

Energy



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Towards a New Spatial Agenda for the North Sea Region

Prepared for Interreg IIIB North Sea Region Programme by

COWI with contributions from UWE

Prepared by, Mr Jakob Dybdal Christensen, Henrik Duer and Søren Adamsen, COWI Group, Denmark. UWE contributions from Prof. Angela Hull, Dr. Stefanie Dühr and Mr. Vladimir Pruidze, University of the west of England, UK.

COWI A/S, Parallevej 2
2800 Kgs. Lyngby
Denmark
Tel +45 45 97 22 11
Fax +45 45 97 22 12
E-mail jdcrc@cowi.com

TOWARDS A NEW SPATIAL AGENDA FOR THE NORTH SEA REGION

Between 1998 and 2001, a spatial vision for the North Sea Region was developed, based on the principles of the European Spatial Development Perspective (ESDP). NorVision, as it was called, is a key advisory document, which has strongly influenced territorial cooperation in the North Sea Region. It describes the existing state of spatial development and suggests directions for the future. Projects that have been developed under INTERREG IIIB NSR put many of them into practice

In mid 2004 the Programme Monitoring Committee for the Interreg IIIB North Sea Programme decided that there should be a selective update to NorVision to have valuable strategic input for the future cooperation in North Sea Region. They agreed that the original NorVision document continues to be relevant and should not be evaluated or reworked. The new spatial agenda, as is has become known, should focus on issues, which have become more urgent or important in recent years or which have not been thoroughly addressed in the original document.

A Working Group consisting of one national and one regional representative per country was set up and discussed the procedure and topics to be addressed. The idea was not to have a complete analysis of the subject concerned, but to develop a more focused approach, which could be used to inform the future programme and which might form the basis for future co-operation projects until 2010. The working group agreed upon the following topics for which studies were carried out:

- Coastal Water Management
- Transport and Accessibility
- Facilitating Innovation and transfer of knowledge and technology
- Energy*
- Demographic Change*

* Energy and Demographic Change were smaller studies than the other three

This is the final report for the study on **Energy**

The findings of these five studies have been summarised and make up part of the **synthesis report**, which will be adopted by the Programming Monitoring Committee and will be published together with each of the final reports. The synthesis document sits alongside and complements the original Norvison document.

Further information is available from: Interreg IIIB North Sea Region Programme Secretariat
Jernbanegade 22
DK - 8800 Viborg
Denmark
Tel +45 87 27 19 99
Fax +45 86 60 16 80
www.InterregNorthSea.org

Disclaimer: The following text summarises the results of research on the update of the spatial perspective for the North Sea Region, Norvision. Please note that experts have prepared the content and that as such it does not necessarily reflect the opinion of the North Sea Programme or the Working Group.

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**Appendix A: Joint Annual Conference in Middleburg,
June, 2005**

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1 Introduction

This report has been prepared to provide the North Sea Programme with valuable strategic input to be utilised in preparing for an eventual new programming period.

The new programming period is running from 2007 to 2013. As stated in the terms of reference¹ the current study should address the challenges of until 2010. The nature of the specific topic of this study, though, makes it difficult not to take into account consequences looking beyond 2010 and even 2013.

This study addressing "Energy" is one out of five simultaneously conducted studies; three larger studies addressing "Costal Water Management", "Transport and Accessibility" and "Facilitating Innovation and the Transfer of Knowledge and Technology" and two smaller studies addressing "Demographic Change" and "Energy".

Regarding the scope of the study addressing "Energy" the consultant has seen it as the prime task to provide recommendations for the North Sea Region Programme that would help suitable, feasible and acceptable programming. In other words: How can the North Sea Region Programme best utilise its unique characteristics? What would actually be possible taking into account the nature of the topic? And finally what would be embraced by stakeholders and potential partners?

To be able to pose these questions a platform has to be established. This platform is setting the scene for the study by addressing the challenges regarding energy in the North Sea Region in general terms for the time to come. The field of "energy" is immense and includes a vast amount of technologies, and the areas for application touch upon literally all facets of sustaining modern life. In addition it is the experience of the consultant that issues related to energy often are connected to strong economical interest and hence easily spurs strongly politicised debate.

Given the narrow limitations of this study it is not possible to provide an exhaustive inquiry into what the North Sea Region Programme should support based on the state of numerous energy related technologies, detailed account-

¹ pp. 3: "Towards a new spatial agenda for the North Sea Region - Modified Tender Document Study 4 - Energy"

ing of levels of availability of resources, prognosis on North Sea Region energy demand etc. Thus COWI has set out to primarily base the recommendations for the North Sea Region on the findings unveiled through the interviews conducted with stakeholders throughout the North Sea Region, the literature study and the general expertise in the relevant fields available to COWI.

2 Report Summary

The North Sea Region is very atypical in terms of access to energy resources. Almost all conceivable types of sources are present in the region, but lately the most predominantly has been oil and gas, the abundance of hydro power and the relative highly developed use of wind turbines.

The main challenges related to energy in both EU and the North Sea Region context are the environmental consequences of the increasing use of fossil resources, the increased dependency on imported energy as local resources deplete and finally the economical consequences related to the above mentioned challenges.

The challenges related to energy are included in a number of EU policy documents. In relation to the Lisbon Strategy the focus is on the economic development of the EU underpinned by knowledge. This should eventually result in better jobs and better social cohesion through out Europe. Energy also relates to this strategy, especially in terms of innovation when it comes to new or more efficient use of energy resources. Establishing a sufficient network for an efficient liberalisation of the energy market also plays a part in this respect. Energy also plays a part in relation to The Gothenburg Council Agreement where especially the issues of the environmental consequences are touched upon.

Besides the work based on the literature study, the current study builds upon a number of interviews conducted with stakeholders through out the North Sea Region. These interviews constitute the core of the study and include the views of private and public, regional and national actors. The recommendations forwarded by COWI would thus be based on the literature study, the interviews, other input from stakeholders and the general expertise in the related fields available to the consortium.

The study showed that energy touch upon many interests. That the issue is widely dealt with by both public and private actors and that often national actors are the key actors. The main future spatial challenges seem to be connected to the construction of wind mills, production of biomass, change in the nature of power plants and in the development of new energy infrastructure. Where the transnational approach will be best utilised is in the field of dealing with fluctuations in energy supply, where planning activities overlap and where the different approaches towards energy efficiency may constitute good

grounds for knowledge dissemination. The study also showed that cooperation with actors outside the North Sea Region might not be that obvious, though cooperation with the Baltic Sea area seems the most appropriate, especially in the field of biomass and wind power.

The study shows that "energy" overall is a relevant and obvious field to address within the framework of Interreg B in the North Sea Region. The issue of energy has clear transregional implications and a large number of energy related aspects will benefit from the transnational approach. In addition the issues often have spatial implications and the access to clean and affordable energy plays a significant role in the continued socio-economic development of the North Sea Region. Challenges related to especially the level of national interest and the general size of investments in the field of energy though have to be addressed.

The conducted study thus leads COWI to conclude that following four recommendations should be observed when embarking on addressing "Energy" in the coming programme for the period 2007-2013:

1. **The regional nature** of the NSR Interreg programme constitutes an ideal basis for demonstration projects, pilot project or even larger projects based on the trend towards decentralisation of energy production and the increased use of renewable resources (wind power, biofuels etc.). This is underlined by the fact that much of the development within this field is going take place in regions with direct access to for example biofuels and thus making it relevant through out the North Sea Region. COWI finds that this support the issues raised in relation to countering increasing energy dependency and the depletion of fossil resources. In addition activities of this kind will support the socio-economic invigoration of regions surrounding the North Sea.
2. **The transregional nature** of the programme is a good base for support to the development of new infrastructural measures, and specifically measures which degree of utilisation is exponential with the degree of extension. (i.e. Infrastructure for hydrogen). Though COWI recommend that the recommendations made above is taken into account limiting the size of the infrastructural projects. This means that primarily projects dealing with preparation or other infrastructure-related activities (i.e. feasibility studies of for example the possibilities of establishing gas pipelines from Russia to the North Sea Region) are promoted. This also goes for increasing the capacity to coordinate planning of exploitation of energy resources i.e. offshore wind farms. COWI finds that specifically the development of a transnational "clearing-body" for energy related infrastructure would fit the both the needs of the region and the purpose of the programme by reducing the negative spatial impacts. Though existing measures facilitated by the EU and dealing with similar activities must be taken into account.

3. **The transregional nature** also constitutes an obvious basis for increased dissemination between actors in the regions. This is of course one of the more traditional activities within the Interreg context not least because it is easy to initiate and can be conducted for a relatively modest sum. COWI would though recommend that dissemination activities are rather concrete and that they build on clear demand from the relevant stakeholders. Based on the current study especially two themes could be relevant to address in this manner. Firstly sharing of knowledge on energy efficiency has been mentioned at several occasions. This could for example help municipalities or regions in developing housing and buildings in energy efficient manners. A lot of knowledge on the matter is available in planning units around the NSR, and this could easily be distributed with success. Another very concrete wish that emerged during the study is the sharing of best practice examples regarding administrative procedures. Especially procedures on the right inclusion of the stakeholders in infrastructure projects (i.e. hearing procedures) were mentioned. In addition examples on how to establish third part investments schemes² in support for energy efficiency was on the agenda.
4. Finally COWI finds that the **geographic locality** of the North Sea Region programme makes it obvious to support research activities that relate to the specific nature of the use and production of energy in the region. The North Sea Region has potential to be leading within a number of energy-related areas which could be constituted as both "renewable" or "fossil". As examples could be research activities related the petrol industry on CO2 enhanced recovery. Other examples could be additional support to the development of the already strong wind power industry in Germany and Denmark, or the research in emerging areas such as Hydrogen and Tidal and Wave Technologies.

