Renewable Energy and Regionalisation

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AMSTERDAM 10-5-2009

ABSTRACT FOR THE EUROPEAN ROUNDTABLE ON CONSUMPTION & PRODUCTION, 8-10 JUNE, AALBORG

IT IS DISCUSSED WHETHER THERE IS A SHIFT FROM FOSSIL FUELS TO RENEWABLE ENERGY IN THE EU AND HOW TO FOSTER SUCH A SHIFT REGARDING HIGHER COST. FROM MID 1990S, THE USE OF RENEWABLE ENERGY HAS GROWN IN THE EU COUNTRIES WITHOUT SIGNIFICANT IMPACT ON THE CONSUMERS' ELECTRICITY PRICES AND THE RENEWABLE ENERGY USE HAS GROWN. THE GROWTH OF RENEWABLE ENERGY PRODUCTION STRONGLY FLUCTUATES IN TIME AND THE COUNTRIES' PERFORMANCE DIVERSIFIES. THE AVAILABILITY OF RENEWABLE RESOURCES IN A COUNTRY LARGELY DETERMINES THE PERFORMANCE. NO SOLUTION FITS ALL. FIVE ASSESSMENTS OF PERIPHERY REGIONS INDICATE THAT THE PERFORMANCE ALSO DEPENDS ON GOOD ECONOMY. THE PERIPHERY REGIONS UNDERPERFORM. ASSESSMENT OF ENLARGING RENEWABLE ENERGY IN THE FRISIAN REGION IN THE NETHERLANDS SHOWS HIGH SOCIAL BENEFITS IN CASE THE POLICY REDUCES INVESTORS' RISK IN RENEWABLE ENERGY, BUT POLICYMAKERS MUST BALANCE VARIOUS PRIORITIES. EU POLICY TO FOSTER INTER-REGIONAL CO-OPERATION IN RENEWABLE ENERGY IS ADVOCATED.

KEYWORDS: RENEWABLE ENERGY, INNOVATIONS, REGIONAL DEVELOPMENT, EUROPEAN UNION

1. Introduction

THE EUROPEAN UNION (EU) POLICY AIMS AT A SHIFT FROM FOSSIL FUEL TO RENEWABLE ENERGY, WHICH REDUCES GREENHOUSE GASSES THAT CAUSE CLIMATE CHANGE (DIRECTIVE 2001/77/EC). THE ENVISAGED TYPES OF RENEWABLE ENERGY RESOURCES ARE BIOMASS AND WASTE, HYDRO-, GEOTHERMAL-, SOLAR-, AND WIND ENERGY. ELSEWHERE, HUNDREDS PUBLICATIONS CAN BE FOUND THROUGH INTERNET ABOUT *which* TECHNOLOGIES ARE AVAILABLE AND *what* ARE THE COSTS AND EFFECTS CAN BE EXPECTED (E.G. INTELLIGENT ENERGY, MANAGENERGY). IN THIS PAPER, WE FOLLOW THE QUESTION THAT IS ISSUED BY STEGER ET.AL. (2005:211-222): *how* TO CREATE THE SHIFT. THIS ISSUE IS CHALLENGING BECAUSE RENEWABLE ENERGY TECHNOLOGIES ARE GENERALLY MORE COSTLY PER ENERGY OUTPUT THAN THE LOWEST-COST FOSSIL FUEL TECHNOLOGIES (EU, 2008) AND THE EU COUNTRIES' SUBSIDIES FOR FOSSIL FUELS WERE MANIFOLD LARGER THAN THE ONES FOR RENEWABLE ENERGY (EEA, 2004). IN THE MAINSTREAM VIEW IS COMMONLY ARGUED THAT THE LOWEST-COST TECHNOLOGIES PREVAIL UNDER COMPETITION, WHICH IMPLIES THAT THE RENEWABLE ENERGY PRODUCTION WOULD STAGNATE (EU POLICY, THEREFORE, SHOULD PRICE THE GREENHOUSE GASSES AND PROMOTE OF RENEWABLE ENERGY). NEVERTHELESS, LOCAL INITIATIVES ARE MUSHROOMING SUCH AS THE COMMUNITY BIOMASS AND WIND POWER, REGIONAL HYDRO ENERGY SYSTEMS, SOLAR AND

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geothermic energy for housing, solar energy products and so on. Other arguments apparently matter like, independence, flexibility, social cohesion, environment, jobs and others.

The starting point in this paper is that the entry of costly innovations under technological rivalry can be explained with regard to the mainstream view. It is argued that innovations have two effects on output. One effect is the cost reduction as function of production, which is commonly acknowledged. The second effect is that innovations can introduce higher grade outputs. The higher grade outputs can be, for example, changing of supplies to improve local resource utilization, tuning to the specific market appreciations, as well as serving the non-market values such as environmental quality (Helpman, 2006; Krozer 2008). It can be argued that the higher grade outputs in the energy system are only incidental. The question, therefore, is whether the EU countries have increased renewable energy use and production at a reasonable cost and whether the regions that are considered relatively poor in a country have performed well. Answers are based on the growth data in the EU countries using the Eurostat statistics and the performance in five periphery regions in five EU countries. The countries' energy systems and the renewable energy technologies are considered black-box. We don't claim final conclusions but underpin hypotheses for validation. The effect of renewable energy on the consumers' electricity prices is discussed in section 2, the growth and diversification in section 3, the energy performance of the region in section 4 and regional benefits in section 5. The paper ends with conclusions.

2. Renewable energy use

The main output of renewable energy is electricity that is largely sold to grid. It can be expected that the consumers' electricity prices increase in line with the larger use of renewable energy in grid because of its high costs, but it is shown that the renewable energy growth has low impact on the prices. The share of renewable energy in electricity consumption in 2007 and the annual growth of this share between 2003 and 2007 are correlated with respectively the consumers' electricity prices and the annual price changes. All prices are excluding taxes. Table 1 present the EU 27 countries in the nomenclature order in column 1, the share and the annual average growth in columns 2 and 3, and the correlations in columns 4 and 5. The correlations are only for the period 2004-2007 because the consumers' electricity prices before 2004 are not consistent for all EU countries. It is not an essential limitation because the renewable energy use has mainly grown in the latest years. The correlations above 0.9 indicate a direct link between the prices and the renewable energy use.

In 2007, the EU (27) as a whole has had 16% share of renewable energy use in the total electricity consumption but there are large differences between the countries. The leading countries in descending order of this share are: Austria, Sweden, Latvia, Portugal, Denmark, Finland, Romania, Slovenia, Spain and Slovakia.

