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Making accessible information on regional sustainable energy development within the North Sea Region

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Abstract
Regional economies are the source and the target of climate change mitigation. Sharing information may facilitate to develop regional economies with sustainable energy. Many initiatives in European regions and a variety of players exist. Regional authorities need the means to engage themselves in networks on sustainable energy, and share their own regional experiences and knowledge, their good examples and tools. To share this information is one of the objectives of the project "Energize Regional Economies" (ERE), funded by the Interreg IIIB North Sea Region programme.

Project partners have collected examples of regional development by sustainable energy in a geographical information system (GIS). Using GoogleMaps® technology, no expert knowledge is required to browse the ERE-GIS for possible project partners, interesting project locations to visit, or technology operating under different conditions around the North Sea perimeter. The ERE-GIS allows retrieving contact information and project details, and to comment and discuss the points of interest.

The participating regions are very diverse as regards their natural and economic resources, their history of sustainable technology, and their policy making. These differences can be used to learn from each other, to enable technology transfer or simply to inspire. A system is being developed, where key socio-economic and energy-related figures can be analysed inter-regionally in a distributed web-map environment. Results indicate that a map is a means of communication that can be understood universally, and the Internet is the means to make accessible the information needed to energise regions.

Keywords
Sustainable energy, regional development, Web-GIS, social learning, collaborative tools

Introduction

Sustainable energy systems are dearly wanted, and so is economic development in remote European regions. One of the means to reach both goals is to “energise” regional economies, i.e. to use innovative sustainable energy solutions to reduce climate change while nursing economic development. Many climate change intensive industries in regions around the North Sea, such as the offshore oil and gas industry in Scotland and Denmark; car manufacturing in Sweden and Germany; as well as fishing, intensive agriculture or tourism, could be converted into business with less climate impact. The regional energy supply can be based on renewable energy and energy efficient supply. Moreover, the buildings, electrical appliances, factories and offices, and the means of transportation can be made more efficient without compromising comfort, employment or economic gain. Solutions exist, but knowledge dissemination and exchange is needed across geographical boundaries and professional or institutional limitations in order to change market regulations, give access to support, or adapt education.

There are three ways how sustainable energy can improve the economic situation of regions: firstly, by investing locally in sustainable energy plants and energy efficiency measures, small and medium sized enterprises (SMEs) are fostered and strengthened. Secondly, by encouraging new industries and energy related services within the region, innovative businesses gain over less competitive sectors. And thirdly, by reducing a region's dependency on imported energy the running costs of businesses and households are reduced (Lund, 2000).

Regional energy systems are composed of connected sub-systems: the end-use system is comprised of energy end-using components such as the built environment, industries and services, as well as the transport system. Any investment in efficiency in this sub-system will ultimately reduce the use of secondary energy such as electricity, heat or transport fuels, which have to be supplied by the second sub-system, the supply system. Improvements to the supply system, such as the use of co-generation of heat and power or the use of heat pumps, will result in a reduced consumption of primary energy sources such as fossil fuels or renewable energy sources. The third sub-system will thus be the system of energy sources, in particular the renewable energy sources available in the region (Illum, 1995).

The regional aspect is quite important here. The regional geography determines the energy end-use and the potential to apply end-use efficiency; it also specifies the availability and costs of energy sources such as wind energy or biomass fuels; and it is determent for the regional and local distribution of settlements, businesses and transport demand, which tell whether improved energy infrastructure such as district heating is feasible or not. Hence the regional geography is decisive for several aspects of sustainable energy development.

The project "Energise Regional Economies", funded by the EU Interreg IIIb North Sea programme and running from 2006 to 2008 aims at finding ways how regions in the North Sea perimeter can stimulate economic development by sustainable energy, which is here understood as the use of renewable energy resources as well as energy efficiency in end-use and supply. Five core partners and several network partners (see figure 1) participate in identifying the potential for sustainable energy within their regions; and they exchange examples for best practices as toolboxes in order to see how they could learn from each other.

Take in figure 1

The participating regions in the Netherlands, Belgium, the UK, Denmark, Sweden and Germany are very different indeed. Not only are they characterised by different potentials for sustainable energy, they also have different levels of experience with the development of energy efficiency and renewable energy. In this project, difference is the basis for learning from each other. Good and bad experiences with sustainable energy development exist around the North Sea perimeter, and by sharing practices, skills or policy examples knowledge transfer may allow for getting projects started on an inter-regional, sub-national level.

This paper describes the use of two instruments, which have been developed by Aalborg University and applied for exchanging knowledge on regions and their energy systems as well as motivating projects, institutions and best practice examples within the partner regions. The first instrument is an Internet-based mapping tool to be used for putting regional examples on the map; and the second instrument is an energy inventory and a simple energy model for each core region. Both are accessible to the public on the ERE project website: www.ereproject.eu.