² I.e. where a public or semi public entity invests in efficiency measures that private or public apply for. The revenue is then constituted by the energy saving over time.

3 Definitions and Demarcations

3.1 Energy

As stated in the introduction (p.2) "Energy" touch upon almost all areas related to modern life. We need energy to produce commodities, to transport these commodities and to transport ourselves. We need it to keep warm, to keep cold, to cook even to be able to read at night. In addition our increased dependency on energy has left us with additional problems like, what to do with waste products, pollution, global heating, how to acquire more energy when we have used what we have and how to deal with this in relation other actors.

The purpose of this study is to provide recommendations for the North Sea Region Programme regarding "if" and "how" to include Energy as a topic in future Interreg IIIB activities. A thorough study on the actual state of energy related technologies, development in supply and demand etc. would constitute a valuable basis on which to base a prognosis of where the North Sea Region should "bet its money". Unfortunately a study of this kind is not within the limits of this assignment.

Still the issue "Energy" set in a North Sea context leaves some fix points by which this study has been guided.

- The specific geography of the North Sea Region and the traditions regarding use and supply of energy leads to that almost all known sources of energy are utilised from one end to the other, from nuclear³ to geothermic⁴.

³ A. o.: "Energy, Transport and Environment indicators 1991-2001", "2001 Annual Energy Review", Eurostat,

⁴ In 2004 Denmark constructed a demonstration plant for exploitation of geothermal Energy, which delivers 1% of the heating in Copenhagen.

- Provision of reliable, ample and "clean" sources of energy for the near future constitutes a major challenge for all regions depending on a high level of energy consumption⁵.
- Commitments have been made by the eligible areas of the North Sea Region Programme to meet energy related targets set by both the EU⁶ and the Kyoto Protocol⁷.
- Transnationality⁸ is a given approach for the Interreg Programmes in general and hence also applies to how the issue of energy can be dealt with in this study.

⁵ A.o.: "Energy Outlook 2004" International Energy Agency, "The European Union's oil supply situation (October 2000) and outlines of a strategy for the future" DG Energy and Transport

⁶ Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources (OJ L283/33, 27.10.2001), Directive 2003/30/EC on the promotion of biofuels (OJ L123/42, 17.5.2003) etc.

⁷ "Kyoto protocol to the united nations framework convention on climate change" 1999 <http://unfccc.int/resource/docs/convkp/kpeng.html>

⁸ In this study "transnational" is understood in a narrow sense, meaning that issues that are dealt with transnationally benefit from this approach. The individual region or country deals with the issues as well, but the issues gain by being dealt with on the transnational level.

4 Energy and the transnational context

4.1 The North Sea Region and its energy resources

The North Sea Region is very atypical in both a European and a global context regarding access to energy sources. The countries surrounding the North Sea are utilising to a higher or lesser degree fossil, nuclear and renewable sources, some of which are present in abundance.

The most characteristic are naturally the sources which are related to the waters from which the region takes its name, The North Sea. These sources have through time been both fossil and renewable.

During the 1960ties the fossil resources beneath the North Sea were discovered, and since the beginning of the 1970ties the fields of crude oil and natural gas have been exploited. The majority of the oil and gas reserves belong to Norway and the United Kingdom but also Denmark, the Netherlands and Germany are in possession of smaller fields. The Netherlands are among the world leading countries regarding technologies for exploitation of natural gas. Regarding the rest of the area eligible in terms of the North Sea Region Programme, neither Sweden nor Flanders (Belgium) has any claim on fossil resources of the North Sea.

When it comes to renewable sources of energy the North Sea has also proven ideal for development and exploitation of off shore wind power. Hence the region has given grounds for the worlds largest off shore wind farm at Horns Rev off the coast of Denmark⁹. Other predominant features regarding renewable sources of energy in the region are the abundant access of Norway to Hydro Power which covers 99% of the country's power demand¹⁰.

The limited access to the fossil resources of the North Sea is perhaps the reason why regions such as especially Sweden are also utilising nuclear power for the production of electricity. Possibilities for exploitation of especially off shore wind power has also proven difficult for regions such as the Netherlands and Flanders due to the limited possibility of utilising costal line for

⁹ Horns Rev is among a total of 8 off shore wind farms. Denmark has a total off shore wind power production of 423 MW. <http://www.energistyrelsen.dk/sw13068.asp>

¹⁰ ENOVA and the Norwegian Ministry of Petroleum and Energy - 2005.

wind power production. This has led to national policies in these regions regarding renewable energy being directed more towards a.o. biofuels¹¹.

4.2 The challenge of energy dependency and the North Sea Region

The North Sea Region is at the moment to a large degree self sufficient with energy supply, with Norway, Denmark and the UK¹² as net energy exporters¹³. The self sufficiency is primarily due to the natural resources of fossil energy in the region and the use of hydro plants¹⁴.

In a foreseeable future the resources of fossil energy will be depleted, and the region will face the same situation of dependency on energy imports as the rest of the EU¹⁵.

To cope with this situation of energy dependency the region would have to utilise its potential of diversifying its sources of energy by using domestically produced energy and using sources of energy less vulnerable to regional changes in supply. This could be done by addressing the potentials as described in the three tables below, utilising the potential of the region for wind power, biomass and other technologies (i.e. sun and wave). This also goes for commitment in development and use of new technologies and a more efficient use of energy.

¹¹ Interview with Ms. Cathy Plasman

¹² According to Eurostat the UK primary energy import has been following (1000 toe):

1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
9237	946	-30029	-36021	-33265	-34413	-36385	-46945	-39031	-21320	-27558	-13728

Thus stating a net export since 1994.

¹³ ESPON PROJECT 2.1.4: Territorial Trends of Energy Services and Networks and Territorial Impact of EU Energy Policy, Final Report – Part Two.

¹⁴ *ibid*

¹⁵ "Towards a European strategy for the security of energy supply" (final report), Green Paper, EU Commission, 2005

4.3 Energy in terms of sources, carriers and consumption - a brief overview

To be able to address the issues related to energy one has to break down "Energy" into components that relates to specific characteristics of the topic.

- **Sources;** where does the energy come from
- **Carriers;** How the energy is distributed from production to consumer.
- **Consumption;** The utilisation of energy.

These issues can be addressed from different aspects which might help create the basic platform described in the introduction (p.2), by firstly establishing a brief overview of which main sources of energy can be exploited in the North Sea Region, and what implication the specific source has.

To be able to present a more fulfilling picture of what "energy" is all about in the context of an interreg programme it makes sense secondly to address some perspectives regarding energy carriers. This is not least because carriers and the development of these play an important role if the available sources should be exploited in an effective manner.

Thirdly we address implications regarding consumption, which has its own logic and potential regarding an efficient utilisation of energy in the North Sea Region.

Thus the three components, Sources, carriers and consumption are addressed by looking at them from the point of "Security of supply", "Environmental consequences", "Job creation" and "Challenges".

Energy Sources:*Table 3.1 Energy source*

Sources:	Security of supply	Environmental consequences	Job creation (NSR)	Challenges
Oil	On the <i>short</i> term there is no immediate threat to the supply of oil world wide. Production might rise in Russia and the Caspian region and the production is expected to decline slowly in the North Sea and in North America ¹⁶ . However, the global oil demand is rapidly increasing ¹⁷ , and at the same time regional conflicts threatens oil supply, resulting in increasing crude oil prices and uncertainty of supply. New technologies have made it possible to extract oil more effectively, but these technologies often prove more expensive ¹⁸ .	Consumption of oil contributes substantially to the emission of greenhouse gasses. In addition production and handling of oil bears significant risks in terms of spills and pollution, especially during transport.	The production and its supply chain, and the subsequent processing and handling of oil provide substantial employment. In addition the sustained rise in oil prices ¹⁹ will make it economical attractive to develop oil exploitation efficiency sustaining jobs both in r&d and the actual production. However, employment in this sector will probably not rise over the coming years.	Existing oil resources in the NSR are gradually being depleted, i.e. the production has plateaued and is projected to decline ²⁰ . This offers a challenge even at shorter term in view of increasing global oil demand .
Gas	On short term there is no major threat to security of supply, but demand in Western Europe and the rest of the world for gas is increasing dramatically ²¹ . This increases the importance of NSR as supplier of gas. As for oil gas prices can be expected to increase, and espe-	Gas is the least polluting fossil fuel when consumed ²³ . In addition it is relatively easy to distribute with little risk of pollution.	The production of gas includes employing a substantial number of people. But like for oil employment is not likely to increase.	Gas production is mature in the NSR, and only Norway is expected to increase production in a few years ²⁴ . Production is then expected to decline, increasing dependency on imported gas from Africa, Middle east

