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Renewable generation data and policy within selected EU countries

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The following paper compares the renewable energy development policies utilised in Denmark, Finland, Germany and the UK. The focus of the paper is 'newer' renewable technologies rather than large-scale hydro which have been ruled out as an option for Northern Ireland.

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Key Points

A number of key themes emerge from the analysis below:

Early moves to develop renewable policy and a long-term and stable approach to financial incentives through robust Feed-in tariffs, local/SME, small-scale ownership and financial support of R&D are traits common to Demark and Germany's successful development of renewable energy.

The UK has employed a variety of market based techniques to fund renewables growth. Such techniques, which offer variable revenue streams, have not stimulated the same levels of investor confidence that exists in regions operating a Feed-in tariff. The UK has also faced a major barrier in local opposition to renewable technologies.

Finland's financial model – based on tax exemption and subsidy – has resulted in a less pronounced penetration of 'newer' renewable sources but the region has done so in a cost-effective manner.

Other common aspects of the four regional policies examined are:

- Tailored energy efficiency policy – in Denmark this has seen an effort to decouple productivity growth and energy use;
- Separate policies for renewable electricity, renewable heat and renewable transport;
- The promotion of combined heat and power; and
- The funding of R&D in renewable technology.

Executive Summary

The following paper compares the renewable energy development policies utilised in Denmark, Finland, Germany and the UK. The focus of the paper is on 'newer' renewable technologies rather than large-scale hydro generation, which has been ruled out as an option for Northern Ireland.

Key aspects of renewable development in **Denmark** include:

- a long-history of renewable energy development, as a result of the 1970s oil crisis, no known (at the time) indigenous sources of oil, coal or hydro power and no public support for nuclear power;
- an established district heating system which could be transformed to renewable energy generation, encouraging the development of a **decentralised energy system**;
- a long-standing Feed-in tariff that has offered security to investors and encouraged a variety of investors into the market – most significantly small-scale investors;
- a local community ownership model that has helped to overcome planning objections associated with renewable technology;
- guaranteed grid access – removing barriers to market;
- investment subsidies;
- high levels of interconnection, which has helped to counter the intermittency associated with renewable generation;
- a strong research and development programme which has led to technology efficiencies and has facilitated growth in the export market; and
- an energy efficiency programme that has included high energy taxes and information campaigns, energy saving obligations, and building requirements.

Significantly, Denmark's renewable energy policy has not been constant. In 2001 a change of government led to a radical change in policy and a free-market approach to financing the industry was adopted. The existing FIT made way for a market-dependent FIT. As a result of this the rate at which new wind turbines were installed slowed considerably. Such policy decisions have been, to an extent, reversed in the pursuit of 100% renewables target.

The growth of renewables in **Germany** has had the following features:

- a long-history of renewable energy development, as a result of the 1970s oil crisis;
- early public acceptance of renewables influenced by the Chernobyl disaster and an awareness of climate change;
- the early introduction of a Feed-in tariff that has been adapted and refined since introduction. The Feed-in tariff has displayed the same benefits experienced in the Danish model;

- a strong financial commitment to R&D;
- investment subsidies and interest free loans;
- Measures that privileged wind turbines in the construction code;
- training programmes for architects;
- public information programmes;
- guaranteed grid access;
- a commitment to energy efficiency;
- an ecological tax;
- financial assistance to renewable heating (€200m, c2004);
- dedicated renewable transport policy, that includes tax exemption and a quota system; and
- Renewable Energies Export Initiative.

Most recently Germany has committed to grid improvements and has introduced the introduction of the Heat Act, which outlines measures to secure 14% of renewables in the heating mix by 2020.

Finland has adopted a different approach to renewable development. The region has opted for investment subsidies and tax incentives rather than a Feed-in tariff. The International Energy Agency has commented that whilst Finland's policy is *typically targeted and limited in scale,* their overall policy has been marked by a *'cost effective approach'.*

The growth of renewables in Finland is also unique amongst the regions examined as the region has access to significant amounts of large-scale hydro generation. The region has also developed nuclear power.

Other key aspects of Finnish policy have included:

- Guaranteed grid access;
- Financial support for R&D - €15m, 2007;
- A Legislative obligation on oil companies to include minimum shares of biofuels in their sales of transport fuel;
- Support for energy wood harvesting and chipping to encourage forest owners to supply wood residues to energy markets;
- Support for energy investment targeted towards the agricultural sector specifically;
- Information campaigns to increase public motivation;
- An energy efficiency programme based on voluntary agreements designed to target specific sectors;
- Energy audits to assess delivery on voluntary agreements;

- The establishment of Energy Service Companies with a remit to carry out auditing of efficiency plans, implement the plans and financing the efforts on behalf of a client; and
- The development of a renewable fired district heating system.

Looking forward, Finland plans to follow the lead of Denmark and Germany by introducing a Feed-in tariff from January 2011.

The previous **UK** Government, Cambridge University's Electricity Policy Research Group and Greenpeace, have identified short-comings in UK environmental policy.

In the case of the former, the 2007 White Paper on Energy recognised that current UK policy (at the time) would only secure 5% renewable penetration in the final energy consumption by 2020 – the UK target is 15%.

Two key factors have been identified as contributing to the UK's failure to effectively exploit the renewable resources theoretically available to the region.

Firstly, the literature suggests that the region's decision to utilise a market-dependent financial model to incentivise renewable energy – the Non-Fossil Fuel Obligation between 1990 -2002 and Renewable Obligation Certificates (ROC) from 2002 to present – are partially accountable for this under-exploitation. Both mechanisms have had a negative impact on investor confidence.

The renewable obligation, in particular, has been criticised for displaying the following tendencies:

- linking the price paid for renewable energy to market fluctuations, the ROC introduces a strong degree of variability into renewable energy investment. As such, investors are may be put off RE projects due to the large upfront costs associated with development without a guaranteed return on investment;
- ROCs tend to favour producers who can *'hedge these risks effectively'*; and
- the price paid per ROC is higher when there is an under delivery. This, it is argued, has been counterproductive to renewable development.

The second major barrier in the UK has been the ability to secure planning permission. This has been largely attributed to local objections to the environmental impacts of renewable technology – particularly their visual impact and the possible knock-on effect this may have on house prices and tourism.

It has been suggested that the local ownership model that forms part of the Danish electricity system has helped to overcome such objections. By contrast, the UK financial support mechanism, which favours large-scale developers who can hedge increased risk, has not facilitated local-ownership. It has been argued that the recently introduced UK Feed-in tariff, which specifically targets microgeneration, may overcome this tendency.

Other aspects of UK policy include:

- an energy efficiency programme;
- financial support for R&D;
- a biofuel grant scheme;
- Renewable Transport Obligation (modelled on the Renewable Obligation Certificate for electricity);
- Alternative Fuel Framework 2003 which introduced tax rebates for renewable fuels (replace by the Renewable Transport Obligation); and
- The Marine Development Fund (£50m) for the development of wave and tidal power, as of 2009 no projects had been financed through the fund.

The most recently introduced policy mechanisms include:

- The UK Feed-in tariff; and
- The *Connect and Manage* proposals which will guarantee access to the grid.

The Coalition Government's Programme for Government makes a number of renewable energy commitments, including an extension of the Feed-in tariff and the creation of a green investment bank.

