framework conditions and the directions in which the internal and external factors of competitiveness may interact proactively.

10.1.5 Spatial characteristics

Spatial factors are of two kinds; environmental and physical. Environmental factors correspond to the quality of the environment; specifically, the availability of basic resources for living, such as clean air and water, food and land, as well for performing economic activities. Physical factors pertain to the nature of the residential, transport and communication infrastructure, as well as infrastructure for energy and water distribution. Not least, spatial factors are also internal factors of competitiveness as explained above.

10.1.6 Internal and external markets

Competitiveness is defined by the balance between internal and external trade in regions; namely, the balance between import and export of tangible and intangible resources between regions. Tangible resource flows are goods and intangible resources flows are represented by knowledge and services. More specifically, regions' competitiveness is influenced to by three key market elements; "where" the served markets are located, "what" is the nature of the products and services offered by a region, and "how" these offers are presented (e.g. through marketing) and delivered to the markets. As markets are formed by consumers, the acceptance of new products and services will be determined by consumer openness towards new products and the availability of those produces. Generally, this availability hinges not only on the physical presence of these products in the market, but equally decisive are price factors - the economic capacity of consumers to pay for a particular product or service - and qualitative factors such as ideologies, life styles and behaviour.



10.2 Drivers of energy development

Energy development can be defined as *"the endeavour to provide sufficient primary energy sources and secondary energy forms to fulfil societies' needs. It involves both deployment of already available energy technologies as well as research, development and deployment of new technologies".*

Traditionally, considerations in energy development include security of supply, energy efficiency, natural resource management and environmental impact. As illustrated, however, the results from workshop I illustrate that energy development comprises a large number of elements that can be grouped into clustered loops that are mutually dependant on each other. These clustered loops are institutional, financial, spatial, informational and technological. Moreover, two elements are intimately related to each of the loops: governance and consumer behaviour.

10.2.1 The institutional loop

Institutions can be governmental, non-governmental and commercial institutions. Furthermore, these institutions can be centralized or decentralized; an important factor in terms of energy development, especially regarding policy orientations and energy development decisions in regions. Regulatory frameworks comprise of the legislations that regulate production, transmission and consumption of energy, and assigns governing powers to authorities in the energy sector. The regulatory framework also steers the exploitation of energy sources and sets limits through, for example, building restrictions, caps on GHG emissions, etc. Energy planning sets the directions for the development of the energy sector and serves the interests of national, regional and local actors depending on the institutional framework for energy planning.

10.2.2 The financial loop

While energy production and transmission is an essential element in industrial production and quality of life, they implicitly involve the availability of economic resources for investment. The manner in which these investments are made is a central issue in energy development. The significant elements in this regard are:

- Market price for energy: is an important factor influencing the investment choices of energy consumers, and therefore it plays an important role in determining which energy sources are exploited. Moreover, the prices traditional energy sources act as drivers for the exploitation of new alternative energy sources.
- Profitability: on one hand, it determines the choice of energy source exploitation for producers, while, on the other hand, it determines whether or not new sources of energy will need financial support.
- Availability of economic resources: has a direct impact on investments in new technologies as well as the allocation of investments. For instance, in research and development for alternative sources of energy and infrastructure deployment.
- Disposable income: determines the price that consumers are willing to pay for energy.
- Financial system: is determined by the legal and policy frameworks for the finance sector.
- Support mechanisms: are widely used by governments as market based instruments to subsidise renewable electricity. Support schemes are of two categories; investment and operating support mechanisms. Operating support (support per unit of electricity produced) promotes the generation of renewable energy, while investment support plays a more determinant role during de development stage and market introduction of renewables as considerable market uncertainties prevail.
- International Agreements on GHG emissions: are of high importance since they create commitment towards common goals on caps for emissions and help to internalize the externalities of energy production from fossil fuels. These agreements are tied to emissions trading

schemes, which is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. A cap trading system is a quantity instrument because it fixes the overall emission level (quantity) and allows the price to vary.

10.2.3 The spatial loop

Settlement structures affect energy consumption patterns due to several factors; for instance, the location of jobs and dwellings, as well as commercial and recreation areas. In this regard, two elements are particularly important:

- The distribution of living and working places: regards the distances between living and working areas (the distance, ICT and transport mode), as well as the aspect of time for transportation and commercial activities associated with everyday life (the spatial arrangement of cities and regions).
- Accessibility to commercial and living areas plays an important role in energy demand, specifically through the availability of infrastructure and technologies that enable energy efficient modes of transportation both for passenger and goods transport. The availability of, and accessibility to, infrastructure define peoples' transport patterns to-and-from work despite the availability of different working arrangements today.

The size of the population also affects total energy demand since each individual requires energy for living. At the same time, reduced per capita energy consumption can be achieved through greater population densities because of the denser living arrangements and increased transportation opportunities they infer.

Economic Structure shapes the energy mix and intensity of a region mainly in the short term. Regions with heavy industries will consume more energy relative to regions with high proportions of the economic mix dominated by the service sector.