¹⁶ World Energy Outlook, 2004, International Energy Agency (IEA)

¹⁷ International Energy outlook, 2004, Energy Information Agency (EIA)

¹⁸ http://www.chevron.com/technology/core_technologies/

¹⁹ The Economist, 25th august 2005

²⁰ Factsheet 2005 Norwegian Petroleum Activity, Norwegian Ministry of Oil and Gas

²¹ World wide consumption will double by 2030, World Energy Outlook, 2004, IEA

	cially political development in Russia is going to influence security of supply ²² .			and Russia.
Coal	Coal is a low cost source of energy and resources are spread out geographically ensuring a stable supply. The consumption of coal is also predicted as stable especially in the OECD countries ²⁵ . The resources in Europe are becoming less and less profitable to exploit ²⁶ .	Coal is the most polluting among the fossil fuels, requiring proper cleaning technology in mining and at end user. In addition it is difficult to transport, and takes up much space when stored ²⁷ .	It is very unlikely that the production of coal will result in additional jobs in the NSR.	Coal is a cheap and reliable fuel, but has substantial environmental consequences (GHG emissions, air pollutants, leakages to soil and water). Further technical development may improve on this ²⁸ .
Nuclear	Access to nuclear material is widespread. Future deposits are however expected to be of lower grades than current, pushing toward increased prices. Most nuclear capacity in the OECD countries is expected to be retired by 2030 ²⁹ . Currently the EU is not promoting the increased use of nuclear energy ³⁰ , though on a national level the issue is being addressed.	Nuclear power emits no greenhouse gasses. Key concerns are on radioactive pollution from leakages and accidents, and risk involved in handling and storage of radioactive materials and wastes.	If nuclear power continues to be as little in favour as it is now, then it does not seem to have any substantial positive impact on the NSR employment. Jobs might be created in connection with development of dismantling technologies - but the continuing closing down of plants will result in fewer jobs.	Ways and procedures for decommissioning and dismantling of existing power plants, and long term handling and storage of radioactive waste are still not developed. Likewise are associated costs uncertain.
Hydro	Hydropower may offer advantages to security of supply in terms of rapid capacity reserves	In relation to greenhouse gasses the only environmental conse-	The NSR seems to have utilised its potential regarding Hydro-	Hydropower is highly depended on the geographical location and the

²² The Economist, June 2nd 2005

²³ Natural Gas Issues and Trends, 1998 - EIA

²⁴ Norwegian Ministry of Oil and Gas, June 2005 (<http://odin.dep.no/oed/norsk/aktuelt/pressesenter/026031-990065/dok-bn.html>)

²⁵ World Energy Outlook, 2004 - IEA

²⁶ "Lets overcome our dependency", EU Commission, DG Energy and Transport, 2002

²⁷ "The role of coal in the European Energy Mix", DG Energy and Transport, 2002

²⁸ "Fostering the use of clean coal technologies" - the Carnot programme, DG Energy and Transport, 2002

²⁹ World Energy Outlook, 2004 - IEA

³⁰ "The future of nuclear energy in the European Union", Fernando De Esteban, Background paper 2002, DG Energy and Transport, 2002

	when storages are available, but seasonal supply is dependent on rainfall.	quence connected to hydropower is the actual construction of the plant. Regarding other environmental consequences hydropower especially affects land use and fragmentation of countryside ³¹ .	power ³² . A change in the level of employment is therefore not likely to occur.	amount of water available. To be able to distribute the produced power, access to an adequately developed power grid is essential. It is widely accepted that the EU has almost fulfilled its large scale hydropower potential ³³ .
Wind	Wind energy is regionally produced and contributes to the security of supply and hence reduces dependency. However the installed power generation capacity will not have the full value in terms of availability due to changing weather conditions. To ensure supply at all times wind power will require access to reserve capacity.	Energy deriving from wind is to be considered sustainable, but may in particular have visual impacts. Especially land based wind turbines will have aesthetical impacts, where offshore wind turbines primarily will affect interests regarding fisheries and sea transport. Generation of sound has also been an issue in relation to externalities of wind turbines.	The production of wind turbines has created a substantial number of jobs in especially the northern part of Germany and Denmark ³⁴ . It is to be assumed that this development will continue if the region continues to be leading within wind power technologies. In 2030 wind power will be the second largest source of renewable energy ³⁵ .	Wind power is approaching the costs of conventional sources ³⁶ , but power generation is highly depended on the weather conditions. Efficient methods to store power or balance power demand and supply will contribute immensely to the applicability of wind power.
Sun	Solar energy is used for production of heat or through solar cells to produce power. Both ways depends on sun light and thus presents a challenge regarding the availability of capacity and security of supply.	Solar energy does not have any environmental implications besides from the production of the solar cells and heat collectors.	The production of solar panels and solar cells may offer employment opportunities if large scale production is established in the NSR, though regions with easier access to abundant sun light have considerable advantages. Still Germany is the most dy-	Solar energy technology is less developed than wind power technology, particularly photovoltaic are still relatively costly compared to conventional power generation sources. The costs have however fallen considerably over the years ³⁸ .

³¹ "The Energy Sector and Water Resources in Norway 2004", Norwegian Ministry of Oil and Gas

³² *ibid*

³³ ESPON PROJECT 2.1.4: Territorial Trends of Energy Services and Networks and Territorial Impact of EU Energy Policy, Final Report – Part Two.

³⁴ In 1995 8.500 were employed in the Danish wind industry out of 30.000 world wide, Source: Danish Wind Industry Association

³⁵ World Energy Outlook, 2004, IEA

³⁶ Cost has fallen 80% over the last 20 years. Source: Research Institution Risø.

			dynamic market for photovoltaic installations ³⁷ .	
Biomass	Biomass is utilised in three ways, as solid, liquid and gas. Particularly liquid biofuels may contribute to increased security of supply as it substitute oil products, e.g. in transport, but also solid and gasified biofuels (e.g. from land fills) reduce dependency on fossil and imported fuels, and contributes to security of supply. Bioenergy is considered to have a considerable potential ³⁹ .	Biomass is generally accepted to be CO ₂ neutral when utilised for energy purposes. Production for energy crops may however require fertilisers and fuel for machinery which cause some CO ₂ generation.	Producing, harvesting, processing and distributing biomass for energy purpose may offer options for increased employment. Alongside Brazil and USA, especially Germany has a substantial production of Biofuels ⁴⁰ . In addition the UK is currently boosting its capacity to produce biofuels, and trends on the world market indicate that the use of biomass will grow considerably and offer employment opportunities. Even though production of biofuels rose by more 25% from 2003 to 2004, production still not meets capacity ⁴¹ .	The EU biofuels directive requires 2% (2005) and 5.75% (2010) of fossil fuel for transport to be substituted by bio fuels. Several challenges prevail ⁴² , e.g.: - Higher costs of liquid bio fuels compared to fossil oil and to solid bio fuels - Distribution of bio fuels to consumers - Limited potential for energy crops, which must be seen in relation to the other crops in agriculture and forest industry.
Wave and Tide	Energy derived from the tide and waves in the oceans. Energy production will depend on weather conditions, but may also utilise predictable tidal waters. Wave and tide energy will contribute to the security of supply in energy terms, but needs backup from reserve	Wave power is not emitting greenhouse gasses and is expected only to have little environmental impact.	If the technology develops in line with wind technology, then job creation is evident. But this development is not immanent ⁴⁴ .	Wave power is an immature technology - and is still on a research and development stage. Technology needs to be developed, and generation costs reduced to make the technology

³⁷ EurObserv'ER 2004

³⁸ Prices seem to fall with 15-20% by each doubling of the market. Source: International statistics, System prices, IEA Photovoltaic Power Systems Programme

³⁹ "Bio-energy's role: A view of developments until 2020", report to the EU Commission, 2004

⁴⁰ The Economist, May 12th 2005

⁴¹ Biofuels Barometer, EurObserv'ER, 2005

⁴² The communication "The share of renewable energy in the EU" (COM(2004) 366 final) stated that with the current trends it will be very difficult to meet the targets set by the EU. Additional 74 Mtoe will be needed in 2010 to meet the targets, indicating that only 18-19% of the RES-E targets will be met.

	capacity to ensure supply at all times. When sufficiently developed wave and tide energy has considerable potential ⁴³ .			commercially viable.
Geothermal and heat-pumps	Energy derived from the heat of the earth. Geothermal solutions usually includes drilling deep (0,5 -3 km) and taking the energy from the below hot water or utilising the heat from dry rock. Use of geothermic power is best utilised in large scale plants and dependents on specific geological preconditions not making it possible for all regions to utilise. Applying heat pump technology is to utilise the differences in surface temperature and the temperature in the ground - making use of thermal mechanisms not unlike a refrigerator. Heat pumps can be utilised in most places since	Energy derived from the heat of the earth is a sustainable energy source, though energy external energy (electricity) is applied to keep the pumps running. Depending on the size of the plant 3-40 khw of electricity can supply 100 khw of heat ⁴⁵ . Depending on how the power is produced geothermal and heat pump generated energy can be considered more or less CO2 neutral.	It is estimated by the European Commission ⁴⁶ that energy deriving from geothermal or heat pumps will only constitute a small part of the total level of energy generated by sustainable sources by 2010 ⁴⁷ . Even though considered a "slow growing" field by the Commission in 1997, the Commission assumed that the installed heat pump capacity would be tripled by 2010.	Geothermic energy production can be very costly since you might have to drill quite deep. But the energy potential is quite impressive especially in the large scale solutions. Small scale heat pumps also have a considerable potential. Is estimated that heat pumps have a future potential for reduction of greenhouse emissions by up to 16%. ⁴⁸

⁴³ 15% of the Danish power supply could derive from wave and tide. Source: "Wave Power Technology, Strategy for research and development, The Danish Energy Authority, 2005

⁴⁴ "Wave energy utilisation in Europe, Status and perspectives", Centre for Renewable Energy Sources, Greece, 2002

⁴⁵ Information from the Heat pump Centre, International Energy Agency.