Contents

1 Introduction 9
2 Renewable penetration 9
3 Denmark 11
4 Germany 15
5 Finland 18
6 United Kingdom 20
6.1 Renewable Electricity 21
6.2 The problem with planning 23
6.3 Other Policy Measures 24
7 Discussion 25

Annex 1
Figure 1: Share of renewable sources in final electricity consumption (2008) 28
Figure 2: Renewable electricity shares in EU-27 and North Africa 28

Annex 2
Table 1: Energy supply and renewables - OECD Europe and selected EU Countries (2009) 29
Table 2: Installed renewable capacity by technology - OECD Europe and selected EU Countries (2008) 29

Annex 3
Table 3: Renewable share by technology - OECD Europe and selected EU Countries (2009) 30

Annex 4
Figure 3: Denmark’s Electricity Infrastructure 1985 and 2009 31

1 Introduction

The following paper compares the renewable energy development policies utilised in Denmark, Finland, Germany and the UK. The focus of the paper is ‘newer’ renewable technologies rather than large-scale hydro which have been ruled out as an option for Northern Ireland (in a 2003 Departmental commission PB Power assessment of Northern Ireland’s renewable recourse).

2 Renewable penetration

Figure 1 (see Annex 1) ranks EU countries by the total share of renewable energy in final electricity consumption for 2008. Based on this information the countries with the largest renewable penetration are Austria and Sweden. However, the figure, whilst not misleading, does not present the full picture. Both Austria and Sweden’s renewables penetration include significant amounts of large-scale hydro generation. Hydropower is a legitimate renewable source and is included in the EU definition of renewables, which states:

> *"energy from renewable sources" means renewable non-fossil energy sources: wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.*[i]

However, from a Northern Ireland perspective, large-scale hydropower has proven to be historically problematic. In their 2003 assessment of Northern Ireland’s renewable energy resource PB Power concluded:

> *In Northern Ireland, attempts have been made over the past 50 years to build large-scale hydro projects. These, however, did not go ahead because of environmental constraints.*[ii]

For the purposes of this paper, discussion will focus on those states whose renewable energy policy has centred upon *‘newer’* technology types. Figure 2 (Annex 2) presents the renewable energy mix of the EU-27 (along with North African nations, which form part of the source analysis). Of the regions outlined in the Figure it is evident that Denmark has the greatest penetration on renewables without the use of hydropower. Germany has also a large deployment of wind and biofuels, as well as a relatively small hydro source. For this reason, the paper looks at both the policy mechanisms utilised by both these regions.

Finland’s renewable development has also been examined. It is included for a number of reasons. Firstly, the region has complimented its hydro generation with a substantial amount of biofuel generation. Secondly, the mechanisms used to stimulate renewable development differ to those employed by Denmark and Germany.

The fourth region examined in the paper is the UK. Its inclusion serves two purposes. It allows an assessment of the policy instruments that have had the largest impact on Northern Ireland's renewable development. Secondly, the region has a low level of renewable penetration despite a large theoretical, as such the UK represents an interesting case study, particularly when examined in parallel with the other regions.

Tables 1, 2 and 3 (Annex 3), provide a further data on the penetration of renewables in each region examined.[iii]

Headline data from each region includes:

Denmark:

- 2020 target for share of renewables in gross energy consumption: 30%;
- Total primary energy supply (2009): 17.84Mtoes;
- Renewables in total primary energy supply (2009): 3.22Mtoes;
- % Renewables in total primary energy supply (2009): 18%;
- Gross Electricity: 36.2TWh;
- Renewables Electricity: 9.96TWh;
- % Renewables in Gross Electricity: 27.50%;
- Largest renewable source and % of gross electricity; Wind, 18.50%

Germany:

- 2020 target for share of renewables in gross energy consumption: 18%;
- Total primary energy supply (2009): 318.33Mtoes;
- Renewables in total primary energy supply (2009): 28.88Mtoes;
- % Renewables in total primary energy supply (2009): 9.10%;
- Gross Electricity: 590.7TWh;
- Renewables Electricity: 95.27TWh;
- % Renewables in Gross Electricity: 16.10%;
- Largest renewable source and % of gross electricity; Wind, 6.3%

Finland

- 2020 target for share of renewables in gross energy consumption: 38%;
- Total primary energy supply (2009): 33Mtoes;
- Renewables in total primary energy supply (2009): 7.97Mtoes;

- % Renewables in total primary energy supply (2009): 24.10%;
- Gross Electricity: 590.7TWh;
- Renewables Electricity: 95.27TWh;
- % Renewables in Gross Electricity: 16.10%;
- Largest renewable source and % of gross electricity; Hydro, 17.75% (Biomass makes the second largest contribution 11.58% of gross electricity)

UK

- 2020 target for share of renewables in gross energy consumption: 15%;
- Total primary energy supply (2009): 197.6Mtoes;
- Renewables in total primary energy supply (2009): 6.11Mtoes;
- % Renewables in total primary energy supply (2009): 3.1%;
- Gross Electricity: 368.1TWh;
- Renewables Electricity: 25.53TWh;
- % Renewables in Gross Electricity: 6.70%;
- Largest renewable source and % of gross electricity; Wind, 2.3%

3 Denmark

The development of renewable energy in Denmark was instigated by the oil crisis of 1973. The region, at the time, was 100% dependent on energy imports[iv], 95% of which came from imported oil and the remaining 5% from coal.[v] As such, securing future security of supply and ensuring self-sufficiency became major policy drivers. However, with nuclear power ruled out due to public pressure and no *known* fossil fuel or traditional hydro resources available, the remaining policy options were limited.[vi] Under such circumstance, the development of alternative energy sources became a necessity.

The policies developed in Denmark, coupled with oil and gas production from the North Sea, have transformed the region from an importer of energy, into a self-sufficient, net exporter of energy. The region also has the lowest energy consumption per unit of GDP and the highest contribution of electricity from *new* renewables in the EU. Furthermore, the Danish Island of Samso has achieved energy self-sufficency.[vii]

The development of renewable energy has led to a fundamental shift in Denmark's energy system – from a centralised fossil fuel generation, featuring a few large-scale generators, to decentralised renewables generation, typified by thousands of individual power producers (IPPs), with the energy supply side operating on a not for profit basis.[viii] Figures 3 (Annex 4) illustrates this transformation.

Two key factors have led to this transformation. Firstly, a shift towards combined heat and power (CHP) and district heating *'created the necessary infrastructure'* to facilitate a decentralised, renewable energy system.[ix] Secondly, financial incentives - including Feed-in Tariffs (FIT), investment subsidies and tax breaks – provided an impetus for renewable energy investment and opened up the possibility of investing to a wide range of actors.[x]

The concept of district heating became part of Denmark's energy landscape during the 1950s, with the first district heating loops installed in the 1960s. Early examples of district heating were supplied by large CHP plants centralised in larger cities. From 1986/87 the Danish Energy Agency and the Steering Group for Renewable Energy implemented programmes to encourage the use of decentralised district heating, that is, they encouraged the development of locally owned community based heating networks supplied by smaller-scale, local CHP plants. During the 1990s a tariff system was introduced that offered a premium for power produced by local CHP plants if it was fed-into the national grid. All of which occurred in parallel with a moratorium on the building of coal fired plants (1990-97)[xi]

These local CHP plants were often powered by non-renewable energy – power supplies ranged from gas turbines, solid municipal waste and biomass. However, the steps taken to develop local CHP and district heating networks created a:

> *… decentralised energy structure that later with modest invests [could] be changed to local renewable energy.*[xii]

An additional benefit of this system is that:

> *…CHP can be regulated within seconds or minutes while coal station need hours, local CHP matches well with the fluctuating solar and wind power*[xiii].