Information basis for energised regional economies

Regions often have no climate change policy and therefore normally little influence on energy politics, which usually happen on a national scale, with national legislation and increasingly under EU directives. Typically, regional policies are aimed at business development, at the environment, or at indirectly related areas such as public health. This means that there is very little to decide on energy policies such as taxation, resource development or safety of supply. In addition, electricity and commodity markets are national or international, and rarely anything is decided on energy markets on the regional scale, making many of the variables in regional energy planning exogenous and leaving little to decide to regional politics. On the other hand, all causes and effects of energy policies, such as climate change and other environmental impact; the recruitment of workforce and the establishment of businesses; as well as the before mentioned geographical limitations of the energy system, are all regional. It is therefore worthwhile to investigate how regional examples can influence national policies with in a manner, where small steps inspire to larger leaps.

As mentioned before, regional energy systems can be very different even within a seemingly homogenous area as the North Sea rim. For instance, the effect of installing 1 MW of wind energy leads to very different savings of CO_2-emissions in each region, depending on the contribution of various power sources and -technologies to the regional power mix. Also, solutions such as district heating, which are very successful in the Scandinavian countries, may be rather unattractive elsewhere. It is therefore necessary to gather knowledge on how the regional energy systems work.

From a problem-oriented perspective it is desirable to identify imminent problems related to the energy system prevailing in a region. For instance, the poor building standard of dwellings in Scotland leads to fuel poverty; whereas the availability of cheap natural gas resources in the Netherlands in the 1970’s now results in high customer bills and reduced competitiveness. Other problems are global, such as the end of cheap oil or climate change, and each region might have its own set of solutions to it. The answer may be to create partnerships for sustainable development, as proposed by Clarke (2007).

Another shortcoming is access to knowledge on how existing and newly developed technologies work under different economical, organisational and political settings (Hvelplund, 2006). Again, a given technology may work under the given tariffs valid in one region, whereas the energy market in another region will make an elsewhere feasible technology unfeasible. Economic change by means of sustainable energy is highly dependent on the existing and the possible future political frameworks. These frameworks rarely change drastically, but gradually, and their change needs a well-prepared information base of stakeholders. In a networking project, this is best achieved by making available information on good practices in other regions. Among these good or best practice tools are descriptions and contact details of successful projects, well-operating plants, thriving organisations and blooming businesses.

To facilitate the exchange of this type of information among partners in a network and among the partners’ networks, an information system is required, which can make available relevant information in a widely accessible, user-friendly and attractive format.

Learning about regional energy systems

In the ERE-project, most participants have a non-technical background. Regional energy balances as the basis for informed decision making are a rather strange concept to the majority of them. However, if the objective is to compare on a regional level the efforts made by various regions, their successes and failures to implement new technologies, a quantitative approach is required. Therefore, part of the project deals with developing methods to learn about regional energy systems. The learning goal is to get an understanding on how renewable energy sources and energy efficiency in end-use and supply interact by means of simple energy flow and basic economics.

Several regions, in particular those who are more successful at implementing sustainable energy systems, are about to reach a penetration rate of renewable energy technologies and energy efficiency which require an analysis of the impact of technological choice on the whole region. Rather than assessing the reduced environmental impact of a single project or a single technology, it becomes important to know the reduced amount of CO_2 within the region, or the money saved for oil imports, if substantial amounts and various combinations of sustainable energy technologies are planned.

An approach where the effects of small initiatives are quantified for an individual region can be advantageous for a project like this. It does however require a regionalised quantitative data base with energy flow data within the region and in exchange with its surroundings.

A problem met in attempting to quantify the problem is that energy statistics normally are made for the national level. Only for Sweden, Scotland and partially for Germany the data base for assembling a regional energy balance does exist in the public domain. Therefore in the beginning of the project the available statistical data base needed to be assessed for each region and requirements for a uniform modelling of the very different regional models had to be described.

Building regional energy inventories and energy models

For each of the participating regions: Fryslân (NL), Aberdeenshire (UK), Västra Götaland (S), Nordjylland (DK) and Schleswig-Holstein (D) a regional energy balance had to be prepared in order to analyse the effects of energy savings, energy efficient supply or renewable energy on the consumption of fossil fuels and the resulting CO_2-emissions.

These energy balances were prepared as so-called regional energy system inventories, which also described the installed capacities of renewable energy technologies. A uniform way to build these inventories was devised, based on the three-subsystem approach, where energy demand in the end-use system (as heating, electricity, industrial process energy and transport fuel demand) was to be supplied by a supply system, which in turn made use of primary energy sources such as fossil fuels. For reasons of simplicity, linear mathematical relations were used to calculate the secondary and primary energy flows, e.g. by means of annually averaged efficiency quotients.

After these regional energy inventories had been quality checked by the partners, they formed the basis for regional energy models, which can calculate the effect on the consumption of fossil fuels and the resulting CO_2-emissions, if investments in the three subsystems lead to reduced energy flows. As some regional systems have a surplus (Schleswig-Holstein, Aberdeenshire) or deficit (Västra Götaland) of regional electricity production, excess or shortage of power needed to be accounted for by modelling national power systems for the regions.