The accessibility to energy is critically important because energy independent regions have little pressure to go through structural changes in the economy due to pressures in terms of energy production, consumption or provision. Further, accessibility to energy can be centralized or decentralized. In centralized energy systems settlements and industries will rely on long distance transmission infrastructure for electricity and gas, while decentralized energy systems provide locally produced energy that is transmitted over short distances. Thus, centralized solutions may fit well in areas lacking energy resources while areas rich in energy resources are able to generate energy in situ. Furthermore, land availability plays a fundamental role for the use of renewables. For wind energy for example, vast areas exposed to suitable wind conditions are needed and the conflict between landscape conservation and wind energy development is well established.

Local climates also play a significant role in the ways energy is consumed and generated. Seasonal cold and heat periods, and extreme weather events increase energy demand in order to maintain comfortable temperatures of homes and workplaces.

10.2.4 The technological loop

The nature of technology availability is delineated between domestic technology developed through innovation, and imported technology. Access to technological solutions not only helps facilitate the shift towards the utilization of alternative energy sources, but it also makes these sources competitive in markets. An important characteristic of technologies is that they are tied to the availability of endogenous energy resources. The Innovation Capacity is a central driver in energy development as it serves the energy sector through the creation and development of technologies on energy efficiency and renewables. Specifically, regions exposed to fluctuations in energy markets due the lack of domestic energy sources can find ways to reduce their dependency though the creation of innovative solutions on energy production and efficiency. Also, innovation enable energy-rich regions to be able to further this by exporting excess energy created by a reduced internal demand and increased energy production from alternative energy sources.

10.2.5 The informational loop

Environmental awareness is part of the culture, but also it can be inculcated through information and education programmes. In this regard information influences consumer's habits by creating awareness on the benefits or negative consequences of the irrational use of energy, as well as the use of unsustainable energy sources. The media works as the link between information sources and energy consumers, and it determines how consumers perceive the information. Consumer associations have also proven to promote environmental awareness among both the general public and government institutions.

10.2.6 Governance and consumer behaviour

Governance relates directly to all the loops by setting the institutional, policy, legal and planning framework for energy production, transmission and consumption, as well as for regional development. The governance style has a direct impact on the Institutional Loop, especially in terms of the regulatory framework and the structure of energy prices (consumer prices, production prices and energy price mechanisms). Therefore, the Governance Loop reflects the particular actions and their respective actors that are embedded within the overall governance style of energy development. Not least, governance styles have a fundamental role in setting up taxation and trade schemes, reaching international agreements, allocating investments and promoting the future development of the economy. Consumer behaviour is crucial for supporting a transition in energy development. Consumers are able to reduce their energy consumption to a large extent through behavioural changes on energy use as well as through their purchase by selecting energy efficient technologies for households and transport. As explained in the Informational Loop section, consumer behaviour tied to cultures and dependant on the level of awareness not only on the negative effects of excessive energy consumption or the use of fossil fuels, but also on how to apply these technologies and consume less energy through behavioural changes.

Annex IV: Cross Consistency Assessment Matrix

		Energy mix			Energy demand		International agreemetns on GHG		Technological accessibility		Innovation			Industrial divelopment			Settlement patterns	
		Emphasis on renewable energy	Emphaisi on fossil fuels	Emphasis on nuclear energy	High decoupling between economic growth and energy demand	Low decoupling between economic growth and energy demand	Enforced international agreements on GHG emissions	Weakly enforced international agreements on GHG	Clean energy technologies are accessible to **most** producers/consumers	Clean energy technologies are accessible to **few** producers/consumers	High innovation capacity	Moderate innovation capacity	Low innovation capacity	High presence of the service and knowledge economy	High precence of the primary and manufactory industry	Balanced presence of all sectors	Increased settlement centralization (Urban gwoth)	Increased settlemetn descentralization (Urban and rural growth)
Energy demand	High decoupling between economic growth and energy demand																	
	Low decoupling between economic growth and energy demand																	
International agreemetns on GHG	Enforced international agreements on GHG emissions		■															
	Weakly enforced international agreements on GHG																	
Technology accessibility	Clean energy technologies are accessible to **all** producers/consumers					■												
	Clean energy technologies are accessible to **few** producers/consumers	■			■													
Innovation	High innovation capacity																	
	Moderate innovation capacity																	
	Low innovation capacity	■		■	■				■									
Industrial divelopment	High presence of the service and knowledge economy												■					
	High precence of the primary and manufactory industry																	
	Balanced presence of all sectors																	
Settlement patterns	Increased settlement centralization (Urban gwoth)																	
	Increased settlemetn descentralization (Urban and rural growth)																	
Passenger transport	Emphasis on public trasport												■					
	Empahsis on private car transport	■					■											
	Emphasis on both public and private car transport																	

Exclusions ■

Table 2 Cross-consistency assessment matrix. The matrix shows selected the drivers (variables) and their hypotheses (Values) as well as the pairs of consistent (empty boxes) and inconsistent (red boxes) hypotheses. The field marked in grey is excluded because it corresponds to repeated pair of hypotheses and those hypothese that are compare with itself.