THE HIGHEST SHARE GROWTH IS ACHIEVED IN HUNGARY, ESTONIA, BELGIUM AND THE NETHERLANDS BUT THESE COUNTRIES LAG FAR BEHIND THE EU SHARE. HIGH GROWTH IS ALSO ACHIEVED IN GERMANY WHOSE SHARE APPROXIMATES THE EU SHARE. THE CORRELATION BETWEEN THE SHARE AND THE PRICES IS NEGATIVE FOR A FEW LEADING COUNTRIES (AUSTRIA, SLOVENIA AND SLOVAKIA) AND LOW FOR A FEW OTHER LEADING COUNTRIES (SWEDEN, LATVIA, PORTUGAL, DENMARK, FINLAND ROMANIA AND SPAIN). IT IS ONLY CORRELATED FOR GERMANY BUT BELOW 0.9. IN OTHER COUNTRIES THE CORRELATION IS LOW. HIGH CORRELATION BETWEEN THE ANNUAL SHARE GROWTH AND THE ANNUAL PRICE CHANGES IS FOUND FOR ESTONIA THAT HARDLY USES THE RENEWABLE ENERGY, BUT ALSO FOR SPAIN WITH LOWER GROWTH BUT HIGH SHARE AND EVEN FOR AUSTRIA WITH THE HIGH BUT DECREASING SHARE. A NEGATIVE CORRELATION IS FOR 11 OUT OF 27 COUNTRIES. THE FINDINGS INDICATE THAT THE HIGH SHARE AND THE HIGH GROWTH OF RENEWABLE ENERGY USE HAVE HARDLY AN IMPACT ON THE CONSUMERS' ELECTRICITY PRICES.

Table 1 Share of renewable energy in total electricity consumption, annual growth of the renewable consumption and correlation with the consumers electricity prices during the years 2003-2007				
	Empirical data		Correlations: ( ) means negative	
	Share 2007	Growth share 2003-2007	Share with prices during 2003-2007	Growth share with price change 2005-2007
EU 27 countries	16%	1.7%	7.8%	N.A.
Belgium	4%	7.4%	0.89	(0.96)
Bulgaria	8%	1.9%	0.63	(0.69)
Czech Republic	5%	0.2%	0.65	0.33
Denmark	29%	3.3%	0.44	(0.43)
Germany	15%	5.4%	0.67	(0.89)
Estonia	2%	9.5%	0.99	0.98
Ireland	9%	4.7%	0.73	0.24
Greece	7%	0.8%	0.58	(0.98)
Spain	20%	3.2%	0.34	0.91
France	13%	-0.3%	(0.20)	0.36
Italy	14%	-0.4%	(0.66)	(0.06)
Cyprus	0%	0.0%	N.A.	N.A.
Latvia	36%	-0.7%	0.13	0.20
Lithuania	5%	3.2%	0.66	0.87
Luxembourg	4%	2.4%	0.89	(0.90)
Hungary	5%	16.4%	0.82	0.43
Malta	0%	0.0%	N.A.	N.A.
Netherlands	8%	6.5%	0.89	0.55
Austria	60%	-0.9%	(0.90)	0.93
Poland	4%	4.9%	0.93	0.48
Portugal	30%	3.2%	0.27	0.31
Romania	27%	-1.2%	0.09	(0.52)
Slovenia	22%	-1.2%	(0.56)	0.61
Slovakia	17%	-1.3%	(0.33)	0.87
Finland	26%	0.8%	0.38	(1.00)
Sweden	52%	0.9%	0.09	(0.56)
United Kingdom	5%	4.9%	(0.01)	(0.82)

How to explain the low impact? This low impact cannot be explained by changes in the countries' energy use and in their fossil fuels production. In Appendix 1, the average annual growth of energy use and fossil fuel production during 1995-2006 are shown. The fastest reduction of the energy use has occurred in the transition economies of Bulgaria, Estonia, Latvia, Lithuania, Poland, Romania and Slovakia, as well as in Ireland but only Latvia leads in the renewable energy use. Most countries have also reduced their fossil fuel production but Denmark with the high renewable energy share in its electricity consumption has increased the fossil fuels production, while Latvia with the larger share has decreased the fossil fuels production, as well as Ireland with the low share. It can be hypothesized that the growth of Gross National Product (GNP) per capita enables to increase the

RENEWABLE ENERGY SHARE BUT THESE TWO ARE NOT CORRELATED. SUBSIDIES COULD REDUCE THE IMPACT OF RENEWABLE ENERGY ON THE CONSUMERS' ELECTRICITY PRICES BUT THIS ARGUMENT IS ALSO RATHER UNCONVINCING BECAUSE SUCH SUBSIDIES IN DENMARK, GERMANY, SPAIN AND SWEDEN DID NOT PROVIDE HIGH GROWTH OF THE RENEWABLE ENERGY IN THEIR ELECTRICITY CONSUMPTION. A MORE CONVINCING HYPOTHESIS IS THAT THE GROWING RENEWABLE ENERGY USE INVOKES A MORE EFFECTIVE USE OF THE COUNTRIES' ENERGY RESOURCES. THIS DIMS THE IMPACT OF THE COSTLY RENEWABLE ENERGY USE ON THE PRICES. SUCH A MORE EFFECTIVE USE CAN BE, FOR EXAMPLE, OPTIMIZATION OF RESOURCES MIX (BACKWARD LINKAGES) AND TUNING TO THE CUSTOMERS' DEMANDS (FORWARD LINKAGES). THE INNOVATIVE RENEWABLE TECHNOLOGIES COULD, THEREFORE, DIMINISH IMPERFECTIONS IN THE COUNTRIES' ENERGY SYSTEMS.

3. Renewable energy production

THE HYPOTHESIS THAT THE ENTRY OF INNOVATIVE RENEWABLE ENERGY TECHNOLOGIES CONTRIBUTES TO A MORE EFFECTIVE USE OF THE COUNTRIES' ENERGY RESOURCES IS DISCUSSED. THE FOLLOWING ASSUMPTION IS MADE. IF THE RENEWABLE ENERGY TECHNOLOGIES ARE ONLY CONSIDERED ON COSTS THE CHEAPEST TECHNOLOGY WOULD DISSEMINATE IN THE EU COUNTRIES. THE COUNTRIES' RENEWABLE ENERGY PRODUCTION WOULD STEADILY GROW AND ONE TYPE OF THE RENEWABLE ENERGY RESOURCE WOULD DOMINATE. HOWEVER, IF THE RENEWABLE ENERGY TECHNOLOGIES ADD VALUE TO THE COUNTRIES' ENERGY SYSTEM THE GROWTH WOULD FLUCTUATE DEPENDING ON TEMPORARY NEEDS AND THE GROWTH WOULD INCREASINGLY DIFFER AMONG THE COUNTRIES AND PER TYPE OF RENEWABLE RESOURCE DEPENDING ON THE SPECIFIC COUNTRY'S ENERGY SYSTEMS. THE GROWTH OF RENEWABLE ENERGY PRODUCTION IN THE EU COUNTRIES IS ASSESSED FOR THE PERIOD 1996-2006 AND IT IS DIVIDED INTO SUB-PERIODS 1995-2001 AND 2002-2006 TO INDICATE FLUCTUATIONS AND TRENDS. STANDARD DEVIATION OF THE COUNTRIES' GROWTH RATE IN RENEWABLE ENERGY PRODUCTION IS USED AS THE YARDSTICK FOR THE CONVERGENCE, OR DIVERGENCE TREND. IT MEANS: THE LARGER THE DIFFERENCES BETWEEN THE COUNTRIES' GROWTH RATES THE LARGER STANDARD DEVIATION. THE DIVERGENCE TREND IS WHEN THE DIFFERENCES INCREASE OVER TIME THAT IS THE STANDARD DEVIATION ENLARGES IN THE SUBSEQUENT SUB-PERIODS. BASIC DATA IS IN APPENDIX 1.