In order to simplify the use of these models, various measures such as the reduction of end-use, shares of co-generation of heat and power, shift to biomass fuels, or the installation of wind turbines were preinstalled in the models.

For comparative analysis one spreadsheet was designed, which allows for loading the basic figures from all other regional models. A series of diagrams then enables the users to evaluate the effects of sustainable energy technologies in all regions.

Take in figure 2!

Using the regional energy models

The main purpose of the regional energy models is to learn about how regions are different and how sustainable energy system components such as investments in energy savings, more efficient energy supply, or renewable energy installation help to reduce the use of fossil fuels and the emission of CO_2.

Early on in the project a seminar was carried out on the renewable energy island of Samsø in Denmark, where the participants, after a day in the field with introduction to renewable energy technologies in their organisational and technical settings, were asked to use a model like the ones prepared in this project. The aim was to make the energy system of this island CO_2-neutral at the least possible costs. As one can imagine, this is not a straightforward task. There are many different technologies that can be used for the purpose, and they all interact. Furthermore, they are limited by the actual regional energy system, the available renewable energy resources and the given energy demand. After a couple of hours, most participants were able to find a solution and while they were experimenting with Samsø's energy system, they increased their understanding of how regional energy systems work, even without a technical background. It was therefore decided to use this approach for the project.

The use of the regional energy models is intended to happen in interdisciplinary settings, interacting with various stakeholders and project partners. A few partners have already good experiences with the models prepared, so as to communicate energy plans, or to discuss their regional energy system compared to other regions.

The models and the inventories were made available on the project homepage, and project partners were encouraged to use them for their daily work, which some of them successfully manage to do.

Sharing information within project networks using Internet mapping

A project network can be considered a group of actors, decision makers and stakeholders within a problem sphere, who have a common vision and who share information in order to find and try out solutions. By learning about the problem and its possible solutions, they become better at understanding the complexity of sustainable energy systems, and may use their knowledge to improve informed decision making. During the process, several forms of social learning and network collaboration paradigms were tried and adopted; see for example Albors *et al.*, 2008. In particular the idea of communities of practice (Wenger, 2000) was interesting in this context to address the dynamics of social learning for groups with a defined interest. Since Wenger developed the concept of communities of practice, the technological development of the Internet towards Web 2.0 has taken place. In this context it may be interesting to apply the concept to employ a Web 2.0 solution such as a mash-up of GoogleMaps and other geographical information.

The group of project and network partners within the ERE project, plus their respective networks, forms social learning network or a community of practice. A common problem and motivation drives the project group towards a clearly defined goal, but not without perceiving the path of development as a goal itself. With a common mission to look at ways and means to strengthen regional economies with sustainable energy, there is much need to keep updated on projects, partners and innovative solutions in the North Sea area and beyond.

The exchange of relevant information within a network of actors is facilitated using the Internet, an interactive web, or a tailor-made web-application in the form of a blog. Having to do with geographical data such as the location of energy plants, projects or organisations, it is obvious to include a map interface to the information exchange system. Google has made available its GoogleMaps ® API (Application Programming Interface) for all users, allowing for the incorporation of a map interface on every website. The GoogleMaps API delivers a commonly used map interface with satellite/aerial photos and a topographical map, both with navigation utilities.
While GoogleMaps delivers a good mapping basis, thematic content such as information on projects, organisations or energy plants needs to be added by the project. This is done using a mash-up technology, which combines geographical data from several sources in a common geographical reference system. Hereby a lot of effort in mapping and procuring basic topographical data is saved, and a series of Internet-maps can be published with an elegant and consistent interface, which most Internet users already know. It has therefore been a foresighted decision to use GoogleMaps back in 2006, when the system was barely available.

Internet mapping is used within the ERE project in three different ways. A first system was built using the commercial site CommunityWalks to locate points of interest for the ERE project, see figure 3. All 12 participating regions have been asked to collect points of interest from within their regions. Points of interest were categorised as project sites, knowledge institutions, governmental institutions or agencies, companies, non-governmental organisations (NGO’s) or other. To also include the type of sustainable energy technology, the following sub-categories were included: wind energy, solar energy, biomass, ocean energy, end-use efficiency, supply efficiency or not applicable. The descriptive data for each of the more than 200 points collected included furthermore a short abstract, postal as well as web addresses, a photo URL and a set of coordinates used for location of the points on the GoogleMap.

Take in figure 3!

Take in figure 4!