11

12 Annex V: Results from the questionnaire survey

1a: Character of emphasis of your current NATIONAL energy policy in relation to the 3 pillars of energy policy?							
Response	0	1	2	3	4	5	**Response average**
Security of Supply	0%	4.88%	4.88%	12.20%	31.71%	46.34%	4.1
Efficiency	0%	7.32%	9.76%	19.51%	48.78%	14.63%	3.54
Environmental Protection	0%	0%	24.39%	26.83%	31.71%	17.07%	3.41
n = 41							
1b: Character of emphasis of your current REGIONAL energy policy in relation to the 3 pillars of energy policy?							
Response	0	1	2	3	4	5	**Response average**
Security of Supply	2.44%	4.88%	21.95%	12.20%	24.39%	34.15%	3.54
Efficiency	2.44%	2.44%	7.32%	21.95%	34.15%	31.71%	3.78
Environmental Protection	0%	2.44%	19.51%	21.95%	31.71%	24.39%	3.56
n = 41							

Response percent	**2a: What energy sources are prioritized in your NATIONAL energy policy?**	**2b: What energy sources are prioritized in your REGIONAL energy policy?**
Energy type	Percent	Percent
Nuclear	37%	10%
Coal	39%	24%
Natural Gas	54%	41%
Renewable Energy	54%	66%
Other, please specify	17%	22%
n = 41		

3: What drives Renewable Energy and Energy Efficiency development in your REGION?	
	Ranking Average
Security of Supply/Energy Self-Sufficiency	2.02
Environmental Protection	2.66
International Commitments	2.98
Energy Price	2.34
n = 41	

4: What level of government has the main role in developing and governing energy policy in your region?	
	Percent
The national level	68.00%
The regional level	32.00%
n = 41	

5: Are REGIONAL governments able to implement binding policies beyond standards set at the national level?	
	Percent
Yes	41%
No	44%
Don´t know	15%
n = 41	

6: In your REGION, which levels of governing institutions are primarily responsible for the dissemination of information and awareness in energy efficiency?			
Sectors	Local government	Regional government	National government
In the Industrial Sector	4.88%	31.71%	63.41%
In the Energy Sector	4.88%	21.95%	73.17%
In the Transportation Sector	7.32%	21.95%	70.73%
In the Residential Sector including the consumption patterns among the general population	29.27%	24.39%	46.34%
n = 41			

7: In your opinion, are the governing institutions in your REGION doing an effective job in spreading energy efficiency awareness to the populace?	
Response	Percent
Yes	29%
No	22%
Only in some sectors	49%
Don't know	0%
n = 41	

8a: How is security of supply for the future considered in your current energy policies?						
Response	1	2	3	4	5	Average
At the national level	2.44%	2.44%	7.32%	36.59%	51.22%	4.32
At the regional level	10.26%	7.69%	23.08%	30.77%	28.21%	3.59
n = 41						

8b: How important are decentralized energy solutions compared to centralized renewable solutions?						
Response	1	2	3	4	5	Average
Relative Importance	0%	24.39%	34.15%	26.83%	14.63%	3.32
n = 41						

9a: Investments in non-renewable energies are prioritized over investments in renewable energy technology		9b: In your REGION, do effective operating support instruments exist to help grow renewable energy technologies?	
Response	Percent	Response	Percent
Yes	17%	Yes	76%
No	83%	No	24%
n = 41		n = 41	

10: Is economic growth tied to energy intensive sectors	
Response	Percent
Yes	51%
No	27%
Don't know	22%
n = 41	

11: What impact would a higher energy price have on consumer decisions/energy demand in your region?						
Total Response	1	2	3	4	5	Average
USD$100 per barrel of oil	14.63%	34.15%	39.02%	4.88%	7.32%	2.56
USD$150 per barrel of oil	0%	12.20%	29.27%	39.02%	19.51%	3.66
USD$200 per barrel of oil	0%	4.88%	4.88%	21.95%	68.29%	4.54
n = 41						

	12a: Which sector would the previously mentioned price increases have the greatest impact on reducing energy consumption?	12b: Which of the following sectors provides the greatest energy saving POTENTIAL in your region?	12c: Which of the following sectors provides the greatest OPPORTUNITY for energy saving in your region?	12d: Which of the following sectors provides the greatest CHALLENGES for energy saving in your region?
Sector	**Ranking average**	**Percent**	**Percent**	**Percent**
The industrial sector	2.24	20%	17%	10%
The energy sector	2.56	7%	10%	12%
The transportation sector	2.44	27%	10%	41%
The residential sector including general lifestyle changes	2.76	41%	59%	34%
Other		5%	5%	2%
n = 41				

13: To account for energy demand, are detailed statistics of energy consumption collected for all sectors in your REGION?	
Response	Percent
Yes	61%
No	29%
Don´t know	10%
n = 41	

13 Annex VI: EU Policy Frameworks

13.1 Regional Development

The enlargement of the European Union (EU) has enriched its cultural and economic prospective, and increased its population and number of regions considerably. The integration of the new members into the single market has also created regional disparities and a cohesion policy has been required to bridge the emerging gaps, as well as to support development in regions facing competitiveness and challenges in labour markets. (EP, 2005)

Thus, the framework for regional development in Europe is built upon the cohesion principal. The Directorate General (DG) for Regional Policy of the EU is working to carry out tangible outcomes in terms of social and economic cohesion aiming to reduce discrepancies between the regions' development levels. Ensuring solidarity and remaining competitive are the main targets that European Regional Policy aims to achieve (EC, 2009). Further, the important financial instruments for the social and economic cohesion have been the Structural Funds. In this regard, working towards a Territorial Agenda has been one of the flagship areas of European collaboration. The objectives of the agenda has been to reduce existing disparities, avoid territorial imbalances, make all policies with a spatial impact more coherent and improve territorial integration between the regions of the EU.