⁴⁶ "Energy for the future - renewable sources of energy" White paper for a Community Strategy and Action Plan , COM(97)599 final (26/11/1997)

⁴⁷ In 1998 geothermic produced power constituted 1,6% of all sustainable power production and 5% of the sustainable direct heating. FRIDLEIFSSON, I. B., 2003.

Status of geothermal energy amongst the world's energy sources. IGA News, No.52, 13-14.

⁴⁸ Information from the Heat pump Centre, International Energy Agency.

	they can be relatively small and that there is no need to drill deep.			
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Energy carriers:

It is necessary also to deal with energy carriers when addressing the future aspects of energy supply and energy demand. Storage and transportation of energy are important issues, especially if the source that supplies the energy is not present at the same time as the energy is needed. Traditionally carriers are **electricity** stored in batteries or for example **heat** stored in water. Other forms of carriers could be **compressed air**. But especially one form of energy carrier has drawn much attention lately; namely Hydrogen.

A number of reasons have brought hydrogen to the attention globally:

- It may offer a no-emission fuel for transport, particularly relevant in cities
- If produced on renewable energy it will become a CO₂ neutral fuel
- It may offer an opportunity to improve the interaction between different energy forms and sources and help balancing electricity demand and electricity supply from wind, sun and waves by enabling conversion of surplus electricity into hydrogen, which may be used for transport or stored for later use.

Hydrogen technology is however not yet mature. Large system energy losses can be foreseen, hydrogen storage tanks needs to be developed further, and fuel cells must be improved and associated costs reduced. Though utilising existing facilities primarily developed for the transportation of natural gas for the transportation of hydrogen could be a way of transporting hydrogen in a more cost efficient manner.

Using existing pipelines presents some challenges since natural gas and hydrogen reacts in different ways with the material of which the pipelines are constructed. Thus hydrogen has some physical properties that may cause embrittlements in some high-strength steel piping materials that to day are used solely for transport of natural gas. Though studies conducted have shown that most of the existing steel pipelines used for transportation of natural gas to some extent can be used for hydrogen⁴⁹. The method for transporting hydrogen is by injecting it into the natural gas stream. The studies show that the portion of hydrogen injected can be up to 10% with little consequences. The portion can be raised to 25%, though this will result in loss of capacity in gas driven engines and some modifications would have to be made to pumping systems etc. Finally it should

⁴⁹ To calculate whether a pipeline can be used for transport of hydrogen a number of factors have to taken into account: the quality of the steel (PVC or HDPE are too porous), the pressure in the pipe, purity of the hydrogen etc. For additional risk analyses see: "Risk Analysis of Hydrogen Gas Transmission Using Natural Gas Infrastructure" by Jo, Crowl and Park, Institute of Gas Safety Technology, Korea Gas Safety Corporation and Michigan Technological University or: "Hydrogen effects in gas transmission pipeline steels" by Maccagno, T.M. (Univ of Alberta); Ikeda-Cameron, K.; Jack, T.; Wilmott, M.; Chen, W.X.; Dorling, D. Source: Proceedings of the International Pipeline Conference, IPC, v 1, 1998, p 479-484

be mentioned that hydrogen infused gas is no new idea. For longer periods during the 20th century, in for example Copenhagen, hydrogen was added to the "city gas" systems for the use in households with a proportion of up to 50%⁵⁰.

Even though existing energy infrastructure to some extent can be used for hydrogen substantial investments in both infrastructure and R&D have to be envisaged to make hydrogen a significant energy carrier in the future.

Table 3.2 Hydrogen and selected aspects

	Security of supply	Environmental consequences	Job creation (NSR)	Challenges
Hydrogen	If proper developed hydrogen may help to overcome imbalances between renewable electricity generation and the electricity demand by utilising surplus electricity for hydrogen production. Further more hydrogen could on the longer term substitute oil for transportation ⁵¹ .	Hydrogen as an energy carrier is considered pollution free since the only bi product is water when used. However hydrogen production is energy intensive and the environmental effects depends on how the energy is provided. Only if produced on renewable energy hydrogen may be pollution free.	Hydrogen as a technology is still not wide spread. But the technology may hold large potential, and thus also in terms of job creation particularly for "first movers" ⁵² . The industry expects the hydrogen market to take off by 2015-2025 ⁵³ .	Hydrogen technology is immature and need significant development to be competitive. Large challenges exists, both on efficient hydrogen production, development of infrastructure and distribution, and end user appliances.

Energy consumption

The energy demand is at least as important to security of supply, environmental impact and employment as the energy supply is. There is large potential for energy savings and energy efficiency improvements that reduce energy dependency and the consequences of energy consumption.

Both new and older technologies that could facilitate a more efficient use of energy could be utilised to a much higher extend than is currently the case. Hence the development and extended use of guidelines and common standards dealing with for example energy efficient construction of housing and office buildings could be a focal point for further activity.

⁵⁰ As another applied example could be mentioned that the US based company "Air Products" has hydrogen pipelines in the US, the UK, the Netherlands and Thailand, some of which have also earlier been used for natural gas.

⁵¹ Hydrogen and Fuel Cells - Review of National R&D Programs, 2004, EIA

⁵² A.o. Researches from the Technical University of Denmark are currently taking out patent on a technology for storage of hydrogen in easy-to-handle salt tablets, a technology that would increase the utilisation of hydrogen considerably.

⁵³ "Transition to Hydrogen", Joep Huijsmans, Team Leader R&D Shell, 2005.

Consumption:	Security of supply	Environmental consequences	Job creation	Challenges
Demand for energy	Decoupling of economic activity and energy consumption is an efficient strategy to reduce the energy dependence, and the exposure to increasing energy costs. ⁵⁴	By using less energy or using it more efficient the environmental consequences from utilizing non renewable sources of energy will be reduced.	Increased energy efficiency will improve the competitiveness of NSR industry and thus indirectly contribute to employment in the region. ⁵⁵	Increase awareness is needed in industry, agriculture, service and households on the potential financially feasible energy savings and energy efficiency improvements that are available (in improved processes, increased insulation, lighting, electric appliances, pumps and ventilation, transportation etc.) To governments the challenge is to provide the right incentives and regulation to promote energy savings and efficiency.

4.4 Energy in an EU policy context

The basis for cooperation in the North Sea Region in the framework of Interreg IIIB is based on the European Spatial Development Perspective (ESDP) which was adopted in Potsdam in 1999. The three fundamental goals for the ESDP are:

- Economic and social cohesion;
- Conservation and management of natural resources and the cultural heritage;
- More balanced competitiveness of the European territory.

This also constitutes the overall aims of the North Sea Region Programmes four priorities.

Since the adoption of the ESPD, a number of EU policy documents have been issued. These policy developments must be taken into account when considering how a future North Sea Region Programme is approached.

The Lisbon Strategy:

⁵⁴ "Improving Energy Efficiency", 2002, IEA

⁵⁵ "On energy efficiency or doing more with less", Green paper, EU Commission, 2005

A policy development which will definitely influence territorial co-operation programmes is the Lisbon Strategy (2000)⁵⁶. The Lisbon Strategy established a new strategic goal for the Union:

... 'to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion'.

Central to the strategy is more concerted action on developing the knowledge economy, information society and R&D, investing in people and addressing social exclusion. A main focus to the Lisbon Strategy is the need for improved co-ordination of policy and action at all levels. The emphasis is on sector investments, the completion of the internal market through liberalisation and other policies, and increased attention to education and training for employment.

In relation to issues related to "energy" the Lisbon strategy addresses this mainly in relation to how the European market for energy is constructed. Thus energy is an issue in relation to the intention of making economic reforms to complete a fully operational internal market. Hence the market for gas and electricity should be fully liberalised ensuring efficiency, competition and adequate quality. The Lisbon strategy thus underlines the efforts set out in the Electricity Directive from 1996 and the Gas Directive from 1998 formally liberalising the energy market, by introducing more competition and giving rise to the restructuring of supply.

A newly issued green paper directly relates increased energy efficiency as supporting the Lisbon strategy. By making energy savings of up to 20%, relative competitiveness will raise and it is estimated that around 1 million new jobs EU-wide will be created⁵⁷.