Denmark's development of renewable generation has been assisted by the use of a FIT. The FIT, first introduced in 1993, obligated utility companies to purchase renewable energy at a specified rate – for wind this rate was equal to 85% of the final price paid by consumers. The FIT was not the only financial mechanism utilised by the region. Other policies, including direct subsidy and tax exemptions for private wind farm owners, a 30% investment subsidy and tax free generation up to 7,000kWh, complimented the FIT premium. At the same time, the Danish government invested heavily in research and development, and implemented a favourable planning regime to encourage participation in the wind turbine market.[xiv]

Two factors are important here. Firstly, the government's choice of policy ensured a high degree of stability, both financial and administrative, which helped to encourage investors. Secondly, a favourable and predictable FIT, alongside the other policies, encouraged a wide range of investors to enter the market. The growth of independent power producers – community groups and farmers, for example – was a significant method of encouraging public support and acceptance of wind farms. As a Danish government report noted:

> *The local environmental disadvantages can lead to a lack of public acceptance of wind farms. Local ownership wind turbines (local farmers, co-operatives or companies) can ensure local acceptance of projects.*[xv]

In addition to the FIT, Denmark has operated a policy of open and guaranteed access to the grid. The policy requires Transmission System Operators (TSO) '*to finance, construct, interconnect, and operate the transformer stations and transmission and distribution infrastructure for renewable energy technologies'.*[xvi] It is argued that such a policy has a number of advantages, namely it:

- serves to minimise barriers to market entry and prevents existing utility companies from using their market share to block entry on transmission and distribution grounds; and
- increases interconnectivity on the grid.[xvii]

Interconnection, to the Nordic hydro based electricity systems in the North and to European continental mainland in the south, has had a significant role to play in enabling Denmark to integrate large amounts of wind generation into its electricity system. The intermittent nature of wind generation results in variable power flows. Large-scale swings in generating capacity, from zero to maximum capacity depending on weather conditions, can occur within a matter of hours. Cross-border interconnection allows the system to address these imbalances in supply – energy can be exported at times of oversupply and imported during lulls. This import/export mechanism is used to balance around 70% of wind power variability – with the remainder balanced through internal mechanisms, typically coal fired generation. However, with significant amounts of intermittent generation coming on-stream in neighbouring regions, it is expected that this balancing act will become increasingly difficult in the future.[xviii]

In 1986, Denmark established the Riso Research Centre, a wind power test station to provide quality assurance of turbines sold to the public. There have been a number of benefits associated with this and the regions support of R&D in general. It has allowed the region to refine turbine and power-system designed, achieving cost reductions of 80% to produce 1kwh of wind power.[xix] Moreover, the expertise developed through R&D has substantially benefitted the export market. Exports of Danish energy technology trebled between 1998 and 2008, reaching 11% of total exports.[xx]

The development of renewable energy in Denmark has occurred in parallel with a long-standing and successful energy efficiency policy. As a government document points out:

Danish gross energy consumption in 2009 was at the same level as in 1972 despite an economic growth of more than 100 per cent over the same period.

Denmark's energy efficiency programme has encouraged energy savings in both end use and the supply sector. Key features of the programme included:

- Increased cogeneration (CHP);
- High energy taxes;
- Periodic subsidies;
- Information campaigns;
- Energy saving obligations placed upon energy suppliers; and
- Specific performance requirements for buildings and appliances.[xxi]

The trajectory of renewable development in Denmark has not been one of constant growth. In 2001, a change of government led to a radical change in policy and a free-market approach to financing the industry was adopted. The existing FIT made way for a market-dependent FIT[xxii]; wind energy generators were paid the market price plus a premium (approximately 0.0013€/kWh). As a result of this the rate at which new wind turbines were installed slowed considerably. At the same time, funding for certain research projects was also cut, leading to uncertainty in the research and development sector.[xxiii]

Such policies have been reversed, to an extent, as the region pursues 100% renewables. FIT support for wind power increased in 2008. However, the overall FIT system has been criticised for being incoherent, with different technologies operating under different FIT schemes. [xxiv]

2008 also saw the introduction of an Energy Agreement, which introduced a number of mechanisms to support renewable growth, including:

- tax reform lowered the tax on work and increased the taxes on energy, climate and transport;
- subsidies for energy efficient building renovations were introduced, as well as stricter requirements for the energy performance of buildings; and
- a commitment to reach DKK 1bn of public financial support for new technology R&D in 2010 (approximately £112m).

4 Germany

The 1970s oil crisis also acted as a catalyst for German renewable development. Intitially policy focussed on research – prototype development and training were funded at increasing levels between 1974 (€10m) and 1982 (€150m), funding levels then declined until 1986, to €82m.[xxv]

1986 proved to be a watershed year for the region. The Chernobyl disaster gave rise to strong anti-nuclear sentiments amongst the German public and, at the same time, the issue of climate change and the possibility of an impending climate disaster became rooted in the public consciousness. In the following year, the Chancellor identified climate change as the most significant environmental problem facing the region. A Commission on Preventive Measures to Protect the Earth's Atmosphere was setup; one of the Commission's first actions was to recommend a 30% reduction in 1987 Co_2 and methane emission levels by 2005, with a target of 80% by 2050.[xxvi]

Examining the development of renewable energy in Germany, it is possible to identify two distinct periods: 1990 to 2000 was marked by the first steps to create a market for renewables and the introduction of the first Feed-in tariff; from 2000 onwards Renewable Energy Sources Act, created more favourable investment conditions by refining the FIT system.

The creation of a market for renewables began with two initiatives in the early 1990s. The '1,000 roof programme', which ran from 1991 until 1995, provided successful applicants with a total of 70% of the investments cost for installing solar PV. A second programme subsidised the wind turbine investment of up to 100MW (later extended to 250MW) by paying €0.04/kWh to producers.

The latter programme was enhanced by the Feed-in Tariff Law 1990. The FIT placed an obligation on utility companies to purchase *all* renewable energy produced at rates equivalent to 65% to 90% of the average retail price of electricity.[xxvii] The introduction of a FIT had a number of impacts. It provided a degree of stability to the renewable electricity investment and in doing so, encouraged investment by smaller producers, leading, in turn, to the development of decentralised generation. [xxviii]

The FIT faced challenges from the large, supra-regional utilities companies. The basis of such challenges was not any perceived threat from the burgeoning decentralised market; rather it was a geographical imbalance inherent in the original law that was the cause of objection.[xxix] The FIT required utilities to pay a premium for all renewable electricity produced. The geographical spread of renewable sources in Germany meant that utility companies in certain regions were obliged to purchase more renewable electricity than others, for the simple reason that a stronger resource existed in their region and more renewable electricity was produced as a result. This imbalance was redressed in 2000 with the introduction of a compensation scheme to spread the cost of funding the FIT across all utilities firms equitably.[xxx]

Other policies from this period that ran in conjunction with the FIT included:

- Approximately €1.85bn research funding for renewable energy between 1990 and 1998;
- More than €3bn in reduced interest rate loans for RES installation between 1990 and 1998;
- Measures that privileged wind turbines in the construction code;
- Training programmes for architects; and
- Public information programmes.