13.1.1 Regions as agents for competitiveness and innovation

EU emphasizes the 'regional dimension' of development policies and refers to regions as creative agents for innovation and competitiveness (EC, 2009b). According to the Lisbon Strategy, this comprises the key ingredients of regional development. The Lisbon Strategy (2000) set out a framework for national and regional policies aimed at making Europe the most competitive and dynamic knowledge-based economy in the world; capable of sustainable growth and greater social cohesion (EU, 2005a). At the Gothenburg meeting of the Council of Ministers in June 2001, sustainability was added as a vision to the cohesion and innovative ambitions of the territorial agenda. Moreover, the Gothenburg Agenda emphasized that sustainable development has to be in line with environmental protection (EU, 2001).

Within the renewed Lisbon Strategy (EU, 2005b); two major tasks have been put forward: delivering stronger, sustainable economic growth and creating more and better jobs through mobilising all national and community resources available. The ambition was formulated as a strategy aimed at supporting the transition to a knowledge-based economy, making necessary structural reforms and modernising the European social model.

In March 2008, The European Council started the second cycle of the renewed Lisbon Strategy “The renewed Lisbon strategy for growth and jobs”, which highlighted the importance of four priority areas: investing in knowledge and innovation, unlocking business potential, modernising labour markets and developing an energy-efficient low-carbon economy (EU, 2005b). In order to strengthen the goals of the Lisbon Strategy in these areas, several action programs have been launched. These include: *The Competitiveness and Innovation Framework Programme (CIP)* developed under the Seventh R&D Framework Programme (FP7) running from 2007 to 2013 (EC, 2009c). The program aims at providing support to the strategy to meet its objectives based on three specified areas:

- *The Entrepreneurship and Innovation Programme* aiming to support entrepreneurship, industrial competitiveness and innovation,
- *The ICT Policy Support Programme* aiming to promote the use of ICT in businesses and public authorities,
- *The Intelligent Energy Europe Programme* aiming to increase demand for renewable energy sources, energy efficiency and energy diversification as well as to strengthen the investment in new and effective energy technologies.

Hence, it is clear from the Lisbon priorities that, EU builds its future policy development around the notion of competitiveness and places the knowledge and innovation together with entrepreneurship and energy efficiency as indispensable tools at the heart of its regional development objectives. The European Development Observation Network (ESPON), provider of the body of knowledge about territorial structures, trends and policy impacts in an enlarged EU, further reflects upon the key objectives of modern regional policy that contributes to the renewed Lisbon strategy with the following three pillars: Competitiveness, attractiveness and liveability (ESPON, 2007). Competitiveness is conceived as developing the region’s strengths and making better use of its potentials based on its economic base. Attractiveness is referred as making the region more attractive place to invest and work by increasing and improving investment in R&D, invigorating the use of new technologies with special regard to ICTs. Liveability is explained as increasing the quality of life and creating sustainable communities.

The Lisbon performance of regions is assessed based on a strategic set of indicators set by the European Commission and the European Council. The indicators stated below are used to measure the regions’ success in relation to the Lisbon Strategy (ESPON, 2007):

- GDP/capita
- GDP/employed person
- Employment rate
- Employment rate of older workers

- Gross domestic expenditure on R&D
- Youth education attainment levels
- Comparative price levels
- Gross Fixed Capital Formation/GDP
- At-risk-of-poverty rate after social transfers
- Dispersion of regional (un)employment rates
- Long-term unemployment rate
- (Change in the) Energy-intensity of the economy
- (Change in the) Greenhouse gas emissions and
- (Change in the) Volume of freight transport relative to GDP

13.1.2 Regional competitiveness

European Commission's study on Regional Policy and Cohesion (EC, 1999: 79), prior to the launch of the Lisbon Strategy, provided the initial definition of regional competitiveness by stating, *"[the ability to produce goods and services which meet the test of international markets, while at the same time maintaining high and sustainable levels of income or, more generally, the ability of (regions) to generate, while being exposed to external competition, relatively high income and employment levels"* and *"In other words, for a region to be competitive, it is important to ensure both quality and quantity of jobs]".* Accordingly, the issues that are central to improving economic well-being and to the distribution of wealth are also integral to the term regional competitiveness. Accordingly, a generally accepted concept of regional competitiveness corresponding to this definition is GDP per capita by region because it can be broken down into a range of factors, each with an economic interpretation (ESPON, 2006).