The Gothenburg Council:

Another major EU policy development is The Gothenburg Council (2001)⁵⁸, which agreed on the Communication on Sustainable Development⁵⁹ and added a third, environmental, dimension to the Lisbon Strategy (in addition to economic and social renewal). It repeats the need to address economic growth in the light of use of resources and identified four priorities:

- climate change,
- transport,
- public health
- and natural resources.

The territorial dimension is given limited attention except for extensive consideration of necessary changes to transport policies. The Council called for

⁵⁶ Presidency Conclusions of the Lisbon European Council 23 & 24 March 2000

⁵⁷ "On energy efficiency or doing more with less", Green paper, EU Commission, 2005

⁵⁸ Presidency Conclusions of the Göteborg European Council 15 & 16 June 2001, SN 2001/1/01 REV 1

⁵⁹ A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development: Communication from the Commission 15.5.2001, COM(2001) 264 final

- a significant decoupling of transport growth and GDP growth;
- a shift from road to rail, water and public passenger transport through a revision to the TEN transport to give priority to infrastructure investment for public transport and for railways, inland waterways, short sea shipping, and intermodal connections;
- more sustainable use of natural resources and levels of waste, maintaining biodiversity and preserving ecosystems;
- The renewed commitment to integrate environment into all Community policies.

Regarding the effect of the Gothenburg council on future regional co-operation programmes on energy, the focus on sustainable use of energy is relevant. The targets for greenhouse gas emissions and ceilings for acidification gases were hence adopted in Gothenburg.

The EU policy on energy can thus be identified as having three main aims:

"to achieve greater security of supply, to create an internal energy market and to protect the environment better."(p. 123)⁶⁰

The territorial dimension of the Lisbon-Gothenburg Strategy is presently being investigated through a study under ESPON⁶¹.

The Trans European Energy Networks:

To facilitate a single market in the EU, efforts have been made to establish a structure that can facilitate the free movement of people and services. Since the 1980ties this has been approached through the so-called TEN (Trans European Networks). The Trans European Energy Networks has thus through the years financed gas and electricity transmission infrastructure investments of European interest, and hence constituted the main focus on cross border issues regarding energy. With reference to the 2003 guidelines for TEN-E especially the remoter areas of the EU should be considered.

The Third Cohesion Report:

In 2004 another significant EU policy document was issued with the publication of the vision paper of the European Commission: "A new partnership for cohesion". The report also addressed the European strategies on energy in relation to the economic and social cohesion of the European Union. The report stated that the European energy strategy had to be harmonised with the commitments

⁶⁰ The Third Report on Economic and Social Cohesion: A New Partnership for Cohesion, Convergence, Competitiveness and Cooperation, Luxembourg, OOEPEC, 2004

⁶¹ ESPON 2006 Project 3.3: Territorial Dimension of the Lisbon-Gothenburg Strategy, First Interim Report, October 2004, www.espon.lu

under the Kyoto Convention⁶². The Commission stated their position as the following:

"The development of new energy sources, such as natural gas and electricity produced from renewable sources, would enable peripheral regions both to diversify their energy sources - and so reduce their vulnerability to disruption of external sources of supply - and to improve the quality of life"

The above mentioned TEN-E therefore needed to be accompanied by support for investment in energy generation from wind, solar and geothermal sources.

The Energy Green Papers:

At least since the issue of the green paper: "Towards a European Strategy for the Security of Energy Supply" adopted by the commission in 2000 (finalised 2005), the key priorities for the future are identified as emphasising improvements in energy efficiency and the development of internal energy sources, especially renewable ones. Thus the green paper concludes that challenges will arise following changes in demand and supply of the next few years. It also concludes that the EU mainly will be able to deal with these challenges on the demand side, by trying to change consumer behaviour. In addition on the supply side a major focus should be on green house gasses, and the Kyoto Protocol. This strategy has been followed up by additional studies commissioned by the Directory General for Energy and transport addressing the Geopolitical aspects⁶³ and the relations with oil producing regions⁶⁴.

Another relevant green paper newly adopted by the Commission: "On energy efficiency - or how to do more with less"⁶⁵, also addresses energy matters from the demand side. The paper states that by 2020 the EU could be saving 20% on its energy consumption. According to the paper 70% of the EU energy needs are covered by imports. Saving around 60 billion Euro on efficiency, the members of the union will be able to invest substantially in the European economy. These investments will to a high degree have to be invested in innovation and research since only half of the anticipated savings will come from implementation of already adopted legislation. The other half has to derive from Europe being imaginative and proactive. Hence the link to the Lisbon strategy is obvious.

Intelligent Energy - Europe

The policies of the European Union has since 2003 been backed by the programme "Intelligent Energy -Europe". The programme is focused on four fields which addresses both the supply and demand side:

- **SAVE** - Efficient and rational energy use in industry and building sector.

⁶² The EU RE targets are that by 2010 the share of the renewable energy constitutes 12% of the total energy consumption and 22% of the electricity consumption, and that the use of biocarburants used in transport is 5.75%.

⁶³ "Study on Energy Supply Security and Geopolitics", 2004, DG-Energy and Transport.

⁶⁴ EUROGULF: An EU-GGC Dialog for Energy Stability and Sustainability.

⁶⁵ "On energy efficiency or doing more with less", Green paper, EU Commission, 2005

- **ALTNER** - Promotion of renewable energy
- **STEER** - Focus on transport issues, diversification of fuels etc.
- **COOPENER** - Support for use of renewable energy in developing countries.

April 2005 the Programme was prolonged for the period 2007-2013.

4.5 Energy and the Nordic Council of Ministers

Besides the EU another forum for cross-border coordination intersects with the North Sea Region, namely the Nordic Council of Ministers. The Nordic Council of Ministers has also been addressing the policy issues on Energy.

The Nordic council states their aim of Nordic co-operation on energy as to promote an effective, competitive, safe and sustainable supply of energy. Energy resources are to be used in an efficient way to strengthen employment in an economic and environmentally responsible way.

The co-operation focuses on three core areas:

- Electricity market,
- Climate issues,
- and regional co-operation in the Baltic Sea region.

In addition particular attention is paid to efforts for sustainable energy supply in sparsely populated areas. The Nordic Council is currently working on a new action plan.

The work in progress also includes a new vision for the Nordic co-operation on energy. This was forwarded in draft, at the meeting of Nordic ministers of Energy in Iceland during September 2004.

4.6 Energy in the NSR context

The strategic document "NorthVision - A Spatial Perspective for the North Sea Region" (2000) addresses the issues of energy policy from the perspective of the two visions statements: "*The NSR, which takes care of its Natural Resources and Ecological Equilibrium and its Cultural Heritage*" (vision statement 4) and "*Urban Regions Developing in an Environment Friendly Way*" (vision statement 5).

NorVision statement 4

The first statement is dealing with energy through the aim "*Environment friendly forms of energy production are widely used*" which has the spatial implications of a growing number of wind farms. The strategies identified to reach this aim is to "*Use the potential for renewable energy in urban and rural areas, taking into account local and regional conditions*" and "*Potential coastal areas are increasingly considered for wind farms*".

NorVision Statement 5

The second statement addresses energy through the aim "*Disadvantages caused by vehicular traffic is reduced and alternatives to the car are promoted*". One of the strategies leading to this aim is to "*promote renewable energy*".

Community Initiative Programme

In the Community Initiative Programme for Interreg IIIB North Sea Region (2001) the issues of energy policy for the region are addressed through priority 3: "*Sustainable Management and Development of the Environment, Natural Resources and the Cultural Heritage*".

The CIP thus states that the full potential of renewable energies is far from realised in the region, and that strategies and actions for the replacement of fossil fuels by renewable sources should be aspired to. This is materialised in the measure: "*3.3 Development and promotion of sustainable management of natural resources and renewable energies*", and in measure "*3.4. Integrated and concerted sustainable management and planning of coastal zones and the North Sea itself*". Measure 3.3 thus deals with the promotion of renewable energy and measure 3.4 with the actual planning and management of i.e. off-shore wind farms.

NSR Projects

In the North Sea Region Programme following active projects are related to Energy:

- North Sea Bio-energy on Biomass
- Pro Bio-energy
- POWER (Pushing Off Shore Wind Energy Regions)

5 Interview based research

The corner stone of this report is the inclusion of points of view stated by different stakeholders through out the North Sea Region.

5.1 Methodology

A literature study as the one above can only help setting the scene of the study by creating a platform for the actual interaction with key stakeholders in the North Sea Region. But to give a more utilisable picture of what could be the future for the issue of energy, the relevant stakeholders have to be consulted.

The stakeholders

The North Sea Region Programme has regional actors as their prime concern. It would therefore be relevant to include regional actors as interviewees in the study to cover the traditional field of potential project owners and project partners - be they regional or municipal authorities dealing with energy. Though the specific nature of this study addressing energy, prerequisite that also other actors are included, hence especially national actors have to be addressed alongside research institutions, NGOs and independent experts.

Besides the interviews conducted by the consultant the input produced by the workshop at Middelburg 2005 is also included as research material (Appendix A).