The Renewable Energy Sources Act (2000) marks the beginning of a second wave of renewable development policy in Germany. The act was introduced with the aim of doubling renewable electricity production by 2010. The key measure of the act was to repeal the Feed-in Law 1990 replacing it with an improved FIT mechanism that feature fixed rates (as the opposed to the previous models percentage of final retail price system) for renewable electricity for twenty years.[xxxi] It is significant that the reform of the FIT served to increase the revenue stability for renewable generators.[xxxii]

Other features of the new FIT tariff included favourable rates for offshore wind, solar PV and biomass, as well as a front loaded tariff structure whereby renewable generators were paid more in the earlier years of a project (when cost were higher) than in the later years.[xxxiii]

The aim of the 2000 Act was to offer more favourable rates to offshore wind, small-scale hydro and biomass, as well as offering bonuses for innovative technologies.[xxxiv] As of 2005, payments under the FIT were approximately €4.4bn, providing 44Twh of renewable electricity.[xxxv]

It is argued that the German FIT model has been instrumental in the growth of renewable energy businesses in general and SMEs in particular:

> *…the Renewable Energy Sources act has also brought about the development of a highly diverse set of actors. Many new businesses have been founded.* ***This is due, in particular, to the fact that all the participants on the market have been able to obtain loans on account of the high degree of security for investors offered by rates of compensation that are set for 20 years.***[xxxvi] (Emphasis added)

The introduction of the FIT was one aspect of the 2000 Act. A second important aspect of the legislation was that it clarified the rules governing and the financing of grid access. Guaranteed grid access featured as part of the act, furthermore it enshrined into law:

> *…the principle that the grid connection is to be paid for by the producer of eco-power, while the upgrading of the grid is to be paid for by the grid operator [TSO].*[xxxvii]

In addition, the possibility of disputes arising from grid operators passing on the cost of grid improvement to producers was avoided by the introduction of a clearing centre – a legal forum for dispute resolution.[xxxviii]

The FIT, although significant, has not been the sole mechanism for renewable development in this period. A number of other policies have positively impacted growth:

- Energy Efficiency: Germany's energy efficiency target is to double energy productivity (that GDP per output of energy used) by 2020 compared to 1990. Policy measures include: €1.5bn per year to improve energy efficiency in buildings; the modernisation of existing power stations; programmes to promote the use of CHP; the support of EU initiatives on energy efficiency; programmes by the German Energy Agency directed at the improvement of energy efficiency in transport, buildings and electricity consumption.
- Taxation: Germany's ecological tax, as reformed in 2003, is aimed at encouraging energy savings by increasing the price of motor fuels, heating fuels and electricity. Renewable energy is exempt from the tax if the producers use it, or if it comes from an electricity line exclusively fed by renewable source.[xxxix] Any monies raised from the taxation of renewables will be used to further promote renewable energy.[xl] Special rates are applicable to combined heat and power plants, liquefied petroleum gas used as motor fuel for rail and public transport, and for organic motor and heating fuel.[xli]
- Heating: promotion of renewables in the heating sector has a long tradition in Germany. Financial assistance (€200m, 2004) is offered to promote the use of biofuels, geothermal and solar thermal. Larger systems have been supported by low-interest loans and debt-relief (between 2000 and 2005 approximately 2,567 loans to the value of €741m were granted).
- Transport; Between 2004 and 2006 they were exempt from this tax, although rising oil prices led to the abandonment of this policy. During 2006 biofuel were subject to a preferential petroleum tax, which was in turn replaced by a quota system that introduced a mandatory obligation to mix biofuels with traditional motor fuels.
- R&D: two policy instruments have been used to promote R&D in renewable technology. Institutional funding has been used to boost the expertise of research intuitions, while project funding has been use to support projects with a limited lifecycle.
- Renewable Energies Export Initiative: with the aim of increasing renewable exports, the German Energy Agency offers support to companies across four areas: network building and coordination; export expertise; marketing abroad; and development of foreign markets.[xlii]

Looking forward, Germany's current renewable policy includes:

- Grid study: a study is ongoing to examine ways to incorporate an increased share (30%) of electricity from renewables into the grid system. The study is examining: forecast as to the quality of wind energy fed into the grid and of electricity consumption; flexible electricity supply mechanisms; demand-side management; provision of balancing and reserve power by wind turbines; the use of storage technologies; comparison of suitable means of transporting wind-powered electricity to load centres inland; reliability of the electricity supply, even under difficult conditions; and the current capacity of overhead lines:[xliii]
- the continuous evaluation of current promotion strategies and their development if necessary;
- the review and possible amendment of the Renewable Energy Sources Act 2000 in 2012 to include demand supply load management and the improvement direct marketing electricity from renewable energy;
- The promotion of sustainable biofuels in transport will be encouraged through a quota system; and
- Taking forward policies introduced as part of the Renewable Energies Heat Act 2009. The act places an obligation on owners of new buildings to use renewable energies for heat. Financial support is provided in the region of €500m per year. Provisions to extend the use of heat grids are also included.

5 Finland

The context in which renewable energy has been developed in Finland differs from that of Denmark and Germany. Nuclear energy and hydro generation form substantial part of the energy mix. The region currently has four nuclear power plants in operation, with a fifth being built (two further plants have received planning permission for 2020).[xliv] Hydro, as is evident from Table 1, is the largest contributor to the region's renewable energy mix, contributing to 17.75% of total electricity supply in 2009. With regard to 'newer' renewable penetration, biomass contributes 11.58% to total electricity supply and 38.25% to total renewable electricity supply. The technology has been the focus of the region's renewables strategy.[xlv]

Development of wind energy in the region, compared to other states, has had a relatively low impact. The technology only supplies 0.39% of total electricity supply and contributes to 1.27% of the total renewable energy mix. However, as is evidenced below, Finland's renewable electricity policy favours wind generation, offering great levels of subsidy and more attractive tax incentives.

Biomass has been used as a fuel in Finland for centuries. However, after the Second World War its use declined. Again, the oil crisis of the 1970s provided the impetus for its revival, with Finland's first energy strategy to promote renewables published in 1979.

Commenting on Finland's policies the IEA have stated that the region:

> *…generally takes a cost-effective approach to renewables promotion, and most promotion policies are typically targeted and limited in scale.*[xlvi]

As of 2007, total annual financial support for renewables was €85m.[xlvii]

Modern Finnish renewable policy has utilised two central drivers - investment subsidies and tax benefits. With regard to investment subsidies, in the case of renewable electricity, a company's construction cost of renewable plants is co-financed by the Finnish government - up to 40% for wind generation plants and up to 30% for other technologies (including combined heat and power).[xlviii] In 2006, the major recipients of investment subsidies were wood burning biomass plants, receiving 60% of all subsidies. The same rules apply to renewable heat investment, the region has also operated a specific programme to subsidise renewable heating systems in residential buildings.[xlix]

Energy-related taxation has had a central role in Finland. The region was the first country to place a tax on carbon emissions in January 1990 (The Netherlands, Sweden, Norway and Denmark quickly followed suit). The Finnish government imposes a tax on electricity suppliers for every kWh of electricity passed onto the consumer. Suppliers then receive a refund for every kWh of renewable electricity supplied – the rate for wind energy is set at 0.69 eurocents per kWh, for all other technologies the rate is 0.42 eurocents per kWh.

The general structure of energy taxes for heat and transport has remained relatively unchanged since 1997. At present these fuels are taxed in relation to their carbon content, approximately €20 is paid for every tonne of $C0_2$ produced. Biofuel oil used in working machines or heating is exempted from the tax.