In the EU context, the concept of regional competitiveness is to meet the Lisbon objectives. ESPON, in its Synthesis Report III, in connection with the recent economic theories, reflects upon the concept of regional competitiveness with a strategic set of arguments and points out that the adaption of policies have to take each regions' actual situation into consideration (ESPON, 2006). Based on ESPON's elaborations; the unique combination of the listed factors below creates comparative advantages relative to other regions and therefore influences a region's Lisbon performance (ESPON, 2006):

- Economic diversity/specialisation
- Accessibility/connectivity
- Human Capital
- Clusters
- Location theories
- Synergy
- A creative milieu
- Innovation
- Quality of Life

- Urban Environment
- Governance
- Vision
- Inclusion
- Implementation capabilities

13.1.3 Territorial Cohesion

Cohesion policy and regional policy share the objectives of cohesion, competitiveness and territorial cooperation that aim to meet new challenges by ensuring a harmonious development of different regions. The final Territorial Agenda (EU, 2007) was adopted in Leipzig on 25 May 2007; 'towards a more competitive and sustainable Europe of diverse regions' and consists of four sections. The first section places specific emphasis on future territorial challenges with the focus on how "territorial cohesion policy" can contribute to the Lisbon and Gothenburg Strategies. The Agenda does not provide a concrete definition of territorial cohesion, but underlines the essentials of its point of departure. It aims to recognize the territorial diversity and identify potentials for integrated development strategies.

According to Andreas Faludi (2009), the concept of Territorial Cohesion is introduced as a practical principle for achieving European solidarity and is put in the service of the Lisbon strategy with an integrative focus. This means that a broad spectrum of policy areas is aimed to be used in the efforts to reduce the gaps between regions´ development levels. These include: innovation policy, employment policy, energy policy, transport policy etc.

The adoption of the Green Paper on Territorial Cohesion (2008) identified a number of spatial characteristics that face particular development challenges and initiated a discussion on the shaping of the cohesion policy concept by addressing the scale and scope of territorial action to overcome these challenges. Mountain regions, island regions and sparsely populated areas may heavily suffer from the likely impacts of climate change, demographic change, accessibility, regional integration and energy supply.

Lastly, Energy policy is one of the nine policy areas addressed in the Green paper further to be discussed in relation to territorial cohesion: "Energy policy contributes to territorial cohesion by developing a fully integrated internal gas and electricity market. Moreover, energy efficiency measures and renewable energy policy contribute to sustainable development across the EU, and may provide long term solutions in isolated regions." (EC, 2008: 9)

13.2 Energy

Each of the EU Member States faces serious energy challenges in the near future. These challenges are based on the fact that the days of cheap and easily accessible energy are waning along with a growing awareness of the implications that unfettered consumption of GHG-emitting energy has on the environment. This is the impetus for the EU's attempt to strengthen a universal approach to energy policy for all Member States. Based on the fact that economic growth is inextricably tied to a secure availability of affordable energy, coupled with the threat of the consequences of global warming, the core of EU energy policy a response to three fundamental challenges:

- *Competitiveness:* EU Member States are increasingly exposed to price volatility in the energy sector because the supply of energy continues to be controlled by a limited number of dominant providers. The effects of this are significant because an increase in energy prices will result in an additional investment on the part of all energy consumers, while very little of this payment transfer will result in economic or employment growth in the EU. The EU believes that if an effective legislative framework is in place to create a truly liberalized internal energy market then fair and competitive energy prices, energy efficiency measures and increased supply investments (particularly in renewable energies) can take place to a greater extent than at present. However, these conditions do not yet exist, which prevents the EU economy from fully benefitting from energy liberalization. (EC, 2007)
- *Sustainability:* Energy production currently accounts for over 80% of the total GHG emissions in the EU and must be combated by promoting renewable energy and energy efficiency (EC, 2007). This acts as the basis for the EU's climate change policy package that has the primary aim of limiting global warming to no more than 2 degrees Celsius above pre industrial levels.
- *Security of Supply:* Even though energy production by domestic renewables is on a rapid increase among the Member States, Europe is still becoming increasingly dependant on imported energy. This carries both political and economic risks, especially if Europe is faced with an energy crisis and is reliant on a limited number of gas suppliers (EU, 2009a).

Taken together, the objectives outlined above indicate that EU energy policy aims at promoting economic development based on highly efficient energy consumption and low-carbon energy production. Essentially, this approach is intended to foster economic growth through continued decoupling of economic productivity and energy consumption, and a dramatic increase in the production of locally generated, low-emission renewable energy (EC, 2007). In turn, this could signal a continued paradigm shift in Europe towards the promotion of a highly-skilled labour force tailored towards innovation in new growth sectors such as renewable energy. Thus, EU energy policy also serves multiple goals of EU energy policy; most notably: competitiveness, environmental or security of supply.

13.2.1 Overview

The current Energy policy of the European Union (EU) is outlined in a series of documents released by the European Commission (EC) during the last three years. In 2006, the EU was without a unified and comprehensive policy with regards to energy and because of this the EC composed the Green Paper, *A European Strategy for Sustainable, Competitive and Secure Energy.* This document established a list of six priority rationales for implementing a common external energy policy, including:

- Energy for growth and jobs: completing the internal energy market
- Security of Supply: solidarity between member states
- Towards a more sustainable, efficient and diverse energy mix
- Solidifying the EU at the forefront of tackling climate change
- Research and innovation at the service of Europe's energy policy
- Towards a coherent external (international) energy policy (EC, 2006a)

Following this, the Commission released, *An Energy Policy for Europe* in January 2007 to provide a review of the current energy situation in Europe and introduce the comprehensive set of European policy measures (the 'energy' package) (EU 2009a).