The interviewees for this study were:

- Norway:
- Johan Vetlesen, Director, Ministry of Oil and Energy
 - Ingunn Ettestøl, International Coordinator, ENOVA
 - Audun Erik Sunde, Official, Regional Authority of Sogne and Fjordane Region
- Sweden:
- Josephine Bahr, Head of international department, the Swedish Energy Authority.
 - Magnus Blümer, Head of Section, Ministry of Sus-

tainability.

- Heinrich Kaufmann, Head of Halland Energy Office
- Denmark:
- Finn Bertelsen, Danish Energy Authority
 - Thomas Fuglsang Andersen, Danish Institute of Technology
 - Bjarne Lungren Jensen, Director, Danish Wind Power Association
 - Benny Christensen, Ringkjøbing Regional Authority
 - Klaus Illum, Independent Energy Expert
 - (Anders Würtzen, Director, Maersk Oil and Gas)
- Flanders
- Eddy Jonckheere, Regional Development Agency, West Flanders
 - Cathy Plasman, Adviser to the Flemish Minister of energy.
 - Dirk De Keukeleere, Flemish Institute for Technological Research
- The Netherlands
- Frank Mennenga., Groningen Municipality
 - Harm Jan Bouwers, Provinces of Fryslan
 - Dr. Joram Krozer, University of Twente/Cartesius Institute
 - Mr. Gerrit van Werven, Director, Energy Valley
- The UK
- Magne Haugseng, Head of Economic Development and Europe, Tees Valley Joint Strategy Unit
 - Dr Dermot Roddy, Director, Renew Tees Valley Ltd South Tees Business Centre
 - Brian Nixon, Director of Energy, Scottish Enterprise
- Germany
- Dr. Karsten Runge, OECOS GmbH
 - Prof. Dr. Wolfgang Pfaffenberger, Bremer Energie Institut

- Dr. Gerhard Wagner, Bundesamt für Bauwesen und Raumordnung (BBR), Section Transport and Environment.

Others:

- Bo Lindroos, Head of department, Nordic Counsel of Ministers

The questions

The terms of reference quite clearly states what questions should be addressed by the study. To meet these requirements a questionnaire guideline was developed in cooperation between the consultant and the North Sea Region Programme Secretariat (Appendix B). Transcripts are attached this report (Appendix C).

5.2 The Interviews

In the following the questions posed by the terms of reference are sought answered based on the input from the different interviewees. The questions are addressed one by one to assure that all questions are addressed.

5.2.1 Main spatial challenges

The first question posed addresses the issues of main spatial challenges following changes in how energy is supplied and produced: "*1. what are the main spatial challenges for facilitating the anticipated changes in energy supply and energy production? How can these challenges best be harmonised with other spatial interests?*"

The answer to this question to a large extent relates to what kind of energy resources will be utilised in the near future. A basic divide addressed by the different interviewees is regarding which role fossil resources are going to have. Will fossil resources continue to be the dominant resources (locally produced or imported) or will different kinds of renewable resources constitute the majority?

All respondents reply positively to the challenge of diversification. Hence the main spatial challenges will derive from a more or less complex combination of fossil and renewable sources.

When addressed directly the interviewees mention following sources that will have impacts: Wind turbines (both land and sea based), production of biomass, size of power plants and consequences from changes in energy infrastructure.

Wind turbines

Increasing utilisation of wind turbines in the production of power is a general reply from the interviewees. In addition there seem to be a common understanding that the main growth will be within the use of offshore wind turbines. Though to what extent is very regionally determined.

Expanding wind turbine activities is very likely in the regions of Norway, Sweden, Denmark, the UK and Germany. Development in the Netherlands and in Flanders is also likely though to a much smaller scale. The decisive factor is the access to available land and sea areas, which are much scarcer in the Netherlands and in Flanders.

The level of spatial impact by wind turbines is disputed by different interviewees. Reactions go from: *"half of what is expected"* to *"enormous"*, though depending on the actual location in the North Sea Region conflict would have to be anticipated with especially the fisheries sector and the sea transport sector. In addition impact on wild life is anticipated by some interviewees. Generally the visual impacts are deemed to be considerable when turbines are placed on land or close to coastal areas. In this case possibilities for conflicts with especially the tourist industry are mentioned. It is widely accepted though that offshore wind turbines build far from the coast has no visual impacts.

Biomass

The use of biomass as a source of energy diversification plays a larger role in the areas of the North Sea Region that has little possibility of developing large wind turbine parks. But the reasons that lead to diminished possibility for the development of wind power also relates to the area of producing biomass, namely space. Hence the main spatial consequence of growing biomass is the loss of potential farmland for the production of food. By some interviewees the consequences for the wild life by utilising coppice was mentioned.

Power plants

Some development regarding the size and nature of the power plants is also mentioned by the interviewees. The direction is though seen as both going towards more centralisation, and more decentralisation. Some see larger and more efficient fossil fuelled plants as the developmental trend, others that the trend goes toward decentralised biomass fuelled co-generation plants at a household or small production facility level.

The possibility of being able to centralise power production is by some seen as a way of avoiding the impact of a large amount of small facilities. On the other hand the possibility of being able to dismantle large power plants and instead utilise "virtual power plants", in the shape of large networks of small household facilities, is considered.

Change in infrastructure

When dealing with different issues related to the future power production change in the energy infrastructure applies. Hence some of the issues related to especially a steady level of sufficient energy are tightly related to infrastructure.

When addressing this issue the interviewees primarily relates to an improved power grid of the North Sea Region and the possibilities of utilising other energy carriers such as Hydrogen.

The power grid has increasingly been utilised for trading power between the regions of the North Sea. This has led to significant overstraining of the exist-

ing grid. Improving the possibilities of utilising the power grid for levelling fluctuations in power supply by developing the grid would have spatial consequences.

Regarding the other main energy carrier addressed by numerous interviewees, hydrogen, the shift towards applying this technology would also have significant spatial consequences. Firstly by using hydrogen as a storage possibility for surplus wind power, this will result in the feasibility of building additional wind turbines. Secondly the extended use of hydrogen for transport etc. would result in the need for facilities for the distribution of hydrogen (fuel stations etc.). Several interviewees mention that the existing infrastructure for natural gas could be used for the storage and transport of hydrogen produced by large off shore wind power facilities.

5.2.2 Using transnational cooperation and the interreg programme

The second issue, that the terms of references wish to address, is the possibility of transnational cooperation and how the specific characteristics of interreg can be utilised. The terms of references address the issue with the following question: *"2. how could transnational co-operation improve the energy supply situation in the North Sea Region: i.e. lower the need for unsustainable energy sources and decrease the dependency on foreign supply as well as reducing the negative side effects of energy supply? What is the particular benefit for using interreg instead of other national and European cooperation instruments and funds?"*

When addressing the issue of transnational cooperation in the North Sea Region and the benefits of using the Interreg programme, a number of topics arise. The topics touch upon responding to fluctuations in energy supply, the need for coordination regarding planning, national and regional interests and cultural differences.

Dealing with fluctuations in power supply

When depending on large quantities of power generated by renewable sources that again depends on weather conditions - significant fluctuations might occur. Cooperation between partners in the North Sea Region dealing with this specific challenge is addressed by almost all interviewees. By utilising an improved power grid reaching across regions and borders, the effects of fluctuations will be softened. Another approach is the utilisation of the access to different kinds of energy through out the North Sea Region which would make it possible to use for example Norwegian reservoirs of hydro power when German wind power fails.

The need for planning

Several interviewees mention the clashes related to especially the building of off shore wind turbines. On several occasions one region have planed to build on locations in close proximity to where other regions had already placed or planed to place off shore facilities. The lack of coordination has hence resulted

in significant difficulties regarding successful planning when aiming at reducing negative impact for sea transports etc. A large number of interviewees therefore requests clearing facilities in line with the agreements regarding the exploitation of fossil fuels in the North Sea. A minority find that there is no need for additional international coordination. Others question the possibility of generally coordinating energy production in the region when actual influence on the specific energy policy of another country isn't possible.

National and regional interests

The energy sector is affected by strong national and regional interest. Access to domestically produced energy and hence the lack of imported energy makes energy high policy in most of the North Sea Region countries. In addition energy production facilities are often located in the more peripheral areas linking to issues dealing with regional development.

The national interests are predominantly connected to the production of fossil energy. Hence cooperation between the regions in the North Sea region within exploitation of fossil resources can prove difficult if it doesn't serve narrow national interest. Other high level issues could be the location of pipelines for liquid natural gas.

The above mentioned circumstances can make it difficult to engage in transnational cooperation in general, and specifically when it comes to the Interreg programme. For example national Danish energy policy is to primarily letting the market control the movement of both fossil and renewable resources. In the case of the Norwegian national policy they actively pursue a centrally coordination of energy activities resulting in a primary focus on bilateral national agreements or activities and agreements involving the whole of the EU.

Cultural differences

Whether or not the regions in the North Sea Region are alike is disputed in the interview round. Some find that the regions share a fairly similar approach for example belonging to similar administrative traditions. Others find the approach to the aesthetics of wind turbines or the inclination to think in terms of energy efficiency highly depending on geographical origin within the North Sea Region. This might prove challenging when trying to cooperate in the field of say energy efficiency. It should be mentioned though that several interviewees emphasise energy efficiency as an obvious area for cooperation and knowledge sharing.