A second system was developed for the purpose of comparing different regions in Europe by means of their socio-economy, demography, innovation parameters as well as parameters describing energy and the environment, see figure 4. Users were to apply this part of the information system for comparative analysis, where the context (education, wealth, demography etc.) of socio-economic development could be included in an analysis of parameters found in the comparative analysis of regional energy systems. For this purpose a method was developed, where statistical data made available by Eurostat on the NUTS 2 and NUTS 3 levels most relevant for regional and interregional studies were visualised on an Internet map. This did require the conversion of polygon geodata themes of administrative boundaries to a format that was compatible with GoogleMaps. It was found rather difficult to incorporate both the polygons and their cartographical interpretation as classified intervals of numerical values in the mapping system. Therefore a method was devised to export these interpreted data to image files, which would form thematic layers on top of the mapping system.

A third system is about communicating the collected best practice examples through the Internet map media. This is work in progress and is done by locating the best practice examples by coordinates, and by linking points on the map to descriptions of these best practice examples in the form of PDF-files. These documents contain the necessary information to briefly read about the best practices, to relate to their value for regional policy making, and to contact the relevant key persons.

Using the Internet mapping system

The Internet mapping system that consists of these three parts can now be used for improving the networking and learning activities on regional economies and sustainable energy. It serves a few important purposes, which are currently evaluated among the project partners.

A first application involves making available information to others. Links to the systems can be given to project partners by email or through other websites, so that the number of users can multiply. The information shared most frequently comprises the points of interest, probably because they were best accessible.

Another use for the system is related to one of the objectives of the ERE-project, which is to create further projects. Using the point of interest system to find new project partners and get inspired by existing projects, the application phase of new projects gets more width. Also, the site can be used to document networking activities for the reporting of project activities.

A second area of use is to navigate and browse for interesting projects in a region, e.g. when planning a trip to interesting project sites or offices of organisations. This can be developed further to the concept of topical tourism, like on the before mentioned island of Samsø, which attracts thousands of tourists every year, which specifically visit the island to see renewable energy installations operating.

A third application of systems like these is education, within the educational system, as well as within the learning networks emerging as part of projects like these. Experience from countries with a long history of sustainable energy development such as Germany and Denmark shows that many of later important stakeholders in fact were making acquaintances on educational trips to plant and project locations early on. While most of these trips earlier happened by physically visiting locations of interest, this may be continuing in a rather sustainable way by virtual visits through a web-based mapping system.

Finally, there is a notion that this is only the beginning of the development. More powerful actors and potent funding sources are about to adopt the idea of using GoogleMaps mash-up technology for creating learning environments for networks and for the open public. EnergyMap.DK is an initiative of the energy branch of the Association of Danish Industry, which is to be launched in 2009 as a portal to sustainable solutions offered by their members.

Learning in a network: lessons from climate change mitigation by means of sustainable energy systems in regions

What can be learned from using web-based mapping and interactive energy inventories for promoting the use of sustainable energy in regions is that (1) lack of knowledge is a great unknown, at least from a university perspective; (2) the development of information means such as the ones sketched in this paper can be an efficient way to explore the nature of problems in a social learning process; (3) it can be surprising to see these tools used by very different project partners; and (4) collaborative models such as energy models and web project inventories can play a distinctive role for the slow process of enabling non-technical decision makers on a regional level to make better decisions. In the following these findings shall be explored.

The lack of knowledge

A project like ERE with many different partners from mainly regional authorities and institutions that work with the promotion of businesses unites many different competencies. It was realised early on in the project that information on sustainable energy solutions, policies and practical examples was often little, and very inconsistent. A project group like the ERE partners seems to be of a very heterogeneous composition as regards the individual knowledge base on sustainable energy solutions. One reason is the different professional background and diverse experience levels; another reason is the more or less advanced development of sustainable energy solutions in the different regions. The fact that some regions such as Germany, Sweden or Denmark have pursued the development of renewable energy and energy efficiency for decades, while others just have realised the potential for sustainable energy development, is clearly visible. It was found that this diversity forms a good basis for information exchange by means of social networking.

Exploring the nature of problems in a social learning process

At the beginning of the ERE project most partners may have had their ideas about the project, but it was only after the first seminars that the nature of their regional problems was associated with the possibilities the ERE project could offer them. A social learning process did happen throughout the project period, during which the nature of problems was realised. The project did encourage partners to join forces on future projects, thereby refining problems such as fuel poverty, lack of innovation, or organisational blockage. Also, by presenting good practices to each other, the level of confidence increased.

Tools getting used by very different project partners

The two groups of tools developed in this project, the Internet-based mapping systems and the regional energy models, were used by most project partners. While some partners were very active using them, others merely seem to have noticed their existence. While web-maps are used everywhere today in everyday situations, energy models have been the domain of experts. By introducing a simplified modelling approach, which left out the complex interactions in the energy system such as hour-by-hour operation and the economic appreciation of supply and demand, problems become easier to handle. It was demonstrated that a simple energy model needs little introduction to make participants in a game solve a complex problem. It was even experienced that some users went on to alter the model; which means that model use is elevated to its next level. Finally, some of the partners were seen to develop ownership to the tools presented in the project.