IN THE EU, THE MAIN RESOURCES FOR THE RENEWABLE ENERGY PRODUCTION ARE BIOMASS AND WASTE (69%), FOLLOWED BY THE HYDRO ENERGY (21%), WHILST GEOTHERMIC, SOLAR AND WIND HAVE SMALL SHARE. ALL TYPES OF THE RENEWABLE ENERGY PRODUCTION GROW, EXCEPT HYDROPOWER. THE HIGHEST PRODUCTION IN DESCENDING ORDER IS ACHIEVED IN SWEDEN, LATVIA, FINLAND, ESTONIA, AUSTRIA AND PORTUGAL (ESTONIA IS A LARGE PRODUCER BUT LOW USER). THE LAGGARDS IN DESCENDING ORDER ARE UNITED KINGDOM, NETHERLANDS AND POLAND; THESE ARE THE MAJOR FOSSIL FUEL PRODUCERS.

THE GROWTH OF THE RENEWABLE ENERGY PRODUCTION IS ACHIEVED IN ALL COUNTRIES, EXCEPT FRANCE AND SWEDEN. THE GROWTH STRONGLY FLUCTUATES BETWEEN THE COUNTRIES AND IN THE SUBSEQUENT SUB-PERIODS. NO COUNTRY HAS ACHIEVED STEADY GROWTH OF RENEWABLE ENERGY PRODUCTION ABOVE 5% DURING ALL TEN YEARS (NEEDED TO ACHIEVE 20% RENEWABLE ENERGY USE IN THE EU BY 2020 COMPARED TO 2000). THE COUNTRIES' GROWTH IS SHOWN IN TABLE 2: THE ANNUAL AVERAGE GROWTH OF THE RENEWABLE ENERGY PRODUCTION IN

THE EU IN COLUMN 1, THE STANDARD DEVIATION OF THE COUNTRIES' GROWTH IN THE PERIOD 1996-2006 IN COLUMN 2 AND THE STANDARD DEVIATION OF THE COUNTRIES' GROWTH IN THE SUB-PERIODS. THESE DATA IS GIVEN FOR THE ENERGY USE PER EURO GNP AND THE TOTAL FOSSIL FUELS USE TO COMPARE WITH THE DATA ON THE RENEWABLE ENERGY PRODUCTION.

THE ENERGY USE DECREASES BY ABOUT 1% A YEAR IN ALMOST ALL COUNTRIES; IT IS AN EU TREND AS THE STANDARD DEVIATION IS LOW. THE TOTAL FOSSIL FUEL USE ALSO DECREASES BY ABOUT 1% A YEAR ALBEIT THE DIFFERENCES BETWEEN THE COUNTRIES ARE LARGER; STANDARD DEVIATION IS LARGER COMPARED TO THE ENERGY USE. THE COUNTRIES EVOLVE IN THE SAME DIRECTION; STANDARD DEVIATION IN THE SUBSEQUENT SUB-PERIODS IS ALMOST THE SAME. THIS IS VERY DIFFERENT FOR THE GROWTH OF THE RENEWABLE ENERGY PRODUCTION. THE ANNUAL AVERAGE GROWTH OF THE RENEWABLE ENERGY PRODUCTION INCREASINGLY DIVERGES AMONG COUNTRIES AND THE STANDARD DEVIATION ENLARGES IN THE SUBSEQUENT PERIOD. A SIMILAR TREND IS WITH RESPECT TO THE TYPES OF THE RESOURCES FOR THE RENEWABLE ENERGY PRODUCTION. THE STANDARD DEVIATION IS LARGE AND IT INCREASES IN THE SUBSEQUENT SUB-PERIODS. WIND ENERGY PRODUCTION IS AN EXCEPTION BUT THERE ARE LARGE DIFFERENCES BETWEEN THE COUNTRIES; THE LARGEST STANDARD DEVIATION INDICATES THIS.

TABLE 2 GROWTH OF ENERGY USE IN THE EU27 AND STANDARD DEVIATION BETWEEN THE EU COUNTRIES.

	GROWTH ANNUAL AVERAGE EU (27)	STANDARD DEVIATION OF COUNTRIES AVERAGE ANNUAL GROWTH		
	1996-2006	1996-2006	1996-2001	2002-2006
INTENSITY, T.O.E. PER € MLN GDP	(0.01)	0.008	0.009	0.010
FOSSIL FUEL PRIMAIRY PRODUCTION	(0.01)	0.027	0.027	0.030
RENEWABLE PRODUCTION TOTAL	0.02	0.032	0.014	0.026
BIOMASS&WASTE	0.02	0.020	0.025	0.031
HYDRO	(0.00)	0.010	0.025	0.038
GEOTHERMAL	0.02	0.036	0.048	0.058
SOLAR	0.05	0.027	0.025	0.035
WIND	0.12	0.075	0.099	0.083

THE ASSESSMENT UNDERPINS THE HYPOTHESIS THAT THE USE OF THE RENEWABLE ENERGY TECHNOLOGIES IS NOT SOLELY A COST BUT ALSO A VALUE ADDED IN THE COUNTRIES ENERGY SYSTEM. IT CAN BE A TEMPORARY COST BUT IT ALSO PROVIDES BENEFITS. IT HAS POLICY IMPLICATIONS. FIRSTLY, THE SUCCESS OF THE EU POLICY LARGELY DEPENDS ON THE COUNTRIES' CAPABILITIES TO EMPLOY RENEWABLE ENERGY TECHNOLOGIES FOR A MORE EFFECTIVE ENERGY SYSTEM. SUBSIDIES CAN HELP TO DEVELOP SUCH CAPABILITIES, WHICH INVOKE THE GROWTH OF THE RENEWABLE ENERGY PRODUCTION, BUT THE SUBSIDIES ARE APPARENTLY INSUFFICIENT TO MAINTAIN THE HIGH GROWTH RATES DURING MANY YEARS. SECONDLY, THE TREND IN THE EU IS TOWARDS THE DIVERSIFICATION OF THE RENEWABLE ENERGY PRODUCTION WITH RESPECT TO THE LOCAL RESOURCES, WHICH MEANS THAT POLICYMAKERS FACE A VARIETY OF COUNTRIES' APPROACHES. THERE IS NO RENEWABLE ENERGY TECHNOLOGY STANDARD THAT FITS ALL SITUATION NOR THE STANDARD COSTS AND EFFECTS IN THE USE OF THESE TECHNOLOGIES BUT WIDE, POSSIBLY EVEN WIDENING, RANGES SHOULD BE EXPECTED. MOREOVER, THIS DIVERSIFICATION SHOULD BE FOSTERED IN THE EU POLICY BECAUSE IT CREATES POSSIBILITIES TO USE THE SPECIFIC COUNTRIES' ENERGY RESOURCES MORE EFFECTIVELY.