Other policy drivers have included:

- Guaranteed access for all electricity users and electricity producing plants, including renewable electricity producers;[l]
- Research and development on new renewable energy technologies - €15m, 2007;
- A Legislative obligation on oil companies to include minimum shares of biofuels in their sales of transport fuels – 2% in 2008, 4% in 2009 and 5.75% in 2010, in line with the EU directive on biofuel;
- Support for energy wood harvesting and chipping to encourage forest owners to supply wood residues to energy markets;
- Support for energy investment targeted towards the agricultural sector specifically (€5m in 2007, mainly supporting biogas and wood-based heating);
- Information campaigns to increase public motivation, targeted towards small-scale consumers and single-family house-owners (€1-2m 2007);

- An energy efficiency programme based on voluntary agreements designed to target specific sectors - industry, the electricity generation sector, district heating, electricity transmission and distribution, municipalities, the property and building sector, housing properties, and the transport sector (Energy grants were provided between 2003 and 2005 to assist with meeting the cost of energy efficiency requirements);
- Energy audits to assess delivery on voluntary agreements;
- The establishment of Energy Service Companies with a remit to carry out auditing of efficiency plans, implement the plans and financing the efforts on behalf of a client;[li]and
- District heating provides around 50% of Finland's heating requirements. Renewables form part of the district heating mix. Approximately 80% of district heating is provided by CHP plants.[lii]

Looking forward, the Finnish government has plans to introduce a Feed-in tariff from January 2011. The tariff will apply to wind energy and biogas. The wind generation tariff is aimed at increasing the level of electricity produced by wind to 6TWh by 2020. Electricity producers using either technology will receive a FIT rate of €83.50 per MWh of renewable produced. An additional €50/MWh will be paid for electricity produced using biogas at a CHP plant.[liii] It is intended that the FIT scheme will run for a 12 year period.[liv]

6 United Kingdom

The share of renewables in the UK's total primary energy supply (3.1%, 2009) is, when compared to the other regions examined, relatively low. This is despite a large theoretical renewable resource. For example, the UK wind resource is estimated to be capable of providing approximately 150TWh of electricity per year (100TWh hours offshore, 50TWh onshore). The total exploitable renewable resource in the UK could, it is estimated, provide 316TWh of electricity each year. By contrast, current renewable exploitation provided 24.53TWh in 2009 – 7.7% of potential renewable supply. This has led a study by the Electricity Policy Research Group at the University of Cambridge to label UK policy as a *'failure'*, stating:

> *The UK is regarded as a country where the considerable potential for renewable energy, relative to other major European countries, has failed to be realised.*[lv]

However, the paper attributes this failure to:

> *…societal preferences and the available mechanisms for encouraging social acceptability [rather than] financial support mechanisms.*[lvi]

Greenpeace are critical of the UK's failure to exploit the resources available. They, however, argue that policy makers are responsible for this failure:

> *To date, our government has largely bungled the development of renewable technologies. They've been held back and undermined by weak policy, indecision, obstacles and the threat of nuclear power. When heat and transport energy is included, the UK ranks near the bottom of the EU league table for renewables development. Only Belgium, Cyprus and Malta are worse…With proper support, renewables can - and must - form the heart of our energy system.*[lvii]

Perhaps most significantly, in 2007, a government White Paper on Energy – *'Meeting the Energy Challenge'* – acknowledged that existing policies would achieve a 5% penetration of renewables in total energy by 2020. The UK's 2020 target is 15% renewables penetration in total energy consumption.[lviii]

6.1 Renewable Electricity

Examining the policies used to promote renewable energy, particularly renewable electricity, it is evident that since the 1990s the UK has utilised two main financial incentives – the Non-Fossil Fuel Obligation (NFFO) (1990-2002) and the Renewable Obligation Certificate (used from 2002 onwards).

The NFFO (parallel arrangements applied in Scotland through the Scottish Renewable Obligation and in Northern Ireland through the Northern Ireland Non-Fossil Fuel Obligation) was originally intended to finance the development of nuclear energy but was extended to include renewables. The NFFO required the then Public Electricity Suppliers to purchase electricity from renewable generators at a fixed rate for a specified period of time (typically 15 years).[lix] Significantly, not all renewable energy was sold under NFFO contracts, rather *'contracts were awarded to the most price-competitive schemes'.*[lx] Renewable generators not awarded contracts under NFFO sold the electricity produced at the wholesale market price. The costs of the NFFO were covered by the Fossil Fuels Levy, a levy placed on the retail price of electricity. The levy was originally set at 10%[lxi] but fell to 1% in England Scotland and Wales, and 3% in Northern Ireland.[lxii] According to Renewable UK, at the end of the NFFO period, the UK had over 60 operational wind farms, with a total installed capacity of 412MW.[lxiii]

A number of criticisms were levelled at the NFFO initiative, including:

- NFFO contracts were released in five tranches, the first two tranche periods offered short contacts. This drove up the price of renewables as developers sought to pay off capital costs before the end the contract, rather than the lifetime of the project. This had two knock on effects, firstly it led to the perception that renewables were more expensive. Secondly, in the case of wind energy, developers often chose to import turbines which had a negative impact on the manufacturing side of the industry in the UK.
- Successive rounds of contract auctions, due to the tranche system, did not provide *'assurance of continuity of support for renewables in general'*;

- Awarding contracts to *price competitive schemes* only led to the support of established or near market technologies. This was problematic for the development of less advanced technologies; and
- Competition for contracts led to the exploitation of the highest wind speed sites, such sites *'often coincide with areas valued for their scenic beauty',* leading to objections from the public.

The ROC scheme replaced NFFO in 2002. The ROC model is a quota based system that requires electricity suppliers to supply increasing amounts of electricity sourced from renewable generation.[lxiv]

In order to demonstrate that their obligations have been met suppliers must produce a Renewable Obligation Certificate (ROC) for every MWh of electricity they supply to Ofgem. Should they fail to produce the predetermined amount of ROCs, suppliers are required to pay a buy-out fee (in Northern Ireland this was £37.19 per MWh during 2009/10). The proceeds of this buy-out fee are redistributed amongst suppliers who have produced the required amount of ROCs in a particular period. [lxv]

ROCs are issued, free of charge, to generators for every MWh of renewable electricity produced. These are then sold to suppliers as a separate entity to the electricity itself.

This has the effect of creating two markets and two revenue streams for generators – the electricity market and the ROC market. ROCs act as a premium on top of the market price (spot price) of electricity, and as such act as an incentive to RE development by contributing to its cost.

Demand, within ROC market, is stimulated by the legal requirement placed upon suppliers to produce an increasing number of certificates at the end of each obligation period.[lxvi] The buy-out fee and redistribution mechanism serve as an extra incentive for suppliers to purchase and hold ROCs.[lxvii]

The ROC has been seen as problematic for a number of reasons:

- By linking the price paid for renewable energy to market fluctuations, the ROC introduces a strong degree of variability into renewable energy investment. As such, investors may be put off RE projects due to the large upfront costs associated with development without a guaranteed return on investment.[lxviii]
- ROCs tend to favour producers who can *'hedge these risks effectively'.* This often results in a market dominated by large-scale producers. This was recognised by the UK government in their 2009 Energy Strategy, which named the ROC as the incentive for developing large scale renewable electricity generation[lxix];
- Finally, the price paid per ROC is higher when there is an under delivery. In other words, the lower the supply of certificates on the market the greater the demand for these certificates, resulting in a higher market price. Therefore, the ROC *'relies on under delivery to trigger the maximum subsidy amount'.*[lxx] Since ROCs are provided

to generators for each MWh of electricity they produce, the tendency towards undersupply appears to be counterproductive to renewable development.

