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Lessons for effective renewable electricity policy from Denmark, Germany and the United Kingdom ☆

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Abstract

Renewable electricity development has taken different paths across countries, underpinned by different policy frameworks. Although there has been a convergence to two main mechanisms, the feed-in tariff (FIT) and the renewable portfolio standard (RPS), much debate remains focused on the effectiveness of each for meeting multiple objectives, especially energy security, CO_2 reduction and economic development. Although most countries share these objectives, their choice of policy varies, explained largely by national context. Denmark, Germany and the United Kingdom stand out as lead countries based on their experiences with the FIT and RPS and provide important lessons for other nations. The evidence from these three, as examined in this paper, suggests that policy design and commitment are key factors for success. Denmark and Germany have 10 years of experience with FITs and are world leaders in the field of renewable energy (RE) development. They are closest to meeting their RE targets and have been able to achieve several other objectives, especially industrial development and job creation, and in the case of Germany, CO_2 emission reductions. Although other factors have been important in determining policy choice and implementation in these countries, the particular design features of the FIT allow it to address the needs of the sector.

Keywords: Renewable energy policy

1. Searching for effective policy

A range of policies has been developed and implemented to promote the use of renewable energy (RE). These include pricing laws, quota requirements, production incentives, tax credits and trading systems. Just which of these support measures (and in what combination) are the most effective for developing RE is an area of ongoing discussion—particularly as more and more countries pursue RE strategies. Although most countries share similar energy policy objectives—reducing reliance on (imported) fossil fuels, reducing the environmental impacts of the energy sector and encouraging new industrial development—the policies a country chooses to pursue these objectives can vary, and is often a question of national context as shaped by different cultures and histories. Yet, two policies have emerged as the most popular for RE promotion: the feed-in tariff (FIT) and the renewable portfolio standard (RPS). Much debate surrounds their effectiveness, with some expectation that a choice has to be made between them (Hvelplund, 2001a, b; Lauber, 2004). This leaves some countries (and jurisdictions), currently in the process of deciding on RE policy, wondering which model to pursue given their own particular circumstances and objectives. According to Ekins (2004), "no optimal model has emerged, and probably none will do so in the contexts that are shaped by different histories and cultures. But there is enormous scope for further analysis and comparison of different experiences in order to inform in any particular context

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how this improved delivery may be achieved'' (p. 1903). This paper takes on that task by comparing the RE policy experiences in three leading countries: Denmark, Germany and the United Kingdom.

When studying policy, a distinction is typically made between policy theory (the study of why we have the policy we have) and policy analysis (the study of how we can improve policies and policy processes) (Howlett and Ramesh, 2003). Policy theory is generally ''interested in explaining how the policy process is shaped by a combination of macro and microvariables [while] policy analysis tends to be more oriented toward the evaluation of policy outcomes'' (Dobuzinskis et al., 1996). These two angles are not mutually exclusive; an understanding of the latter requires knowledge of the former and this paper is interested in both aspects. It examines the use of the FIT and RPS as applied in three countries, exploring the effectiveness of each policy for meeting national objectives, and identifies additional factors that have influenced policy choice (and success).

The analysis is based on interviews with RE policy actors in Denmark (DK), Germany (DE) and the United Kingdom (UK) and on a review of RE policy documents from a range of countries, institutions and the academic literature. Personal interviews were conducted in spring 2006 with eight RE policy experts in each country who represent a range of interests: government, industry, non-governmental organisations and academia. (Where possible, two from each group were interviewed in each country.) The work was also informed by an international conference on the harmonisation and co-ordination of support policies in the European Union (EU) held in November 2006. A case-study approach is used to assess distinctive circumstances in which there are multiple variables of interest, and specifically to help explain the implications of certain policy within particular political and geographical contexts (Yin, 2003).

Focusing on the case of RE for electricity generation, this paper begins with a review of the most common RE policies used to encourage the sector (Section 2). Factors that influence policy decisions are discussed in Section 3, setting the framework against which each case study is later compared. RE policy development in the three case countries is presented in Section 4, and progress towards objectives is covered in Section 5. Experiences in the three countries are discussed in Section 6 and lessons for effective RE policy are presented.