4. **Diversification in the regional renewable energy**

One can expect that the renewable energy technologies emerges in the countries' regions that are in peripheries of economic activities because lower costs of labour and land in such regions facilitate the renewable energy production in such regions. The regional statistical data on the renewable energy, however, are not available to underpin this expectation. In this paper, we can only use data of the project Energizing Regional Economies (ERE), supported by the EU Interreg North Sea. The project was purposed to assess the energy use and production in five North European regions and develop a method that can benchmark the regional performance in energy systems.

Five regions have participated: Nordjylland in Denmark, Schleswig-Holstein in Germany, Fryslân in the Netherlands, Västra Götaland in Sweden and Aberdeenshire in United Kingdom. The regions are comparable on some aspects such as lowlands along sea, location in moderate climate and they are considered peripheries of the national economic centres, even though Aberdeenshire is a major oil and gas hub in United Kingdom. In this paper, we use some date to compare the region's performance with its country's performance. It should be noted that the regional data is collected by consultants, not by the statistical offices, which can cause deficiency in the assessment because of different data collection methods. Appendix 2 presents the main data with permission of the project leader that is province of Fryslân. The results, even though indicative, do not confirm the expectation that the renewable energy production emerges in the peripheries.

Table 3 shows the ratio of the regional performance to the country's performance. All data is per capita because the number of inhabitants varies, for example, Västra Götaland covers more than 31% of the Swedish population and Aberdeenshire only 0.3% of the United Kingdom population. In all regions, the regional Gross Product (GDP) per capita is lower than the national Gross Product (GNP) per capita, which confirms the periphery position of the regions except for Aberdeenshire that has nearly the same income per capita as the United Kingdom. Despite similarities in geography, climate and the economic lower performance, the differences in regional performance compared to the country's performance are striking.

Firstly, the regional energy use per capita varies from half lower of the country's energy use in Västra Götaland to one and a half time higher than the national energy use in Aberdeenshire. This difference reflects the industrial economy of Aberdeenshire compared to the other rural regions.

Secondly, the regional renewable energy use varies from two-third of the country's consumption in Schleswig-Holstein up to two and a half times higher use in Aberdeenshire. The latter is mainly connected with regional production of electricity and heat from waste processing. The regions that have low GDP per capita use less renewable energy in electricity consumption; the correlation

between the GDP per capita and the percentage renewable energy in the electricity consumption is nearly 0.9.

Thirdly, the renewable energy production per capita in the regions is far below the country's production per capita except in Aberdeenshire that is twice as high as the country's production (correlation between GDP per capita and the renewable energy production is above 0.6). For example in Västra Götaland and Fryslân, the renewable energy production per capita is 50% of the country's production per capita.

The regional renewable energy resources compared to the country's resources suggest high opportunities in wind energy. The regional wind energy production per capita is far above the country's production, except for Västra Götaland. The availability of land can explain the high wind energy production. However, the regional renewable energy production from all other resources is per capita far below the country's production except for Aberdeenshire due to its waste processing. It is remarkable that Nordjylland, Fryslân and Schleswig-Holstein, which are traditionally typical agricultural regions use less biomass energy resource compared to the country's use. Production of hydro energy is low in all regions, which can be due to the lowland geography. The regions do not produce geothermic energy. The regions produce less solar energy compared to the country even though Fryslân for example, has the highest solar influx in the Netherlands.

Table 3 Regional energy use and renewable energy production: the regional use and production divided by the national use and production

ratio region to country	Denmark	Germany	Netherlands	Sweden	United Kingdom
	Nordjylland	Schleswig-Holstein	Fryslân	Västra Götaland	Aberdeenshire
million people (region/country)	11%	2%	4%	31%	0.3%
GDP to GNP (€/capita)	0.89	0.88	0.80	0.96	1.02
Energy use (MWh/capita)	0.98	1.42	0.78	0.44	1.52
Renewable in electricity (percent)	0.67	0.76	0.88	1.64	2.55
Renewable production (MWh/capita)	0.83	0.99	0.40	0.28	2.08
Renewable production mix (MWh/capita)					
Biomass	0.65	0.41	0.19	0.38	1.70
Hydro	-	0.01	-	0.10	-
Geothermic	-	-	-	-	-
Solar	0.61	0.20	0.88	-	-
Wind	1.66	5.35	2.20	0.15	7.95

THE ASSESSMENT OF THE REGIONAL RENEWABLE ENERGY USE AND PRODUCTION COMPARED TO THE COUNTRIES' ONES SUGGEST THAT THE LOW COST OF LABOUR AND LAND IN THE PERIPHERY RARELY MATTER FOR THE RENEWABLE ENERGY PRODUCTION. ON THE CONTRARY, IT CAN BE HYPOTHESIZED THAT THE HIGH GDP PER CAPITA PROVIDES MORE OPPORTUNITIES FOR THE RENEWABLE ENERGY USE AND PRODUCTION. THIS CAN BE DUE TO CONCENTRATION OF KNOW-HOW AND BUSINESS CAPABILITIES IN THE COUNTRIES' ECONOMIC CENTRES, WHICH ENABLES MORE EFFECTIVE UTILIZATION OF THE RENEWABLE RESOURCES. AN EFFECTIVE UTILIZATION OF THE RENEWABLE RESOURCES, IN TURN, BENEFITS THE COUNTRIES' ENERGY SYSTEM. IN THE PERIPHERY REGIONS, A MAJOR INVESTMENT BOOST IN THE RENEWABLE ENERGY USE AND PRODUCTION WOULD BE NEEDED TO CREATE THE KNOW-HOW AND BUSINESS CAPACITIES THAT CAN CATCH UP WITH THE ECONOMIC CENTRES. THIS HYPOTHESIS SHOULD RECEIVE MORE ATTENTION BECAUSE TUNING OF THE REGIONAL ENERGY RESOURCES WITH THE REGIONAL KNOW-HOW AND BUSINESS CAPACITY COULD BE A IMPORTANT WAY TO INVOKE AND MAINTAIN HIGH GROWTH OF RENEWABLE ENERGY PRODUCTION AND USE.