Using collaborative models to improve decision making

In the beginning, the project participants had no or little experience with cartographic information or energy systems. In fact the choice of methods and tools was subject to profound discussions with the project leaders. But it was believed that in a process of social learning there could be agreement on these issues as soon as participants began to realise the value of these tools. It must be said that the success is ambivalent: for the first, the project did not come too far in the process of actually deciding on ways to energise regional economies. But secondly, it is felt that the information basis has been improved for most participants. A final conclusion on this issue has to be made yet.

Conclusions and perspectives

During the Interreg IIIb North Sea Programme project Energise Regional Economies two collaborative tools for social learning in networks were developed and applied to stimulate the mitigation of climate change in regions while strengthening regional economies. The task is highly interdisciplinary, complex of nature, and vast.

A set of five regional energy system inventories was built and discussed within the project group, after which these inventories were further developed to regional energy models, which can now be used to analyse in a simple fashion the effects on carbon emissions and fuel consumption if investments are made in the energy end-use sector, the energy supply system, or the system of energy sources. The models have since been used to exemplify the effects of suggested policies, realising that methods were crude, in order to quickly produce answers to imminent questions such as how much CO_2 can be saved by installing any MW of wind energy, replacing oil boilers with wood chip boilers, or reducing the heat demand in the buildings of a specific region by a given amount. A tool for comparative analysis was developed, which enables the users to compare the effects of a given technology in each of the regions. It was realised that the use of these models could improve the knowledge base of regional decision makers, and enhance their ability to see problems.

A second field of activity concerned the development and application of web-based mapping tools. Three systems were developed, containing points-of-interest; statistical data for regions; and the locations of best-practice examples. All three applications used mash-up technology, where the GoogleMaps interface was combined with geodata from the ERE project on the ERE homepage. Using a commonly known web interface like this, it was found that most users were familiar with it and focus could be on content rather than technicalities. In the trial period it was found that these applications could be used for many project-related tasks. It was also assessed that they could be beneficial for a social learning network process like in the ERE project.

A further perspective on the development and application of these collaborative tools is that because of the prolific nature of technologies related to Web 2.0, there will simply be more users and more applications. As regards the use of energy models, these will probably remain in the domain of experts, unless they are made more user-friendly and better accessible. A main obstacle seems to be that technical energy systems and energy balances remain something engineers work with.

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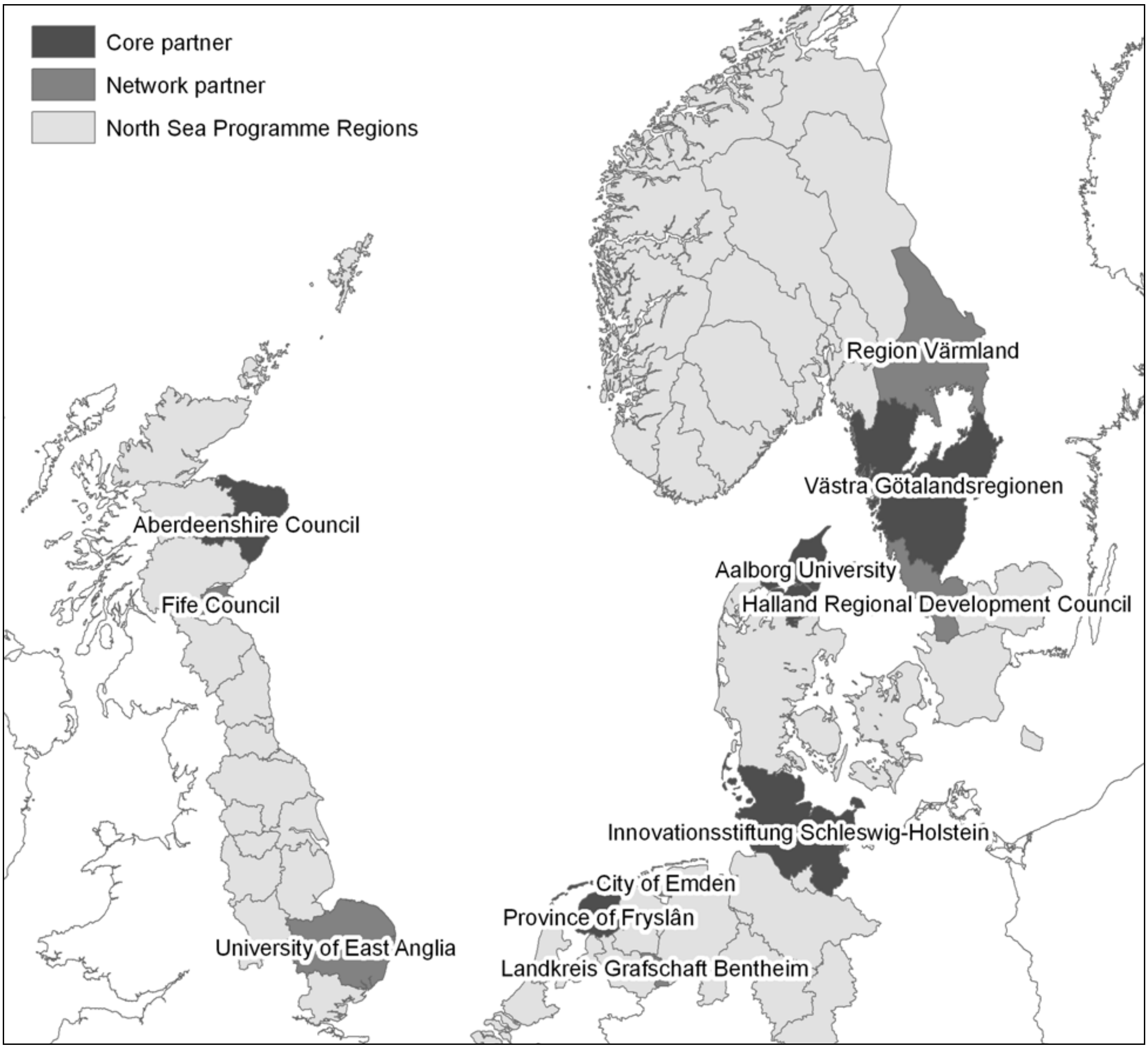