5.2.3 Actors

A central topic for this study is who the potential key actors will be when cooperating on energy related projects. The question is addressed by the terms of reference in the following way: "*3. who would benefit/participate in such cooperation? Answers should both look at the key players which would be interested in undertaking the work (the likely actors), as well as those which might not be prone to co-operate, but would be crucial for significant progress (the crucial actors).*"

Energy - a national matter?

Characteristic for this study is that many of the main actors turned out to be national authorities, especially in the regions with strong national interests in the field of energy production. When the study is addressing the regional or municipal levels, feedback has been weaker, suggesting that energy issues do tend to have a more national nature. This might link to the often very large investments related to energy production, and the way energy planning is conducted. At the same time investments in regional or local energy production are smaller in size and hence easier to handle for the local or regional actors.

The role of private actors

Another issue which has had specific focus in this study is the possibilities of including private actors. Hence also private actors have been included in the interview rounds. Based on the interviews it was clear that private actors in deed have a role to play when it comes to energy. Though the extent to which private actors should be included is more debated. Are they to be included in planning activities or are they strictly to be the driving force in the actual exploitation of energy sources etc.

Initially many find it difficult to include private actors in especially Interreg funded projects. This is due to the fact that private companies are not allowed to capitalize on EU funding and that they are obliged to publicise know-how acquired through the project in question. This is already a well known fact though.

The study showed that the public authorities tend to have a reluctant approach to the inclusion of private actors in the projects that include aspects of sustainability regarding energy. Surprisingly enough some private actors we interviewed during this study showed significant interest in being included in projects. This was mainly the case when the private actor was an association of private or private and public actors.

5.2.4 Actual activities and investments

A part of the study addressed potential activities and investments based on the input from the interviewees. The terms of reference phrase it as the following: *"4. what sort of activities/investments would be valuable to undertake? This should give an insight into innovative approaches that would be useful to test in pilot projects or into the questions, which could be looked at in a transnational context. Especially for this question it is important to take into account the very specific situation in the North Sea Region and consider where co-operation could be fruitful."*

The interviews revealed a broad spectre of possible activities and investments that ought to be conducted when dealing with the challenges of energy in the North Sea Region. Some of the proposed projects clash, if a focus for the North Sea Region Programme should be identified. Generally the proposed activities can be grouped in the following way, there are projects dealing with large scale investments, projects on a lesser scale, projects dealing with research and projects on dissemination.

Large scale energy related projects

A number of the interviewees find that the challenges facing the countries surrounding the North Sea are of such a scale that yet another pilot-project will not help much on the situation. Another point in relation to the case for the large scale energy projects are that "energy" often is large scale.

A reoccurring issue, when addressing the cross-border nature of energy in the North Sea Region is the further development of the power grid. Development of the grid has clear transnational and transregional perspectives and the grid constitute a central nerve in the energy market of the region. Hence it might be the way to deal with fluctuations in the production of weather dependent renewable energy sources.

Development of the facilities for exploitation and transport of natural gas is also addressed by some interviewees. Central to this possibility is the role that this relatively abundant and relatively clean source of energy presents.

A number of interviewees address enhanced oil exploitation from the off shore fields as a main focus for further investment. Increasing the yield of the oilfield and at the same time reduce CO₂ emission to the atmosphere by infusing the carbon dioxide into the field is hence seen as one of the primary challenges.

Another bold endeavour proposed by some interviewees are the development of a hydrogen infrastructure connecting the North Sea Region. This will include production sites, transport facilities, storage capacity, filling stations, technical backup capacity etc.

Small scale energy related projects

Another group of the interviewees find that large scale solutions might be the way to go eventually, but that the programme in question is not scoped to deal with activities of this size.

A reoccurring theme here is the trend towards decentralisation of the energy production. The approach is demonstration projects realising the potential of locally produced energy from local renewable sources. A concrete project in pipeline is a project that combines regional economical development with the regional energy self-sufficiency.

In connection to the above mentioned issues of decentralisation also addressed the supporting of the increased use of waste-to-energy facilities. Development of other types of plants was also mentioned, some operating on renewable resources some on enhanced fossil resources.

Another concrete small scale project proposed by an interviewee is a pilot project combining wind power and hydrogen production.

Research

Efforts within research and development dealing with energy in the North Sea Region were also touched upon during the interviews. Different projects were mentioned reaching from studies addressing the most efficient way of constructing the future mix of energy resources to establishing a more accurate picture of the potential for wind turbines in the region. Other interviewees found that actual research activities addressing especially the technologies connected with hydrogen and CO₂ infusion should be supported.

Dissemination

This traditional activity of different interreg programmes also emerged during the interviews. Knowledge sharing, best-practice and the risk of "inventing the wheel twice" were reoccurring themes when addressing the potential of the North Sea Region Programme. Especially when addressing the topic of energy efficiency. Sharing experiences a. o. on how to insulate buildings more efficiently was an example. Other fields, where dissemination was sought after, were the more administrative aspects of energy planning. One concrete example was the wish to know more about third party financing, where a third part (usually a public foundation) pays for energy efficiency measures and finances this through the anticipated savings on energy. A second concrete example is best-practice procedures for planning activities, where stakeholders are to be included in decision making (i.e. building of wind turbines).

5.2.5 Cooperation outside the North Sea Region

With the following question: "*5. what partners outside the North Sea Region would be crucial to consult or to co-operate with?*" the terms of reference wish to reveal where potential cooperation partners outside the North Sea Region can be identified.

On this question the interviewees are divided into two almost equally sized groups. One that believes that cooperation beyond the region is futile at the moment, and one that see cooperation with actors outside the North Sea Region as a most natural activity.

When it comes to cooperation, especially activities addressing biomass and the Baltic Sea region keeps popping up. Several interviewees mention that if cooperation should go beyond sharing of knowledge and for example include increased trading of biomass, then the energy level of biomass has to be raised. This could be done by refining biomass to carbon rich liquefied fuels and enhancing the supply chain.

In addition it must be mentioned that the perspectives related to the increasing dependency on fossil resources makes it obvious to consider how easy access for the NSR to external produced energy can be established (i.e. establishment of infrastructure supporting import of natural gas from Russia).

5.2.6 Future programming

"*6. In what way should this theme be formulated in order to get the most out of transnational spatial development co-operation in a new programming period?*" By stating this 6th and final questions the terms of reference seek the right formulation to encompass the findings of the study in a forth coming programming effort for the period 2007-2013.

The answer to the above question should be found in the amalgamation of the conducted interviews. Thus the question was not addressed directly during the interviews. The question hence has to be dealt with during the recommendation of the consultant.

6 Recommendations

Energy is an immensely important issue. It touches upon all aspects of modern life, and the prospects of the bulk of the sources and technologies currently utilised look increasingly bleak. Access to clean, affordable and plentiful energy is a prerequisite for sustained development in the region and increased dependency on a small number of external producers of fossil energy is not a desirable position. It therefore seems obvious to address the energy challenges of the North Sea Region on all possible levels both geographically and politically, especially when the issue has such clear transnational implications. COWI would therefore recommend that "energy" as a topic continues to be addressed by the North Sea Region Program.

A number of aspects have to be taken into account if "energy" should be included successfully in the coming programming period for the NSR Interreg IVB programme - and leading to the development of a number of well developed and executed projects that can help meet the transregional challenges of the North Sea Region. To ensure this, COWI finds that two aspects must be considered: the nature of energy related issues and the framework constituted by the Interreg programme.

6.1 The characteristics of energy issues and the North Sea Region Programme

The study has shown that energy issues often relate to strong national or regional interests even though the issues often have transnational or even global implications. That implies that, when drafting the framework for future activities, the NSR Interreg Programme is going to meet energy stakeholders that are not necessarily committed to primarily address the transregional aspects of the challenges related to energy. Since the Interreg B activities are defined as promoting exactly transregional cooperation this constitutes a challenge. COWI therefore recommends that, when the future program is drafted, issues are addressed that constitute "common ground" for the involved regions when dealing with energy issues. In this way the more myopic national or regional interests can be countered, and obvious obstacles for successful project development and implementation are avoided.

Secondly - energy is big business and that often implies large investments. Laying down pipelines or establishing other large scale energy infrastructure has a clear transnational perspective as the study has also shown. Though the sheer

size of the projects and their direct relation to an overall EU policy in the field leads to the conclusion by COWI that these large scale activities are much more adequately handled by the support programmes run by the European Commission and the Directorate-General for Energy and Transport.

A final issue that emerged during the study and which might be hard to address in the Interreg B context is related to energy efficiency. COWI finds that projects that promote efficient use of energy are obvious to include in a future programming for the NSR programme but some of the issues that were raised during the study will not apply. Developing common standards for a.o. energy efficiency and the use of fiscal measures (taxation etc.) are efficient measures but they are more appropriately utilised on a national or supranational level and not on a regional or transregional level.