5. Frisian investment programme

THE ISSUE IS WHETHER THE INVESTMENT BOOST IN THE RENEWABLE ENERGY USE PRODUCTION PROVIDES BENEFITS TO THE PERIPHERY REGIONS. A POSITIVE ANSWER IS BASED ON THE FRISIAN INVESTMENT PROGRAM. THE PROGRAM IS FRAMED BY THE ENERGY AGREEMENT SIGNED IN 2006 BY THE DUTCH GOVERNMENT AND THE PROVINCES OF FRYSLÂN, GRONINGEN, DRENTHE AND THE NORTHERN PART OF THE PROVINCE OF NORTH-HOLLAND. THE ENERGY AGREEMENT ENVISAGES 50 PJ OF RENEWABLE ENERGY PRODUCTION AND 5 MILLION TONS OF CO_2 EMISSION REDUCTION IN 2011. THE FRISIAN TARGETS BASED ON THE NUMBER OF INHABITANTS ARE: 13.5 PJ OF RENEWABLE ENERGY AND 1.2 MILLION TONS OF CO_2 EMISSION REDUCTION (A HUGE INCREASE COMPARED TO THE 2.8 PJ OF RENEWABLE ENERGY USE AND NO CO_2 EMISSION REDUCTION IN 2006). IT IMPLIES 21% REDUCTION OF THE FOSSIL FUEL USE, EQUIVALENT OF 100 000 ZERO-ENERGY HOUSES THAT IS ABOUT ONE THIRD OF ALL HOUSES IN THE REGION. POSSIBLE ACTIONS ARE BASED ON WORKSHOPS WITH BUSINESSES, EXPERTS AND AUTHORITIES (ABOUT 70 ORGANIZATIONS). THE ACTIONS ARE SUMMARIZED IN SCHEME 1. THE FOLLOWING IS ESTIMATED FOR EVERY ACTION: PRESENT ENERGY USE, REDUCTION OF FOSSIL FUEL USE AND THE CO_2 EMISSION REDUCTION, INVESTMENT COSTS, CAPITAL COSTS AT 4% INTEREST RATE, OPERATIONAL COSTS AND SAVINGS DUE TO LESS ENERGY USE. THIS INTEREST RATE IS USED THE NATIONAL ENVIRONMENTAL PLANS TO ASSESS THE IMPACT OF THE ENVIRONMENTAL MEASURES OF ECONOMY (ASSUMED LONG-TERM INTEREST RATE). THE RESULTS ARE SUMMARIZED IN TABLE 4.

SCHEME 1 SUMMARIZED ACTIONS IN THE ENERGY SAVING AND RENEWABLE ENERGY PROGRAM IN FRYSLÂN; ENERGY SAVING FOR CO_2 EMISSION REDUCTION (ITALICS), INVESTMENTS IN MILLIONS OF EURO (BETWEEN BRACKETS).
HOUSEHOLDS: *Insulation (447),* HEAT PUMP PLUS STORAGE (98), SOLAR BOILERS (56), *Micro co-generator (63),* PV (157), *Economy* LIGHT (17), CO_2 NEUTRAL DWELLING (168)
TRANSPORT: *Cars 50 bio-fuel & gas stations (15),* HYBRID CARS (81), *Gas for gasoline (244),* SNG (244), CBG (244), BIO-DIESEL (49), *EU CO2 standard (98)*
INDUSTRIES: WIND ENERGY ON INDUSTRIAL PARKS ON LAND (70), CLOSED GREENHOUSES (68), OTHER (11)
BIOFUELS: INCINERATION FOR ELECTRICITY AND HEAT (150), THREE TECHNOLOGIES FOR BIO-FUELS (331), OTHER

(5)

Table 4 Summary of the results of investment energy program in Fryslân without interest and without subsidies

Summary	Total fossil reduction in PJ		CO_2 emission reduction	Investments in € mln		Annual costs (savings between brackets)
	Total	of which renewable	Mln tons	Total	of which renewable	in mln euros
Households	8,1	4,2	0,475	1.016	478	110 (-10)
Cars mobility	16,3	9,1	0,941	974	244	136 (110)
Industries	3,8	3,8	0,223	70	70	28 (20)
Horticulture	0,2	0,2	0,017	68	68	10 (-8)
Subtotal	28,4	17,3	1,656	2128	860	275 (112)
Bio-waste to biofuels				481	481	46 (-3)
Total				2609	1341	321 (108)
Import biofuels (*)	-9,0	-9,0	-0,502	Import from Groningen and Drenthe		

* excess of bio-fuel consumption of bio-fuel in Fryslân compared to regional production

The expected result of the investments is 19.5 PJ of fossil fuel reduction, of which 8.4 PJ due to renewable energy. The program enables to catch up with the Netherlands climate and energy policy targets. About one quarter of all waste can be utilized.

There are high costs. The total expected investments are estimated to be € 2.6 billion, of which € 1.3 billion in renewable energy. The total investments of energy users are expected to be € 2.1 billion, of which € 1.34 billion in renewable energy. It means an investment of € 662 per inhabitant per year. The total expected investments of producers in the biomass and waste processing are estimated to be about € 0.5 billion. Based on 4% interest on capital, without subsidies and excluding lower energy costs due to lower fossil fuel use, the annual costs are expected to be about € 0.3 billion. There are also socio-economic benefits. The estimates of the benefits including lower energy costs due to lower fossil fuel use are based on the energy prices at the end of 2006. The net revenues approximate € 0.1 billion a year due to the savings, mainly in households. About 27,000 jobs can be created during the five years of the program. It means on average about 5,500 jobs a year, thus giving substantial job opportunities to about 30,000 unemployed people in the region in 2006. Based on indicative qualitative strength assessment, one finds about € 0.8 billion sales opportunities for the Frisian businesses. The estimates show that the program is attractive.

The challenge is as how to reach the assumed 5% interest on capital because this interest is below the commercial one. Consequently the program cannot emerge spontaneously through the market. Policymakers must find a way to invoke the investments. One possibility is to subsidize the delivery of renewable energy and energy savings technologies. The second possibility is to reduce investors' risk, which can be done through state investments at the interest that is similar to the interest for investments in infrastructure. The effect of these options on annual benefits differs. The effect is compared in the following manner. It is assumed that all actions are taken in the region. In the case of the subsidies, we have calculated with 15% interest on capital. Then, the subsidies are estimated that are needed to achieve the break-even point between the annual costs and the savings due to lower energy use (it means that the calculations are based on the assumption of perfect allocation of the costs and revenues between the sectors). The subsidy is added to the annual costs up to the break-even point. The alternative is the policy that enables 5% interest rate, which is not unusual for state loans, securities and even in mortgage. Table 5 shows the results of this comparison.