Renewable electricity has also been supported through the climate change levy exemption, which places a £4.3MWh charge on all non-renewable electricity sources.[lxxi]

6.2 The problem with planning

Planning issues have negatively impacted the development of renewable electricity and have had a particular effect on the of growth on onshore wind. The problem can be summarised as follows:

> *There has been consistent evidence that gaining planning permission is a serious obstacle to the development of wind farms or more precisely that the costs of obtaining permission are often prohibitive in terms of imposed delays, negotiation costs and planning restrictions on the precise nature of the final investment.*[lxxii]

During 2007, the average time for local and national planning decisions for onshore wind was 24 months, with an approval rate of 62%. Since 2007, *'attempts have been made to place obligations on local councils to set target levels of energy renewables for new developments'.* The 2008 Planning Act enabled the setting up of Infrastructure Planning Commission to decide on onshore wind farms of more than 50MW.[lxxiii]

Planning problems have arisen due to a conflict between land use and energy supply. The major local objections to wind farms have centred on their visual impact, and the possible knock-on effect this may have on house prices and tourism.[lxxiv]

Evidence suggests that in cases where wind farm development has coincided with a community ownership model successful development has been achieved.[lxxv] This corresponds to the experiences in Denmark where local ownership has been central to overcoming local objections to development.[lxxvi]

However, under the NFFO and ROC financial mechanisms, the high risk of investment has tended to hamper the growth of this ownership model. Wind farm development in the UK has tended towards large power company dominance.[lxxvii]

The introduction of the UK FIT (April 2010) (for more information on the UK FIT see NIAR 300/10), by concentrating on stimulating microgeneration should serve to increase levels of locally owned renewable generation[lxxviii] and in doing so, may serve to ease planning objections. The Department of Enterprise, Trade and Investment state in their Strategic Energy Framework 2010, that they will *scope the costs and benefits* of a FIT for Northern Ireland.[lxxix]

In addition to the UK FIT a consultation process on enhancing grid access has recently been included. Proposals arising from this process will ensure:

> *…all prospective generators (whether embedded or directly connected) will be offered a Connect and Manage connection where works are required on the transmission system. Under a Connect and Manage offer, prospective generators will be guaranteed connection to the network once their 'enabling works' are complete.*[lxxx]

Final legislation on this issue has yet to be passed, although, as of July 2010, the Secretary of State had *'commenced his statutory powers'.*[lxxxi]

6.3 Other Policy Measures

Other policy measures aimed at the promotion of renewables in the UK include:

- The UK Energy Efficiency Action Plan 2007, which outlines a number of policy instruments designed to encourage greater energy efficiency. Policies are targeted towards specific sectors – households, businesses and public sector, and the transport sector – and include: building regulations; a code for sustainable homes; carbon reduction commitments for businesses; public procurement standards; and voluntary agreements with motor manufacturers;[lxxxii]
- The UK currently uses three mechanisms to support renewable energy R&D: research councils which provide grants for basic scientific research (£30m 2007/08): the Environmental Transformation Fund which provides grants for technology development and deployment including subsidies for installation, energy crop growth, and biomass infrastructure development (£400m over three years from 2008/09)[lxxxiii]; and Energy Technologies Institutes which provide grants to accelerate the development of renewables (£62m of projects underway, and £100m of projects in development as of August 2010)[lxxxiv] .
- Biofuels have been incentivised through the Renewable Transport Fuel Obligation (RTFO) since 2008. The RTFO will require 5% of all fuel sold at forecourts to come from a renewable source by 2010. The incentive is modelled on the RO as outlined above.[lxxxv]
- In addition, through the Alternative Fuel Framework 2003 the UK Government sets fuel duty incentives for biofuels and other fuels as part of each year's budget. For example, the budget in 2007 introduced a 20 pence per litre rebate on fuel duty for all biofuels.[lxxxvi] The 2009 pre-budget report announced the cessation of this rebate from the 1 April 2010.[lxxxvii] The June 2010 budget did not alter this situation.[lxxxviii]As such the RFTO has become the main mechanism for incentivising biofuel penetration.[lxxxix]
- The Bioenergy Capital Grants Scheme, funded through the New Opportunities Fund, provides capital grants for biomass generation (£33m), small-scale biomass and CHP (£3m), and *'planting grants'* for energy crops (£29m).[xc] The scheme, announced in 2006, was forecast to run for five years.[xci] The Marine Development Fund has also made £50m available for the development of wave and tidal power.[xcii] The fund was set up in 2004. However, in July 2009 the Department of Energy and

Climate Change reported that *'there have been no projects which have met the necessary requirements'*, although the Department were optimistic that Renewable Energy Strategy published in the same month would redress the situation.[xciii]

The 2009 Renewable Energy Strategy made a commitment of £30bn in financial support for renewable heat and electricity up to 2020. Key incentives in the strategy include:

- An extension of ROC to 'ensure that it can deliver around 30% renewable electricity by 2020[and] provide continued support for large-scale, centralised renewable electricity generation';
- The introduction of a 'clean energy cash-back' for households, industry, businesses and communities to use renewable heat and small-scale clean electricity generation through the UK FIT (see above);
- The proposed amendment of the RFTO; and
- Facilitate up to £4 billion of lending from the European Investment Bank for renewable and other energy projects.

The Coalition Programme for Government makes a number of commitments with regard to renewable energy policy, including:

- to establish a *'full system of Feed-in tariffs'* and maintain the banded ROC;
- the introduction of *'measures to promote a huge increase in energy from waste through anaerobic digestion'*;
- the creation of a Green Investment bank;
- the introduction of measures to promote marine energy;
- the introduction of efficiency performance standards for coal-fired power stations not equipped with carbon capture and storage;
- a public sector energy efficiency programme which aims to reduce central government carbon emissions by 10% in 12 months;
- establish a smart gird and roll out smart meters; and
- delivery of an offshore electricity grid.

7 Discussion

A number of key themes emerge from the above. Firstly, it is evident that both Denmark and Germany have long-standing renewable policies which have remained relatively stable for the last two decades. In comparison, UK policy since 1990 has utilised two main financial incentives (with a third introduced recently) and has, in comparison, been marked by uncertainty at policy level.

Evidence suggests that the financial incentive a region employs has a significant impact on the effectiveness of its renewable energy policy. Denmark and Germany have used variations of the Feed-in tariff successfully. The Feed-in tariff, employed over a long period of time, facilitates revenue stability for investors and encourages growth by removing some of the risk from investing in relatively new technology types.

The UK, by contrast, has employed a variety of market based techniques to fund renewables growth. Such techniques, which offer variable revenue streams, have not stimulated the same levels of confidence in investors.

Denmark's move away from its successfully employed Feed-in tariff in the early 2000s and the subsequent stagnation in renewables growth reinforces the need for stability in approach and long-term vision.

Finland's financial model – based on tax exemption and subsidy – has resulted in a less pronounced penetration of 'newer' renewable sources, but the region has done so in a cost-effective manner. Furthermore, the region has a significant amount of large-scale hydro on-stream, an advantage not afforded to either Denmark or Germany.

The use of a Feed-in tariff in Denmark and to an extent in Germany has encouraged investment amongst small-scale producers in general, and amongst local community groups in particular. In Denmark this has been aided by the evolution of distributed heat and power to a decentralised electricity system. An electricity system that includes local ownership, it is argued, tends to encourage public acceptance of renewable technologies. As such these regions have avoided the major barrier to development experienced in the UK – local objections during the planning process. The recently introduced UK Feed-in tariff, with its focus on microgeneration, appears designed to redress this problem by encouraging smaller producers into the market.

A key feature of renewable electricity policy in Denmark, Finland and Germany has been guaranteed grid access. All three regions have ensured grid connection for renewable producers, although, the cost of this policy is distributed differently in different regions. For example, in Denmark the cost of connection is borne by the Transmission System Operator, whereas, in Germany the producer pays. There are significant benefits to guaranteed grid access: it removes a specific barrier to market; and it improves interconnection.