Figure 1: Participating regions in the ERE project: Core and network partners.

Energy Inventory Northern Jutland

Energy Sources

RENEWABLE ENERGY SOURCES			
Wind energy, on shore			
Installed wind power	608	MW	
Annual production	1.077	GWh	25%
Wind energy, off-shore			
Installed power	-	MW	
Annual production	-	GWh	0%
Solar power			
Installed capacity	0	MW	
Annual production	0	GWh	0,00%
Wave power			
Installed capacity	-	MW	
Annual production	-	GWh	0%
Biomass fuel consumption			
Wood, straw, manure etc.	3.267	GWh	13%
FOSSIL FUELS			
Fossil fuel consumption			
Oil	2.072	GWh	8%
Petrol & Diesel	6.735	GWh	26%
Jet fuel	1.392	GWh	5%
Coal	9.048	GWh	35%
Natural gas	3.197	GWh	12%
CO2-EMISSIONS			
By energy sector			
Power production	2.363.970	t	37%
Combined heat and power	1.306.270	t	20%
Heat production	636.057	t	10%
Transportation	2.152.917	t	33%
TOTAL	**6.459.215**	**t**	
By fuel			
Oil	552.031	t	9%
Petrol & Diesel	1.782.064	t	28%
Jet fuel	370.853	t	6%
Coal	3.094.425	t	48%
Natural gas	657.433	t	10%

This inventory has been produced using a regional energy atlas for Denmark (Möller, 2007).

Additional data come from the 2006 energy statistics by the Danish Energy Authority (DEA), available on www.ens.dk. Efficiencies are based on the chart "Danish Energy Flows 2005" (DEA, 2005).
Specific emissions are based on the assumptions made by DEA.

Bernd Möller, Aalborg University, October 2007

Energy Supply

HEAT AND POWER PRODUCTION			
Central power plants			
Annual power production (residual)	3.378	GWh	
Biomass etc	-	GWh	0%
Natural gas	-	GWh	0%
Oil	-	GWh	5%
Coal	6.912	GWh	95%
Central co-generation plants			
Annual power production	918	GWh	
Annual heat production	1.531	GWh	42%
Waste heat from cement industry	306	GWh	20%
Waste incineration	743	GWh	17%
Oil	107	GWh	3%
Coal	2.136	GWh	60%
Decentralised co-generation plants			
Annual power production	1.059	GWh	
Annual heat production	1.604	GWh	44%
Natural gas	2.572	GWh	85%
Biomass	-	GWh	0%
Waste	363	GWh	12%
Biogas	30	GWh	1%
Oil	61	GWh	2%
District heating plants (no power production)			
Annual heat production (residual)	510	GWh	14%
Natural gas	54	GWh	10%
Biomass	380	GWh	70%
Waste	81	GWh	15%
Biogas	-	GWh	0%
Oil	27	GWh	5%
TRANSMISSION AND DISTRIBUTION			
Total electricity to be produced	4.278	GWh	
Power network losses	280	GWh	7%
Total district heat produced	3.644	GWh	
District heating network losses	729	GWh	25%
INDIVIDUAL HEAT SUPPLY			
Central heating, oil			
Oil consumption	1.878	GWh	32%
Central heating, natural gas			
Gas consumption	571	GWh	10%
Central heating, biomass			
Biomass consumption	335	GWh	6%
Central heating, electricity			
Electricity consumption	126	GWh	2%
Central heating, heat pumps			
Electricity consumption	6	GWh	0,1%
Solar energy			
Solar thermal heat, all buildings	7	GWh	0%