6.2 The potential for North Sea Region Programme in relation to potential energy project

Based on the conducted study taking into account the points made by the interviewees, comments by stakeholders and the nature of the energy issues COWI recommends that the following will constitute the basis on which programming is conducted by the North Sea Region Programme for the period 2007-2013 that is both suitable, feasible and acceptable and in accordance with overall EU policy:

5. **The regional nature** of the NSR Interreg programme constitutes an ideal basis for demonstration projects, pilot project or even larger projects based on the trend towards decentralisation of energy production and the increased use of renewable resources (wind power, biofuels etc.). This is underlined by the fact that much of the development within this field is going to take place in regions with direct access to for example biofuels and thus making it relevant throughout the North Sea Region. COWI finds that this supports the issues raised in relation to countering increasing energy dependency and the depletion of fossil resources. In addition activities of this kind will support the socio-economic invigoration of regions surrounding the North Sea.
6. **The transregional nature** of the programme is a good base for support to the development of new infrastructural measures, and specifically measures whose degree of utilisation is exponential with the degree of extension. (i.e. Infrastructure for hydrogen). Though COWI recommends that the recommendations made above are taken into account limiting the size of the infrastructural projects. This means that primarily projects dealing with preparation or other infrastructure-related activities (i.e. feasibility studies of for example the possibilities of establishing gas pipelines from Russia to the North Sea Region) are promoted. This also goes for increasing the capacity to coordinate planning of exploitation of energy resources i.e. offshore wind farms. COWI finds that specifically the development of a transnational "clearing-body" for energy-related infrastructure would fit both the needs of the region and the

purpose of the programme by reducing the negative spatial impacts. Though existing measures facilitated by the EU and dealing with similar activities must be taken into account.

7. **The transregional nature** also constitutes an obvious basis for increased dissemination between actors in the regions. This is of course one of the more traditional activities within the Interreg context not least because it is easy to initiate and can be conducted for a relatively modest sum. COWI would though recommend that dissemination activities are rather concrete and that they build on clear demand from the relevant stakeholders. Based on the current study especially two themes could be relevant to address in this manner. Firstly sharing of knowledge on energy efficiency has been mentioned at several occasions. This could for example help municipalities or regions in developing housing and buildings in energy efficient manners. A lot of knowledge on the matter is available in planning units around the NSR, and this could easily be distributed with success. Another very concrete wish that emerged during the study is the sharing of best practice examples regarding administrative procedures. Especially procedures on the right inclusion of the stakeholders in infrastructure projects (i.e. hearing procedures) were mentioned. In addition examples on how to establish third part investments schemes⁶⁶ in support for energy efficiency was on the agenda.
8. Finally COWI finds that the **geographic locality** of the North Sea Region programme makes it obvious to support research activities that relate to the specific nature of the use and production of energy in the region. The North Sea Region has potential to be leading within a number of energy-related areas which could be constituted as both "renewable" or "fossil". As examples could be research activities related the petrol industry on CO2 enhanced recovery. Other examples could be additional support to the development of the already strong wind power industry in Germany and Denmark, or the research in emerging areas such as Hydrogen and Tidal and Wave Technologies.

⁶⁶ I.e. where a public or semi public entity invests in efficiency measures that private or public apply for. The revenue is then constituted by the energy saving over time.

Appendix A: Joint Annual Conference in Middleburg, June, 2005

During the period 15th -17th June 2005, the Interreg North Sea programme and the North Sea Commission conducted a joint annual conference and exhibition. The consultant participated in this conference presenting input at the workshop addressing Energy.

The workshop was facilitated by Mr. Mark Overman, from VROM, the Hague and included a presentation by Mr. Jacques Roberts, TERSYN, and Mr. Henrik Duer, COWI.

Jacques Roberts presented an overview and status of different sources of energy and the challenges that are related to the trends in energy production and consumption. The presentation by Henrik Duer addressed similar issues and underlined the challenges related to specific energy sources and technologies. In addition Mr. Duer addressed different socio-economic implications.

On the basis of the two presentations the participants engaged in questions and comments to the speakers and took part in group discussions.

Outcome of the workshop

The discussions resulted in the general statement that the points main focus for coming activities supported by the NSR programme ought to be on cooperation, sharing of knowledge and exchange of experience. In addition a number of more specific comments were presented:

Waste to energy	Implementing the EU Waste Directive impose a regulatory framework and a number of challenges to the waste sector and may help to increase focus on "Waste-to-Energy" facilities, e.g. as seen in the UK. Experiences on how to involve consumers on this specific area were needed.
Bio fuels	Knowledge on bio fuels are scattered through out the NSR. To enhance the use of bio fuels cooperation and knowledge sharing must take place across the NSR. Issues to be addressed ought to be: How to organise. How to fit bio fuels into existing energy systems (heat/electricity). How to motivate, support and initiate the use of bio fuels. Tools for this purpose, proposed by the workshops, were creating networks and establish an exchange system of people and their knowledge between different projects.
Regional self sufficiency	As energy to a larger extend is going to derive from sustainable energy sources a decentralisation of energy production is going to be observed. This will provide periphery and rural areas with new developmental prospects. A project on boosting regional development through energy self sufficiency will be forwarded for the November NSR programme deadline. Invitations to participate were given.
Energy saving	Curbing demand is an efficient way of dealing with dependency. The participants suggested that efforts were made to facilitate transfer of knowledge on this area within the NSR. In addition local and regional plans to meet the targets set by the EU and the Kyoto Protocol could be made.
Balance RE	At the moment renewable energy sources (notably wind and sun) are not able to

with demand	match the demand load in terms of availability of capacity due to the natural fluctuation of wind and sun. An effort could be made to cooperate and share experience on capacity balancing measures.
Coal Gasification under ground	Coal may constitute a feasible alternative to more and more expensive oil. By gasifying coal under ground a relatively clean fossil alternative for liquid fuels can be produced.

Other comments addressed the possibilities of making it more attractive for private companies to participate in projects within the framework of the NSR programme. Careful consideration must however be given to the formal requirements for including private companies into Interreg funded projects as this may seriously limit the options for private sector involvement.

To summarise, the focus of the participants was very much on regional and local initiatives and less on the inclusion of national actors. Also primary activities were to be conducted in the area of cooperation, knowledge sharing and dissemination rather than on large scale planning and construction (e.g. development of the infrastructure for the use of hydrogen).

Appendix B: Introduction and guideline questionnaire

Update of Norvision - Energy

Jun. 2005

Why this study:

The North Sea Region Programme is a programme funded by the European Regional Development Fund, a Norwegian equivalent and the countries involved (areas of Sweden, Denmark, Germany, The Netherlands, The Flemish Region of Belgium, UK and Norway). The purpose of the programme is to stimulate transnational cooperation in the region during the period 2000-2006 and has a budget of € 132 mio.

The basis of the programme is a strategy paper developed in 2000 called "NorVision - A Spatial Perspective for the North Sea Region". As the EU is progressing towards a new programming period (2006-2013), the North Sea Region Programme wants to prepare for an eventual prolongation of their programme. This preparation consists of an update of the initial NorVision strategy paper on five specific areas. One of these areas is "Energy". COWI together with the University of The West of England, Bristol has been given the task of providing this study.

The status of the North Sea Region regarding energy:

On energy the North Sea Region has a unique position. Access to natural fossil energy resources has made parts of the region more than self sufficient on energy. But the region has also utilised parts of its vast potential regarding renewable sources of energy.

But the North Sea Region will, as the rest of the EU, within a foreseeable future face challenges related to energy dependency. In addition the EU and the Kyoto agreement have set ambitious targets for the increased used of non fossil energy resources and the reduction in green house gasses.

The North Sea Programme would like to identify a number of aspects related to energy - which will benefit form the transnational approached utilised by the programme. We will therefore like to put forward the following questions to you being identified as representing a key stakeholder related to energy in the North Sea Region.

The Questions

Please take a brief look at the following questions. As agreed with you, a consultant, conducting the study will contact you on the phone addressing the same questions, asking for your views.

Your input has a significant impact on a coming North Sea Region Programme addressing energy.

- The need for a diversification of energy resources in the North Sea Region seems obvious. What do you see as feasible sources of diversification?

- The North Sea Region is characterized by the fossil resources and the depletion of these. How can this be dealt with in the context of the North Sea Region? (*For ex. cooperation on dismantling of oilrigs etc.*)
- The supply of a number of energy resources depends on weather conditions (wind, sun and wave). As a result uneven supply the whole year round poses some technological challenges. How can these challenges be addressed optimally by the regions in the North Sea Region? (*For ex. is it just a matter of putting up enough wind turbines? Is a joint system for energy storage feasible?*)
- Different energy sources have different spatial impacts. By choosing a different mix of energy sources in the NSR, what are the spatial claims and impacts? Is it feasible that the regions in the North Sea work together to address these spatial challenges? And should private actors be included in the process?
- In regions with little domestic energy production, moderating energy demand is the primary and most important tool when addressing dependency issues. What is your general view on the use of energy efficiency measures in the North Sea Region, and could a transnational approach have specific qualities that a national approach doesn't?
- What could constitute actual actions or investments that addresses the challenges of diversifying energy in the North Sea Region? (*For ex. ideas for actual projects be they pilot projects or full fledge concepts*)
- What priorities regarding energy in the North Sea Region would benefit from cooperation with external actors and who could these actors be? (*For ex. Does it seem more obvious to cooperate with the Baltic Sea area on bio fuels or should efforts instead be made to cooperate on solar power with regions in the south of Europe? etc.*)