In the UK a consultation on gird access was carried out in March 2010. The consultation outlined proposals for an *'enduring regime for grid access',* which will ensure guaranteed gird access under the Connect and Manage Scheme:

Final legislation on this issue has yet to be passed, although, as of July 2010, the Secretary of State had *'commenced his statutory powers'.*[xciv]

Early adoption, expenditure on R&D and resulting technological advancements, as well as specific policy incentives, have stimulated the growth of a substantial export market in both Denmark and Germany.

Other key aspects of the four regional policies outlined above include:

- Tailored energy efficiency policy, in Denmark this has seen an effort to decouple productivity growth and energy use;
- Separate policies for renewable electricity, renewable heat and renewable transport;
- The promotion of combined heat and power; and
- The funding of R&D in renewable technology.

Annex 1

Figure 1: Share of renewable sources in final electricity consumption (2008)

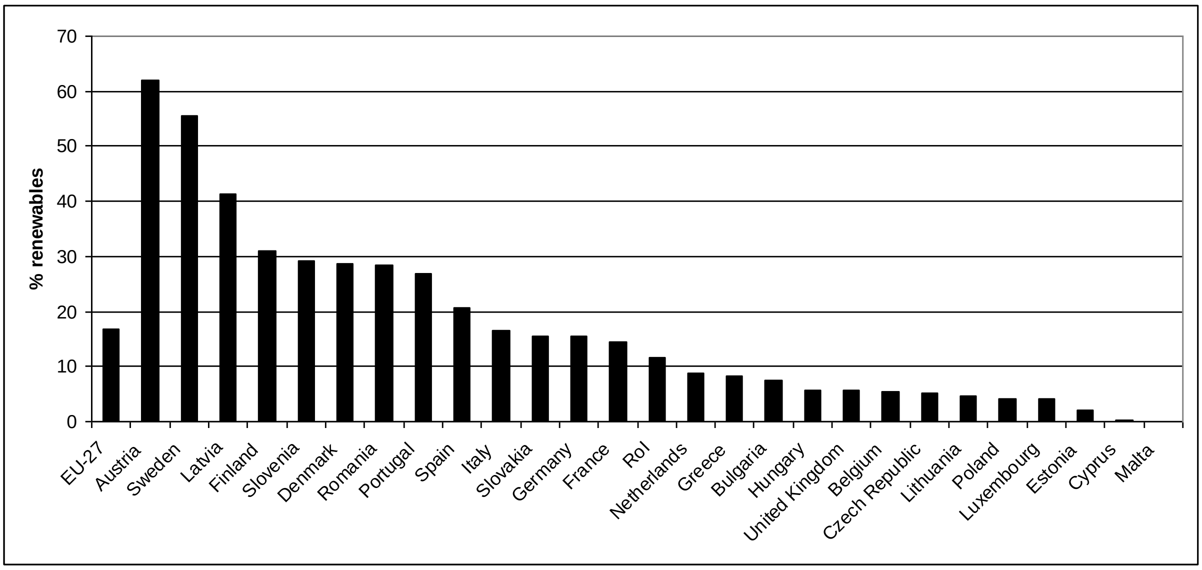
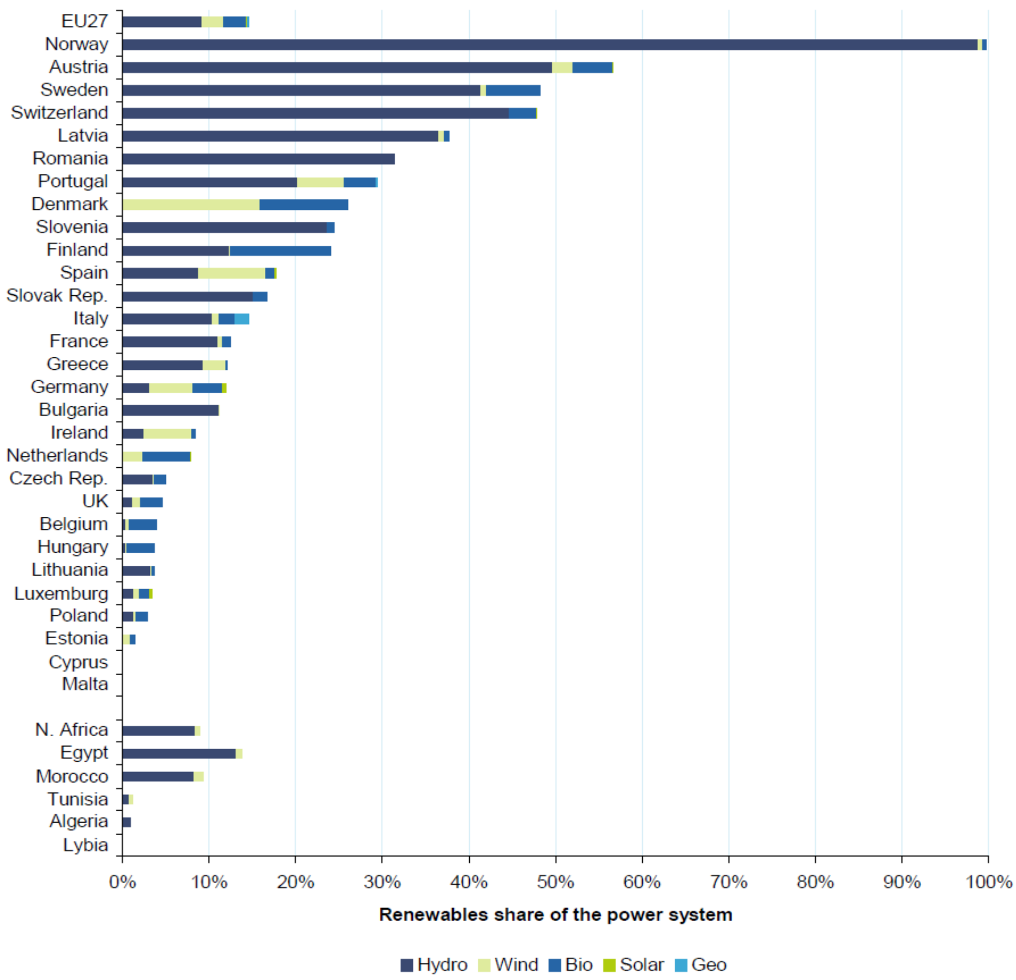


Figure 2: Renewable electricity shares in EU-27 and North Africa



Annex 2

Table 1: Energy supply and renewables - OECD Europe and selected EU Countries (2009)[xcv]

	OECD Europe	Denmark	Finland	Germany	UK
2020 Target - % Renewables in Gross Energy	20%	30%	38%	18%	15%
Total primary energy supply (Mtoe)	1720.9	17.84	33	318.83	197.6
Renewables in TPES	170.87	3.22	7.97	28.88	6.11
% Renewables in TPES	9.90%	18%	24.10%	9.10%	3.10%
GDP (billion - US $)	10330.28	172.67	142.98	2027.79	1711.84
TPES/GDP (toe/1000 US $)	0.17	0.1	0.23	0.16	0.12
Population (million)	545.42	5.5	5.33	82.05	61.78
TPES/capita (toe/capita)	87	3.24	6.19	3.89	3.2
Gross Electricity (TWh)	3420.6	36.2	71.6	590.7	368.1
Renewable Electricity (TWh)	770.51	9.96	21.68	95.27	24.53
% Renewable of Gross Electricity	22.50%	27.50%	30.30%	16.10%	6.70%
Largest renewable source	Hydro	Wind	Hydro	Wind	Wind
TWh Largest Renewable source	504.4	6.7	12.71	37.8	8.5
% Gross Electricity	14.70%	18.50%	17.75%	6.30%	2.30%
% Renewable Electricity	65%	67.45%	0.59	39.69%	34.65%