The EU also concretized the goals of energy policy with the signing of the Lisbon Treaty in December 2007. The Lisbon clearly outlined that EU policy making on energy shall aim to:

- Ensure the functioning of the energy market
- Ensure security of supply in the EU
- Promote energy efficiency and energy saving and the development of new and renewable forms of energy
- Promote the interconnection of energy networks. (EU, 2008)

As described, energy policy is clearly set out in stand-alone policy documents; however, it is highly interrelated with EU climate change policy. This is especially true for two fundamental components of EU energy policy: energy efficiency and renewable energy.

In January 2007, the EC published a communication, *Limiting Global Climate Change to Two Degrees Celsius: The way ahead for 2020 and beyond,* which provided developed and developing countries alike with a set of actions for keeping climate change at manageable levels. Furthermore, in December 2008, the EC and European Parliament agreed on a far reaching *Climate Action and Renewable Energy Package* that will simultaneously turn Europe into a low carbon economy and improve energy security through the promotion of renewable energy (EC, 2009a). According to the package, the EU is committed to addressing climate change by reducing EU and worldwide greenhouse gas emissions to levels that will limit climate change to less than two degrees Celsius above pre-industrial levels (EC, 2006b). In this regard, current EU Energy and Climate Change Policies rely on the same sets of policy documents; two of the most important of which are: the *Action Plan for Energy Efficiency: Realising the Potential,* and the *Renewable Energy Roadmap.*

The focal policy targets of these two documents, relating to energy and climate change policy in the EU, are binding national targets to reach a unilateral 20% reduction of GHG emissions throughout the EU by 2020 and a 20% increase in the share of primary energy coming from renewable energy sources by 2020 (IEA, 2008). Furthermore, the *Climate Action Renewable Energy Package* mandates that if international agreements between all developed countries are reached for reducing national greenhouse gas emissions by 30% by 2020, then the EU will also elevate their objective to a 30% reduction compared with 1990 levels (EU, 2009a).

13.2.1.1 The internal energy market

The pillars for creating an internal energy market able to meet each of Europe's energy challenges are:

- Competitiveness: to stimulate investment in energy efficiency and diverse energy sources that will create a competitive market, thereby reducing the relative cost for all consumers.
- Sustainability: to allow for the effective application of efficiency mechanisms such as the EU Emissions Trading System (EU ETS), and renewable energy promotion programs such as national feed-in laws that create a rationale for transmission system operators to promote all renewable energy sources
- Security of supply: by providing an incentive for companies and individuals alike to invest in energy infrastructure, a true single market will promote diversity of energy supply to enhance to long term security of the European network. (EC, 2007)

The findings during the Green Paper consultation period identified that the dangers of companies controlling energy networks and production or sales must be halted. The concern specifically hinged on the fact that national monopolies tend to protect their own interests and prevent competition, thereby stymieing innovation and technological development. The EC concluded that a proactive series of measures must be established with the goal to create a truly competitive pan-European Gas and Electricity Grid. In this regard, three key policy measures include:

- Unbundling: one of two options must be pursued: a full independent system operator, where a company can maintain ownership of the network and receives a regulated return on its operation, but is not in control of the operation, maintenance or development of it, or, ownership unbundling where networks are completely separate from the supply and generation companies

- Effective regulation: specifically regarding the EC's ability to review the decisions of national regulators in matters that affect the Internal Energy Market, and the establishment of a European network of independent regulators, and a unified regulatory body at the community level that would be responsible for adopting EU decisions and making cross-border trade work in practice.
- Energy as a pubic service: In EU policy discourse, energy is seen as a necessary good for all Europeans, but the commission recommends that the EU goes further to tackle energy poverty by: helping citizens deal with increase in energy prices, information for choosing between suppliers and supply options and protecting customers from unfair selling practices. (EC, 2007)

13.2.1.2 Ensuring security of supply

Assuming a 'business as usual' trajectory, EU foreign energy dependence will increase from 50% of total energy consumption to 65% in 2030 (EC, 2007). This increase is due to the fact that although improvements have been made in terms of electricity consumption, energy use in the transportation and heating sectors continues to be heavily dependent on foreign energy sources (EC, 2007). Accordingly, policy mechanisms that address energy efficiency and the promotion of new domestic sources energy are important for meeting security of supply challenges. At the same time, however, the EU understands that even with vast advancements in terms of energy efficiency and renewable energy, member states will still rely on foreign sources of energy, most notably from Norway, Russia and Algeria. Therefore, EU policy aims at promoting energy security by:

- Emphasizing the importance of continuing to strengthen these relationships with external suppliers while simultaneously ensuring solidarity among member states in the event of an energy crisis. This is particularly important for those countries that are reliant on a single gas supplier.
- Assisting those countries that are overly dependant on one gas supplier by diversifying their supply countries and establishing new gas storage and transfer hubs in central Europe and the Baltic countries.
- Maintaining the EU's strategic oil stocks mechanism.
- Enforcing reliability standards specifically regarding electricity infrastructure throughout the member states. (EC, 2007).
- Reducing greenhouse gas emissions & meeting international climate change agreements

13.2.1.3 The European Union's Emissions Trading System

The EU favours the use of economic instruments for promoting environmental mechanisms in order to internalize costs and allow the market to determine how to react most efficiently. The ETS was first introduced as a trial between 2005 and 2007 and covered 40% of the EU's CO_2 emissions. Modifications were made for the second phase between 2008 and 2012, and changes for phase three will include the addition of the aviation industry. As the ETS continues to develop it remains the key mechanism for stimulating investments in renewable energy and energy efficiency for all users apart from the individual consumer and it is the central pillar of the EU's effort to improve energy efficiency, promote renewable and fight climate change (EC, 2007).

13.2.1.4 Promoting Energy Efficiency

In the EU, energy efficiency provides the greatest opportunity for achieving sustainability, competitiveness and security of supply; especially in the short-to-medium term. On October 19th 2006 the EC adopted the *Energy Efficient Action Plan (EEAP)* that identifies the comprehensive set of measures for achieving the goal of a 20% reduction of primary energy use by 2020 to either be introduced immediately or gradually over the course of the Plan's six year period. Also, the Plan intends to mobilize the general public and policy makers at all governance levels on the benefits of improving energy efficiency in terms of competitiveness, the environment and security of energy supply. (EC, 2006b)

In terms of energy saving potential, the EEAP identified that the largest cost-effective energy saving potential lies in the residential and commercial buildings sector, with a 27% and 30% reduction potential respectively. For example, the Plan identifies that the largest savings opportunity in the residential sector is in terms of roof and wall insulation, while improved energy management systems are most important for the commercial buildings. The EEAP also lists a 25% savings potential for the manufacturing industry and a 26% potential for the transportation sector. (EC, 2006b)

The EEAP outlines its policies and measures by identifying priority actions that demand focused attention through the creation of individual programmes and initiatives. These actions include:

- Appliance and equipment: establish labelling and minimum energy performance standards. Especially in terms of stand-by energy consumption.
- Building Sector: building performance requirements in terms of energy management, retrofitting existing buildings and new constructions.
- Energy Sector: making power generation and distribution more efficient.
- Transportation Sector: improving fuel efficiency of cars and improving urban transportation systems.
- Facilitating the appropriate financing of energy efficiency investments for SME's and Energy Service Companies.
- Promoting energy efficiency in new member states

- Establishing a coherent use of taxation as a means to internalize the externalities of energy production and consumption.
- Raising the awareness of energy efficiency through labeling, education and training programmes, community programs and the media.
- Special attention to energy efficiency in built-up environments.
- Fostering energy efficiency worldwide through effective collaborations with both developed and developing countries, as well as with various international organizations such as the United Nations, International Energy Agency, G8, World Trade Organization and World Bank. (EC, 2006b)

13.2.1.5 Promoting Renewables

Alongside the energy efficiency, the second fundamental aspect of energy development in the EU is renewable energy. In 1997, the EU set the target of 12% share of renewables in the overall energy mix by 2010, a doubling of 1997 levels. By 2007 production increased by 55% and the EU is set to fall short of its target. The main reason for this are that, with the exception of large scale hydro and some wind energy installations, all renewable sources still have a higher cost than traditional energy sources and there is a lack of a coherent and effective policy framework throughout the EU account this. Thus, the main challenge for renewable energy policy is to find the balance between installing renewable energy capacity now and waiting until research and development lowers the cost. (EC, 2007)

Nevertheless, the EU's *Renewable Energy Roadmap* has set a binding target of increasing the level of renewable energy to 20% by 2020. It also provides an analysis of the renewable energy targets set by the EC in 2006 and a detailed course of action across all sectors for achieving the renewable energy goals of Europe. In particular, the three main energy sectors where renewable electricity is used: electricity, biofuels, and heating and cooling. However, EU renewable energy policy does not lay out specific guidelines for renewable energy in itself because each Member State must take into consideration its own unique national circumstance and starting point, particularly regarding its own energy mix and natural resource availability. (EC, 2007)

The 20% target is notably ambitious especially considering the inability of Member States to achieve the 2010 goals; however policy frameworks for each of these sectors have been established in different Member States and can act as framework examples for best practices. Accordingly, each Member State is responsible for establishing their own objectives for each of the three energy sectors, which must be verified by the EC to ensure it contributes to the EU goals in a fair and equitable fashion.