Table 5 Simulation of economic instruments in policymaking: subsidy for output and lower interest on capital

	15% interest rate with subsidy for output		5% interest rate without subsidies	
In million euros	capital costs	net revenues after savings = subsidy	capital costs	net revenues after savings
Households	179	-117	102	-40
Cars mobility	194	13	126	81
Industries	14	-3	9	14
Horticulture	14	-15	9	-10
subtotal in use	400	-122	246	44
Biofuel processing	77	-56	39	-18
Total	477	-178	285	26

In case of the commercial interest on capital about € 178 million in subsidies would be needed, particularly in housing (insulation and low-fossil use in households) and production of bio-fuels from waste. In case of the low interest on capital, the net revenues approximate € 26 million without the subsidies. The advantage of the low interest on the capital compared to the subsidies for output adds to the total of € 205 million. This outcome is due to high investments in energy saving and renewable energy use. The simulation suggests that the policy making based on subsidies is more expensive than policy making based on the low interest on capital. The latter, however, is difficult to enforce on the country's scale without distorting of the

FINANCIAL SYSTEM. THIS COULD BE DONE ON LOCAL AND REGIONAL LEVELS THROUGH THE COMMUNAL AND REGIONAL ENERGY ENTERPRISES, OR PRICE GUARANTEES.

Conclusions

THE EU POLICY AIMS AT THE SHIFT FROM FOSSIL FUEL TO RENEWABLE ENERGY BUT IT FACES HIGHER COST OF THE RENEWABLE TECHNOLOGIES THAN THE LOW-COST FOSSIL FUEL TECHNOLOGIES. NO DOUBT THAT HIGH PRICING OF GREENHOUSE GASSES AND LOWER-COST RENEWABLE TECHNOLOGIES THROUGH SUBSIDIES ARE NEEDED. THIS PAPER ADDS A PERSPECTIVE. THE STARTING POINT IS THAT INNOVATIONS CAN PROVIDE HIGHER GRADE OUTPUTS, IN THE CASE OF RENEWABLE ENERGY IMPROVEMENTS IN USE OF ENERGY RESOURCES. THE QUESTION IS POSED WHETHER DEVELOPMENTS IN THE RENEWABLE ENERGY USE AND PRODUCTION IN EUROPE INDICATE CREATION OF THE HIGHER GRADE OUTPUTS THAT ENABLE TO OVERCOME THE COSTS AND HOW TO FOSTER BETTER UTILIZATION OF THE ENERGY RESOURCES. A POSITIVE ANSWER TO THIS QUESTION, THOUGH INDICATIVE, IS BASED ON THE EU STATISTICS AND PERFORMANCE IN A FEW REGIONS.

THE USE OF RENEWABLE ENERGY IN ELECTRICITY CONSUMPTIONS INCREASES BUT IT DOES NOT LEAD TO THE HIGHER ELECTRICITY PRICES FOR CONSUMERS. THE COUNTRIES' RENEWABLE ENERGY PRODUCTION ALSO GROWS ALBEIT THE GROWTH RATE STRONGLY FLUCTUATES IN TIME AND BETWEEN THE EU COUNTRIES. MOREOVER, THE PRODUCTION GROWS STEADILY MUCH FASTER IN SOME COUNTRIES, WHICH ARE NOT NECESSARILY THE COUNTRIES WITH THE PRONOUNCED POLICY IN FAVOR OF THE RENEWABLE ENERGY. IT IS RATHER LOCAL AVAILABILITY OF THE RENEWABLE ENERGY RESOURCES THAT MATTERS. THE GROWTH OF RENEWABLE ENERGY PRODUCTION INCREASINGLY DIVERSIFIES BETWEEN COUNTRIES. SOME COUNTRIES, APPARENTLY, HAVE CREATED THE CAPACITY TO TUNE THE RENEWABLE ENERGY TECHNOLOGIES TO THEIR ENERGY SYSTEM, WHICH ENABLES A MORE STEADY PRODUCTION GROWTH. SUCH TUNING IMPROVES UTILIZATION OF THE COUNTRIES' ENERGY RESOURCES, THEREBY DIMMING THE IMPACT OF THE COSTLY RENEWABLE TECHNOLOGIES ON ELECTRICITY PRICES, OR EVEN REDUCING THE PRICES. FOR THE EU POLICY IT IMPLIES THAT ITS SUCCESS LARGELY DEPENDS ON THE COUNTRIES' CAPABILITIES TO EMPLOY THE RENEWABLE ENERGY TECHNOLOGIES EFFECTIVELY IN THEIR SPECIFIC ENERGY SYSTEM. SUBSIDIES HELP TO CREATE THE CAPABILITIES THAT INVOKE THE GROWTH, BUT THEY ARE INSUFFICIENT TO MAINTAIN THE HIGH GROWTH. FOR THE POLICYMAKERS IT IMPLIES THAT INCREASING VARIETY OF SOUND APPROACHES CAN BE FOUND, WHILST THE STANDARDS FOR RENEWABLE ENERGY TECHNOLOGIES, COSTS AND EFFECTS RATHER OBSCURE THE EFFECTIVE USES THAT ARE TUNE TO THE ENERGY RESOURCE. THE EU ACTIONS, THEREFORE, SHOULD FOSTER THE DIVERSIFICATION BECAUSE IT CREATES OPPORTUNITIES FOR THE MORE EFFECTIVE USE OF THE RENEWABLE ENERGY RESOURCES AT LOWER COSTS AND EVEN A NET BENEFIT IN MANY CASES IN COMPARISON WITH THE FOSSIL FUELS (AS LONG AS THERE IS EQUAL LEVEL PLAYING FIELD IN TERMS OF SUBSIDIES, INFRASTRUCTURE AND SO ON).

THE DIVERSIFICATION IN RENEWABLE ENERGY PRODUCTION AND USE ALSO EMERGES ON THE REGIONAL LEVEL, WHICH IS ASSESSED FOR FIVE ECONOMIC PERIPHERY REGIONS IN DENMARK, GERMANY, NETHERLANDS, SWEDEN AND UNITED KINGDOM. THE PERIPHERY REGIONS,

however, underutilize the renewable energy resources compared to the economic centers. The progress in renewable energy use and production is apparently not primarily due to the low costs of labor and land, which can be found the periphery, but rather due to the high regional know-how and business capability. It is a major challenge in the periphery regions to boost these capabilities. The major competitive factor in a periphery region is low interest on capital for the investments in renewable energy. On the regional level, the low-interest on capital can be created through the regional state and communities' enterprises and guarantees. On the EU level, in addition to the emission pricing and trading instruments, the regional initiatives can be fostered through inter-regional co-operation on the know-how and business capacity building in renewable energy production and use.