Table 2: Installed renewable capacity by technology - OECD Europe and selected EU Countries (2008)[xcvi]

	OECD Europe	Denmark	Finland	Germany	UK
Total Capacity (MW)	243930	3817	5008	34403	6618
Hydro (MW)	148536	9	3102	3207	1679
Geothermal	1309	0	0	7	0
Solar PV (MW)	9524	3	6	5333	23
Solar thermal (MW)	61	0	0	0	0
Tide,wave, ocean (MW)	241	0	0	0	1
Wind (MW)	64889	3166	143	23895	3406
solid biomass (MW)	14062	558	1757	1380	513
biogas (MW)	4573	81	0	184	996
Liquid biomass (MW)	735	0	0	397	0

Annex 3

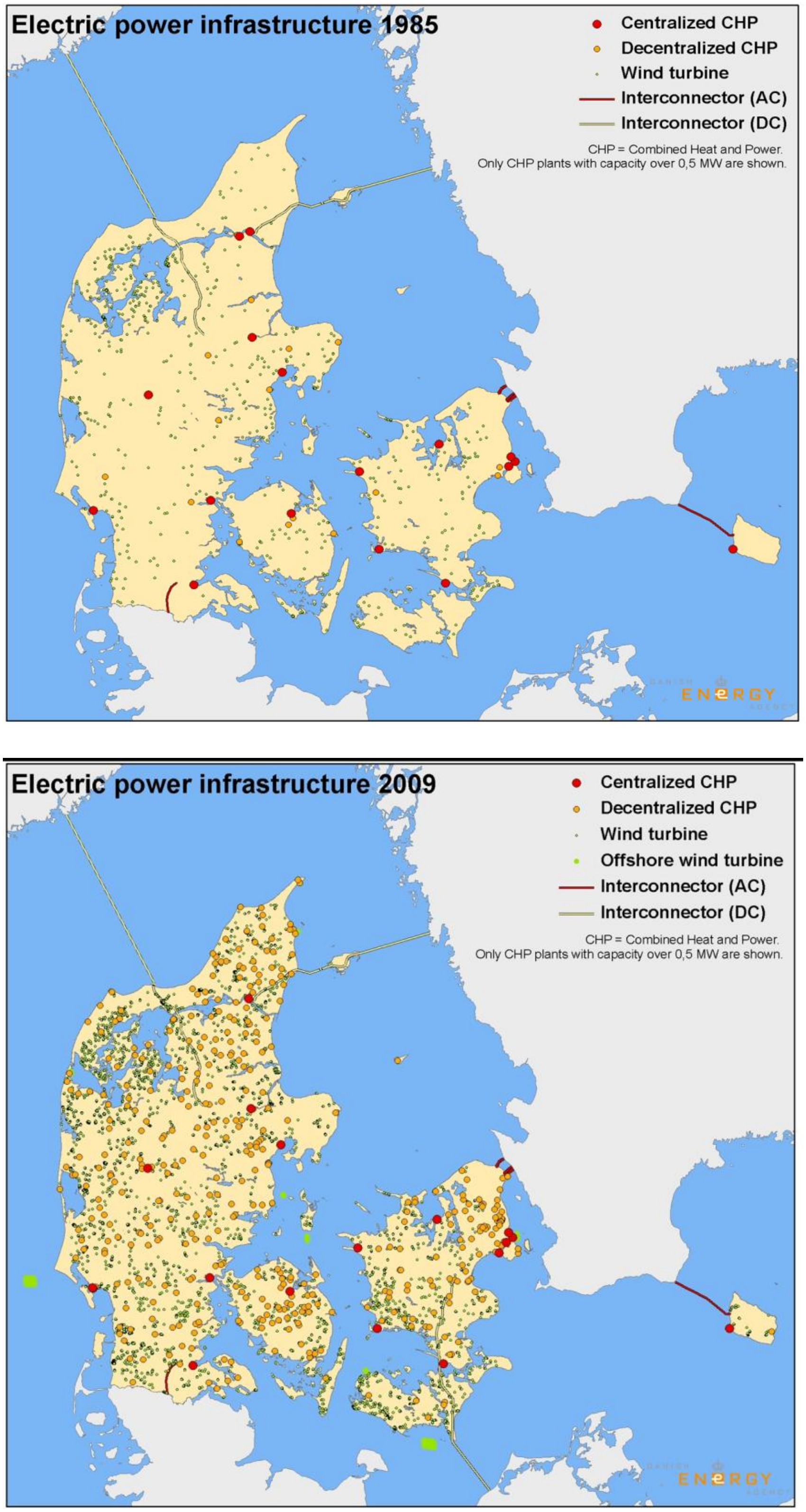
Table 3: Renewable share by technology - OECD Europe and selected EU Countries (2009)[xcvii]

	OECD Europe			Denmark			Finland		
	Twh	% Total Electricity	% Total Renewable Electricity	Twh	% Total Electricity	% Total Renewable Electricity	Twh	% Total Electricity	% Total Renewable Electricity
Total Electrify	3420.6	-	-	36.2	-	-	71.6	-	-
Total Renewable Electricity	770.51	22.53	-	9.96	27.51	-	21.68	30.28	-
Hydro	504.37	14.75	65.46	0.019	0.05	0.19	12.715	17.76	58.65
Geothermal	10.56	0.31	1.37	0	0	0	0	0	0
Solar PV	13.8	0.4	1.79	0.003	0.01	0.03	0.006	0.01	0.03
Solar thermal	0.04	0.001	0.005	0	0	0	0	0	0
Tide, wave, ocean	0.49	0.01	0.06	0	0	0	0	0	0
Wind	131	3.83	17	6.721	18.57	67.48	0.276	0.39	1.27
Renewable municipal waste	16.7	0.49	2.17	1.042	2.88	10.46	0.3	0.42	1.38
Solid biomass	64.07	1.87	8.32	1.924	5.31	19.32	8.292	11.58	38.25
Biogas	25.16	0.74	3.27	0.255	0.7	2.56	0.091	0.13	0.42
Liquid biomass	4.21	0.12	0.55	0	0	0	0	0	0

	OECD Europe			Germany			UK		
	Twh	% Total Electricity	% Total Renewable Electricity	Twh	% Total Electricity	% Total Renewable Electricity	Twh	% Total Electricity	% Total Renewable Electricity
Total Electricity	3420.6	-	-	590.7	-	-	368.1	-	-
Total Renewable Electricity	770.51	22.53	-	95.27	16.13	-	24.53	6.66	-
Hydro	504.37	14.75	65.46	17.443	2.95	18.31	5.246	1.43	21.39
Geothermal	10.56	0.31	1.37	0.019	0	0.02	0	0	0
Solar PV	13.8	0.4	1.79	6.2	1.05	6.51	0.017	0.005	0.07
Solar thermal	0.04	0.001	0.005	0	0	0	0	0	0
Tide, wave, ocean	0.49	0.01	0.06	0	0	0	0	0	0
Wind	131	3.83	17	37.809	6.4	39.69	8.515	2.31	34.71
Renewable municipal waste	16.7	0.49	2.17	5.05	0.09	0.53	1.415	0.38	5.77
Solid biomass	64.07	1.87	8.32	12.957	2.19	13.6	3.193	0.87	13.02
Biogas	25.16	0.74	3.27	12.481	2.11	13.1	6.143	1.67	25.04
Liquid biomass	4.21	0.12	0.55	3.308	0.56	3.47	0	0	0

Annex 4

Figure 3: Denmark's Electricity Infrastructure 1985 and 2009[xcviii]



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