13.2.1.6 *Developing Energy Technologies*

The two objectives of energy technology are lower the cost of clean energy and to put the EU industry at the forefront of the clean energy and energy efficiency production sector. To meet these objectives, the EC put together the *European Strategic Energy Technology Plan (SET)* in 2008 as part of the 7th Framework Programme. The plan covers the development process from the initial research phase through to entry on the market and is intended to establish a predictable conditions for the finance sector, SME's and other companies investing, developing or disseminating these technologies. (EU 2009b)

13.2.1.7 *The future of nuclear*

The official EU policy on nuclear energy is that each Member State shall decide on their own whether or not to rely on nuclear activity. Given that nuclear energy is carbon free, any Member State that decides to phase out nuclear energy must have a complimenting plan for offsetting nuclear energy supply with another source of low-carbon for electricity production. Otherwise, any initiative to phase out nuclear will contradict the environmental and security of supply goals of EU energy policy. Furthermore, the EU's *Nuclear Illustrative Programme* identifies that even though EU has not taken a formal position for or again nuclear energy, it does provide a framework for meeting the highest standards of safety, security and non-proliferation as well as standards concerning the dismantling of installations and storage of waste. (EC, 2007)

13.2.1.8 *Implementing a common international energy policy*

The very nature of global climate change implies that the EU cannot act alone to transition the world away from its degrading GHG emissions. In the future, the EU will consume only 10% of the world's energy and will be responsible for less than 15% to global GHG emissions. Therefore, the EC considers it necessary that all Member States display a unified approach toward international institutions, and the international community in general, for fostering energy development and reaching international energy agreements that move diverge economic development away from carbon intensive energy production. (EC, 2007)

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14 Annex VII: List of workshop and working group participants

14.1 Preparatory workshop I

Name	Organization	Country
Asli Tepecik Dis	Nordregio	Sweden
Borys Kharchuk	Nordregio	Sweden
Jose Sterling	Nordregio	Sweden
Lise Smed Olsen	Nordregio	Sweden
Peter Schmitt	Nordregio	Sweden
Patrick Galera-Lindblom	Nordregio	Sweden
Rasmus Ole Rasmussen	Nordregio	Sweden
Ryan Weber	Nordregio	Sweden
Sigrid Hedin	Nordregio	Sweden
Susan Brockett	Nordregio	Sweden

14.2 Workshop I

Name	Organization	Country
Adam Gula	AGH-University of Science and Technology	Poland
Arvid Strand	The Institute of Transport Economics	Norway
Asli Tepecik Dis	Nordregio	Sweden
Bent Sørensen	Roskilde University	Denmark
Daniela Velte	Inasmet Tecnalia	Spain
Efrén Feliu	Labein Tecnalia	Spain
Gema Garcia	Labein Tecnalia	Spain
Hélène Lajambe-Connor	Helio International	France
Jörg Neubauer	Swedish Energy Agency	Sweden
Lise Smed Olsen	Nordregio	Sweden
Maria Giaoutzi	National Technical University of Athens	Greece
Michael Viehhauser	Regional Planning and Transport Office of Stockholm (RTK)	Sweden
Murat Mirata	Lund University	Sweden
Niclas Damsgaard	Econ Pöyry	Sweden
Oihana Blanco Mendizabal	Innobasque	Spain
Ole Damsgaard	Nordregio	Sweden
Patrick Galera-Lindblom	Nordregio	Sweden
Rasmus Ole Rasmussen	Nordregio	Sweden
Ryan Weber	Nordregio	Sweden
Sigrid Hedin	Nordregio	Sweden
Stamatis Kalogirou	National Technical University of Athens	Greece
Susan Brockett	Nordregio	Sweden

14.3 Working group I: Industrial development

Name	Organization	Country
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Ryan Weber	Nordregio	Sweden
Sigrid Hedin	Nordregio	Sweden
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14.4 Working group II: Transport at settlement structure

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Ryan Weber	Nordregio	Sweden
Alexandre Dubois	Nordregio	Sweden
Rasmus Ole Rasmussen	Nordregio	Sweden

14.5 Working group III: Energy

Name	Organization	Country
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Rasmus Ole Rasmussen	Nordregio	Sweden
Ryan Weber	Nordregio	Sweden

14.6 Preparatory workshop II

Name	Organization	Country
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Patrick Galera-Lindblom	Nordregio	Sweden
Rasmus Ole Rasmussen	Nordregio	Sweden
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Sigrid Hedin	Nordregio	Sweden
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14.7 Workshop II

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Anastasia Stratigea	National Technical University of Athens	Greece
Chrysa-Aliki Papadopoulou	National Technical University of Athens	Greece
Daniela Velte	Inasmet Tecnalia	Spain
Edurne Magro Montero	Inasmet Tecnalia	Spain
Elias Grammatikogiannis	National Technical University of Athens	Greece
Gema Garcia	Labein Tecnalia	Spain
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Maria Giaoutzi	National Technical University of Athens	Greece
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14.8 Workshop III

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Álvaro Pérez de Laborda	EVE – The Basque Energy Board	Spain
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Anastasia Stratigea	National Technical University of Athens	Greece
Dámaso Munarriz Guezala	NASURSA	Spain
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Gemma Garcia	Labein Tecnalia	Spain
Izaskun Jimenez	Inasmet Tecnalia	Spain
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Lise Smed Olsen	Nordregio	Sweden
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Oihana Blanco	Innobasque	Spain
Patrick Galera-Lindblom	Nordregio	Sweden
Rasmus Ole Rasmussen	Nordregio	Sweden
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