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Appendix 1 Statistical data on energy use, fossil fuels and renewable production in EU 27 countries

Table 1. Average annual growth of energy use per GNP, fossil fuel production and renewable energy production in the EU									
1995-2006	Energy use: t.o.e. per € mln GNP			Fossil fuel primary production			Renewable production total		
	1996-2006	1996-2001	2002-2006	1996-2006%	1996-2001	2002-2006	1996-2006	1996-2001	2002-2006
EU (27 countries)	-1%	-1%	-1%	-1%	0%	-1%	2%	1%	2%
Belgium	0%	0%	-1%	1%	1%	0%	3%	1%	5%
Bulgaria	-2%	-1%	-2%	0%	0%	0%	5%	5%	5%
Czech Republic	-1%	-1%	-1%	0%	0%	0%	5%	1%	10%
Denmark	-1%	-1%	0%	3%	4%	1%	3%	3%	3%
Germany	0%	0%	0%	-1%	-1%	-1%	5%	3%	6%
Estonia	-3%	-3%	-3%	0%	-1%	1%	1%	1%	1%
Ireland	-2%	-2%	-2%	-5%	-7%	-2%	4%	3%	5%
Greece	-1%	-1%	-1%	0%	0%	0%	1%	0%	3%
Spain	0%	0%	0%	-1%	0%	-1%	2%	3%	1%
France	0%	0%	-1%	0%	0%	0%	0%	0%	-1%
Italy	0%	0%	0%	-1%	-2%	-1%	2%	1%	3%
Cyprus	0%	0%	-1%	0%	0%	0%	1%	0%	1%
Latvia	-2%	-2%	-3%	-13%	-11%	-15%	1%	1%	2%
Lithuania	-3%	-2%	-3%	-1%	0%	-3%	2%	2%	2%
Luxembourg	-1%	-2%	0%	0%	0%	0%	2%	0%	4%
Hungary	-1%	-2%	-1%	-1%	-2%	-1%	3%	-2%	8%
Malta	-1%	-3%	1%	0%	0%	0%	0%	0%	0%
Netherlands	-1%	-1%	0%	0%	-1%	0%	3%	4%	2%
Austria	0%	0%	0%	0%	0%	-1%	1%	1%	0%
Poland	-2%	-3%	-1%	-1%	-2%	0%	1%	0%	2%
Portugal	0%	0%	0%	0%	0%	0%	1%	1%	1%
Romania	-2%	-2%	-2%	-1%	-1%	-1%	2%	1%	3%
Slovenia	-1%	-1%	-1%	0%	0%	1%	1%	3%	0%
Slovakia	-2%	-1%	-3%	1%	2%	0%	2%	3%	1%
Finland	-1%	-1%	0%	1%	0%	2%	1%	1%	1%
Sweden	-1%	-1%	-1%	0%	0%	-1%	0%	1%	0%
United Kingdom	-1%	-1%	-1%	-1%	0%	-3%	3%	2%	4%

Table 2 Renewable production in energy consumption and renewable energy mix						
Year 2006	total	Renewable resource in total renewable energy 2006				
		biomass	hydro	geothermal	solar	wind
EU (27 countries)	11%	69%	21%	4%	1%	6%
Belgium	3%	95%	2%	0%	0%	2%
Bulgaria	12%	66%	31%	3%	0%	0%
Czech Republic	8%	90%	10%	0%	0%	0%
Denmark	19%	81%	0%	0%	0%	18%
Germany	9%	76%	8%	1%	2%	12%
Estonia	22%	99%	0%	0%	0%	1%
Ireland	3%	52%	15%	0%	0%	33%
Greece	8%	56%	29%	1%	6%	8%
Spain	10%	55%	23%	0%	1%	21%
France	11%	70%	28%	1%	0%	1%
Italy	9%	31%	26%	41%	0%	2%
Cyprus	3%	14%		0%	86%	0%
Latvia	44%	87%	13%	0%	0%	0%
Lithuania	17%	95%	4%	0%	0%	0%
Luxembourg	2%	80%	11%	0%	3%	6%
Hungary	7%	92%	1%	7%	0%	0%
Malta	N.A.					
Netherlands	5%	89%	0%	0%	1%	10%
Austria	26%	53%	43%	0%	1%	2%
Poland	8%	96%	3%	0%	0%	0%
Portugal	23%	70%	22%	2%	1%	6%
Romania	20%	67%	33%	0%	0%	0%
Slovenia	16%	60%	40%	0%	0%	0%
Slovakia	8%	57%	43%	1%	0%	0%
Finland	32%	88%	11%	0%	0%	0%
Sweden	45%	64%	36%	0%	0%	1%
United Kingdom	3%	80%	10%	0%	1%	9%

Table 3 Annual average growth of the renewable energy production total and by resource									
	Renewable energy growth			Biomass & Waste growth			Hydro growth		
	1996-2006	1996-2001	2002-2006	1995-2006	1996-2001	2002-2006	1995-2006	1996-2001	2002-2006
EU 27 countries	2%	1%	2%	2%	1%	3%	0%	1%	-2%
Belgium	3%	1%	5%	3%	1%	5%	0%	2%	-2%
Bulgaria	5%	5%	5%	5%	7%	3%	3%	0%	8%
Czech Republic	5%	1%	10%	6%	1%	12%	1%	0%	2%
Denmark	3%	3%	3%	2%	2%	2%	-2%	-3%	0%
Germany	5%	3%	6%	5%	4%	7%	0%	0%	-1%
Estonia	1%	1%	1%	1%	1%	1%	0%	0%	0%
Ireland	4%	3%	5%	3%	4%	3%	0%	-1%	2%
Greece	1%	0%	3%	0%	1%	0%	2%	-4%	9%
Spain	2%	3%	1%	1%	1%	2%	0%	4%	-4%
France	0%	0%	-1%	0%	0%	0%	-1%	0%	-3%
Italy	2%	1%	3%	5%	3%	7%	0%	2%	-2%
Cyprus	1%	0%	1%	-2%	-1%	-3%	0%	0%	0%
Latvia	1%	1%	2%	1%	1%	2%	0%	0%	0%
Lithuania	2%	2%	2%	2%	2%	2%	0%	-1%	2%
Luxembourg	2%	0%	4%	2%	1%	3%	1%	-9%	13%
Hungary	3%	-2%	8%	3%	-2%	10%	1%	1%	0%
Malta									
Netherlands	3%	4%	2%	3%	3%	2%	0%	2%	-1%
Austria	1%	1%	0%	1%	2%	1%	0%	1%	-1%
Poland	1%	0%	2%	1%	0%	2%	0%	2%	-1%
Portugal	1%	1%	1%	1%	0%	1%	1%	4%	-2%
Romania	2%	1%	3%	3%	3%	4%	0%	-1%	2%
Slovenia	1%	3%	0%	2%	4%	0%	0%	1%	0%
Slovakia	2%	3%	1%	7%	11%	3%	0%	0%	-1%
Finland	1%	1%	1%	2%	2%	2%	0%	0%	-1%
Sweden	0%	1%	0%	1%	0%	2%	0%	1%	-2%
United Kingdom	3%	2%	4%	3%	2%	4%	0%	-1%	1%