Energy Enduse

Heat demand			
Dwellings, single			
District heating	1.460	GWh	22%
Individual heating, oil	1.018	GWh	15%
Individual heating, gas	247	GWh	3,7%
Electric heating	119	GWh	1,8%
Heat pumps	15	GWh	0,2%
Biomass	218	GWh	3,2%
Other	15	GWh	0,2%
Dwellings, multiple			
District heating	552	GWh	8,2%
Individual heating, oil	25	GWh	0,4%
Individual heating, gas	10	GWh	0,15%
Electric heating	3	GWh	0,05%
Heat pumps	0	GWh	0,002%
Biomass	1	GWh	0,01%
Other	2	GWh	0,03%
Trade & service			
District heating	740	GWh	11%
Individual heating, oil	196	GWh	2,9%
Individual heating, gas	128	GWh	1,9%
Electric heating	31	GWh	0,5%
Heat pumps	1	GWh	0,02%
Biomass	13	GWh	0,2%
Other	216	GWh	3,2%
Other, incl industry and agriculture			
District heating	164	GWh	2,4%
Individual heating, oil	263	GWh	3,9%
Individual heating, gas	129	GWh	1,9%
Electric heating	102	GWh	1,5%
Heat pumps	2	GWh	0,03%
Biomass	53	GWh	0,8%
Other	1.017	GWh	15,09%
Supplied by district heating	2.916	GWh	43%
Supplied by individual heating	3.824	GWh	57%
TOTAL	6.740	GWh	
Electricity demand			
Households	1.133	GWh	28%
Industry & agriculture	1.773	GWh	44%
Trade & service	1.092	GWh	27%
Transport	-	GWh	0%
TOTAL	3.998	GWh	
Transport energy demand (fuel or el.)			
Road transport	6.242	GWh	77%
Railways	165	GWh	2%
Sea transport, domestic	200	GWh	2%
Air transport, domestic	50	GWh	1%
Air transport, international	1.342	GWh	17%
Defences	128	GWh	2%
TOTAL	8.127	GWh	

Figure 2: Example for a regional energy inventory.