TABLE 3 CONTINUED									
	GEOTHERMAL GROWTH			SOLAR GROWTH			WIND GROWTH		
	1995-2006	1996-2001	2002-2006	1995-2006	1996-2001	2002-2006	1995-2006	1996-2001	2002-2006
EU (27 COUNTRIES)	2%	0%	4%	5%	4%	6%	12%	14%	10%
BELGIUM	3%	10%	-6%	4%	0%	10%	14%	8%	20%
BULGARIA	0%	0%	0%	0%	0%	0%	0%	0%	0%
CZECH REPUBLIC	0%	0%	0%	2%	0%	4%	5%	0%	12%
DENMARK	7%	3%	12%	3%	3%	2%	7%	9%	3%
GERMANY	12%	19%	3%	10%	9%	10%	11%	13%	9%
ESTONIA	0%	0%	0%	0%	0%	0%	8%	0%	17%
IRELAND	0%	0%	0%	0%	0%	0%	19%	24%	14%
GREECE	5%	-3%	15%	1%	1%	1%	15%	22%	7%
SPAIN	4%	7%	0%	5%	3%	7%	18%	24%	10%
FRANCE	0%	-1%	2%	3%	2%	4%	21%	17%	25%
ITALY	2%	0%	4%	6%	4%	9%	22%	33%	8%
CYPRUS	0%	0%	0%	1%	1%	2%	0%	0%	0%
LATVIA	0%	0%	0%	0%	0%	0%	5%	0%	12%
LITHUANIA	-6%	0%	-13%	0%	0%	0%	0%	0%	0%
LUXEMBOURG	0%	0%	0%	0%	0%	0%	6%	5%	8%
HUNGARY	0%	0%	0%	3%	0%	6%	0%	0%	0%
MALTA									
NETHERLANDS	0%	0%	0%	7%	7%	6%	9%	7%	10%
AUSTRIA	10%	11%	8%	4%	4%	4%	17%	15%	20%
POLAND	6%	0%	13%	0%	0%	0%	12%	0%	27%
PORTUGAL	3%	4%	3%	2%	2%	2%	22%	22%	21%
ROMANIA	3%	-3%	11%	0%	0%	0%	0%	0%	0%
SLOVENIA	0%	0%	0%	0%	0%	0%	0%	0%	0%
SLOVAKIA	-2%	0%	-4%	0%	0%	0%	0%	0%	0%
FINLAND	0%	0%	0%	0%	0%	0%	10%	13%	7%
SWEDEN	0%	0%	0%	1%	1%	0%	9%	11%	6%
UNITED KINGDOM	0%	0%	0%	7%	6%	9%	9%	6%	13%

Appendix 2 Economic and energy data on five regions in North Europe

THE TABLE SHOWS BASIC DATA ON FIVE REGIONS IN NORTH EUROPE. THE DEFINITIONS OF THE REGIONS IN THE EUROSTAT DATABASE AND IN THE ERE RESEARCH MATCH NORDJYLLAND, SCHLESWIG-HOLSTEIN AND FRYSLÂN. THERE ARE DIFFERENCES FOR VÄSTRA GÖTALAND AND ABERDEENSHIRE IN THE ERE PROJECT. T THAT ARE SMALLER AREAS THAN RESPECTIVELY VÄSTSVERIGE AND EASTERN SCOTLAND IN EUROSTAT DATA. IN THESE CASES IT IS ASSUMED THAT THE GNP PER CAPITA ARE EQUAL.

ECONOMIC DATA AND ENERGY CONSUMPTION		DENEMARKEN	DUITSLAND	NEDERLAND	ZWEDEN	UK
NUTS REGION BY NAME		NORDJYLLAND	SCHLESWIG-HOLSTEIN	FRIESLAND (NL)	VÄSTSVERIGE	EASTERN SCOTLAND
NUTS REGION BY CODE		DK05	DEF0	NL12	SE23	UKM2
NAME IN RESEARCH		NORDJYLLAND	SCHLESWIG-HOLSTEIN	FRYSLÂN	VÄSTRA GÖTALAND	ABERDEENSHIRE
COUNTRY	POPULATION MLN CAPITA	5.4	82.4	16.3	9.0	60.4
REGION		0.58	1.52	0.64	2.83	0.21
REGION TO COUNTRY		11%	2%	4%	31%	0.3%
COUNTRY	GNP, GDP, €/CAP.	40,229	28,161	33,055	34,644	32,106
REGION		35,777	24,685	26,514	33,348	32,883
REGION TO COUNTRY		0.89	0.88	0.80	0.96	1.02
COUNTRY	FINAL ENERGY CONSUMPTION, MWH/CAP	33.5	31.5	36.2	42.7	29.0
REGION		32.7	44.7	28.4	18.8	44.1
REGION TO COUNTRY		0.98	1.42	0.78	0.44	1.52
COUNTRY	RENEWABLE ENERGY IN ELECTRICITY PRODUCTION %	26%	12%	8%	48%	5%
REGION		17%	9%	7%	79%	12%
REGION TO COUNTRY		0.67	0.76	0.88	1.64	2.55
RENEWABLE ENERGY PRODUCTION		DENEMARKEN	DUITSLAND	NEDERLAND	ZWEDEN	UK
COUNTRY	RENEWABLE ENERGY PRODUCTION MWH/CAP	6.3	3.0	1.7	19.0	0.8
REGION		5.2	2.9	0.7	5.2	1.6
REGION TO COUNTRY		0.83	0.99	0.40	0.28	2.08
COUNTRY	BIOMASS PRODUCTION MWH/CAPITA	5.16	2.28	1.51	12.10	0.63
REGION		3.35	0.94	0.29	4.55	1.06
REGION TO COUNTRY		0.65	0.41	0.19	0.38	1.70
COUNTRY	HYDRO MWH/CAPITA	0.00	0.24	0.01	6.82	0.63

Region		0	0.003	0	0.67	0
Region to country		-	0.01	-	0.10	-
Country	Solar MWh/capita	0.02	0.07	0.02	0.01	0.01
Region		0.013	0.013	0.014	0	0
Region to country		0.61	0.20	0.88	-	-
Country	Wind MWh/capita	1.12	0.37	0.17	0.11	0.07
Region		1.87	1.99	0.37	0.02	0.56
Region to country		1.66	5.35	2.20	0.15	7.95