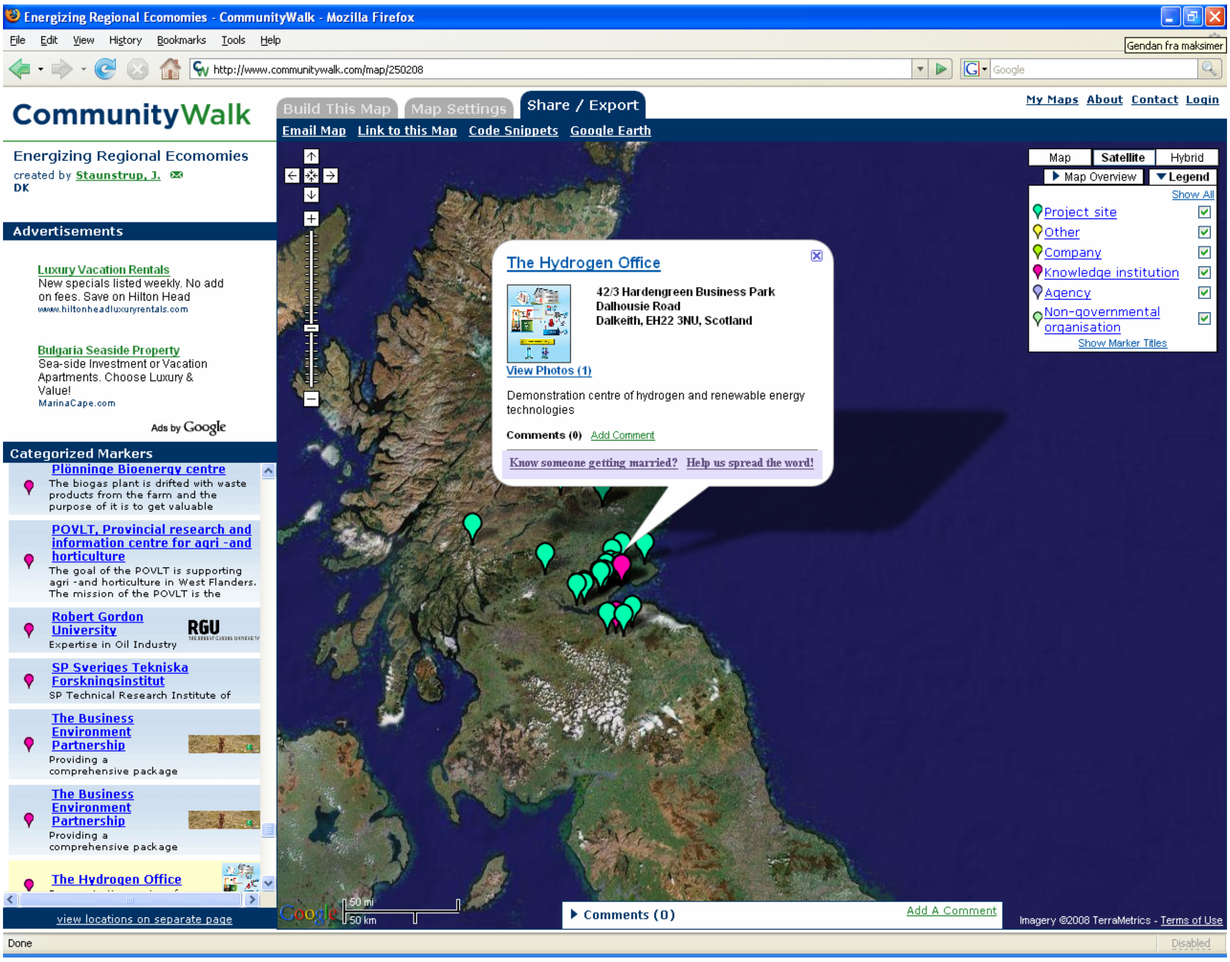

Figure 3: The first version of a points-of-interest theme using the commercial site Community-Walks.

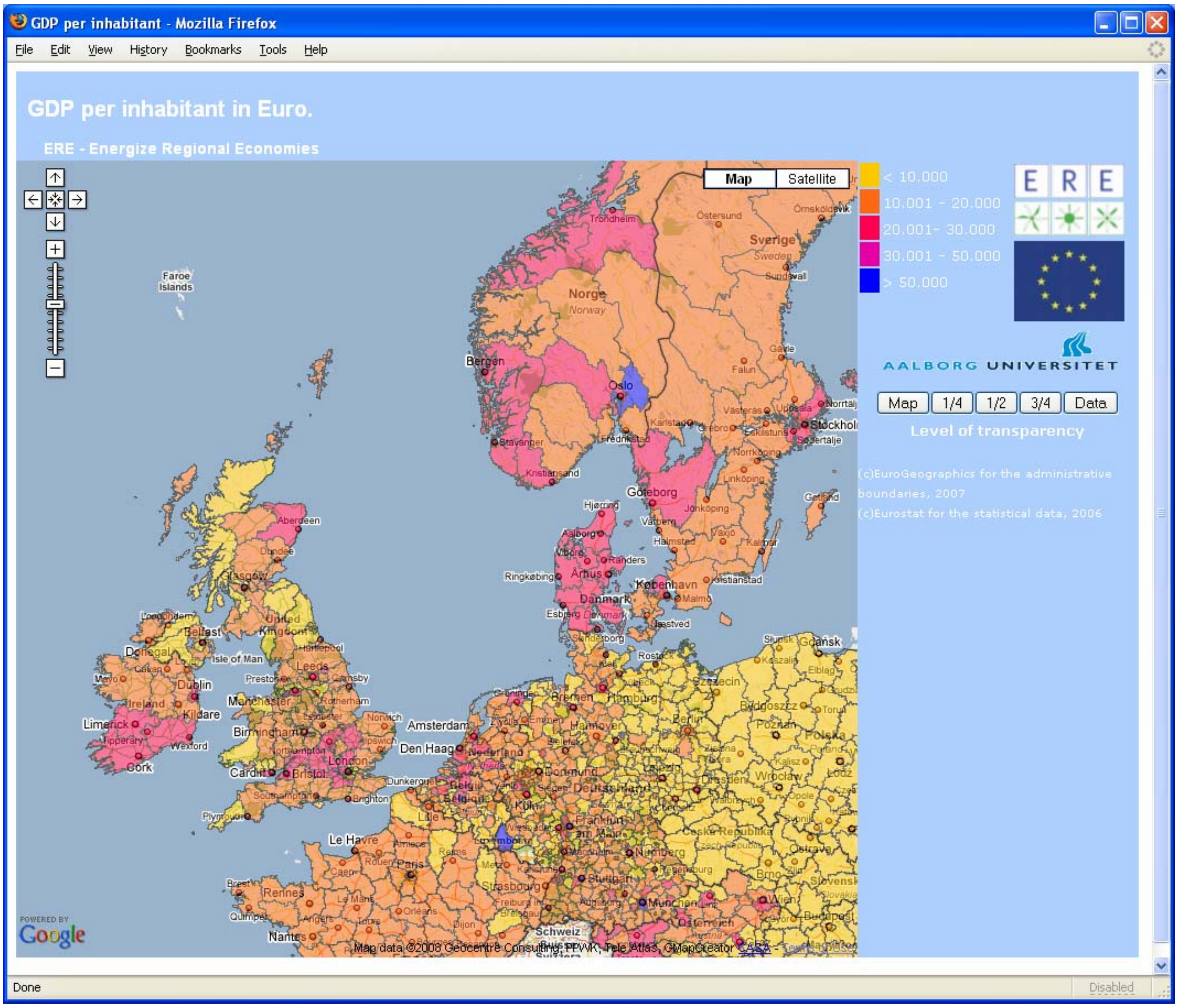

Figure 4: A GoogleMaps mash-up with statistical data from Eurostat to support regional analyses.