2. The RE policy debate

In the last 10 years, the FIT and RPS have emerged as two key policies to promote the development of RE for electricity generation. Several other policies are also in use but are generally peripheral to the FIT and RPS approaches. The FIT is a pricing policy, guaranteeing RE generators a fixed price for the electricity they produce (Gipe, 2003; Sawin, 2004). The RPS (known as the renewables obligation (RO) in the UK) is a quota system that requires electricity suppliers to source a certain proportion of their electricity from RE (Komor, 2004). Most countries in Europe have adopted some form of FIT and, internationally, more than 40 jurisdictions (38 countries and five sub-national entities—e.g. states and provinces) have implemented it. At the last tally, the RPS was implemented in about 38 jurisdictions, of which eight are national governments (e.g. the UK, Australia and Japan) (REN21, 2006).

In political terms, the FIT has been classified as a ''political price/amount market model'' where prices are set politically and quantities are market driven, whereas the RPS is a ''political quota/certificate price market model'' in which the price is determined by the market and the quantity established politically (Hvelplund, 2001a, b, p. 7). It is on this political basis (around the role of government in supporting the RE sector) that much of the disagreement over these two policies resides. However, as more experience is gained with these approaches, the discussion is moving beyond ideology to an examination of policy outcomes.

2.1. *Feed-in tariff*

By guaranteeing a fixed price based on the learning curve associated with a particular technology, the FIT can support various technologies at varying stages of development (Klein et al., 2006). All eligible projects are guaranteed grid access and a certain price for the electricity produced. Price may vary by technology (calculated according to the cost of generation). The long-term price guarantee—often from 8 to 15, but sometimes as many as 20–30 years—provides market stability and security for investors (Sawin, 2004). A market demand for RE is ensured by obligating electricity utilities and/or grid operators to purchase it. In some countries, the tariff is reduced over time to account for maturity of the technology (Klein et al., 2006).

FIT policies have existed since the late 1970s, when the US Public Utility Regulatory Policies Act of 1978 (PURPA) introduced guaranteed prices based on the long-term anticipated cost of fossil energy (estimated at \$100 per barrel of oil by 1998) (Komor, 2004). Those high prices did not prevail and the programs were slowly dismantled, especially with the introduction of liberalised markets in the US (Komor, 2004). The second wave of FIT policies started in Denmark and Germany in the mid-1990s, where utilities were required to purchase RE in their service area at a price established by the government. The rationale was to compensate RE developers for the environmental benefits of generation (Grotz, 2005). The FIT has been implemented differently across countries, but a price guarantee is always a central feature. The discussion here concentrates on the design features in Germany and Denmark.

2.2. Renewable portfolio standard

The RPS is generally favoured by free-market proponents who prefer leaving technology choice and price unregulated (Komor, 2004). Rather than requiring suppliers to purchase particular RE generation at fixed prices, the RPS stipulates the amount of generation to be purchased (in many cases, a growing percentage of electricity providers' supply) but leaves the decision of source and price to the market (Sawin, 2004). This means that it is usually RE technologies producing power at the lowest cost that are purchased to meet the obligation, and least cost is typically achieved by large developers using well-established technologies. In this way, the RPS supports those technologies (and developers) that are closest to market maturity (Mitchell and Connor, 2004). To ensure compliance, an obligation or quota system is ideally accompanied by a penalty for those failing to meet the target. Trading may also be a feature of this policy to facilitate fulfilment of the quota, and in this way it is closely linked to the idea of tradable certificates (Komor, 2004). In some countries, a buy-out price has been set to provide a cost ceiling to contain the price at which the RE electricity is sold (Dinica, 2005).

2.3. FIT vs. RPS: arguments for and against

Opponents of the FIT argue that it is an expensive way to support RE development, putting an excessive burden on consumers or taxpayers. The guaranteed prices, they claim, do not encourage competition; therefore, renewable power is not being generated at the lowest possible price (Komor, 2004; Zisler, 2006). Champions of liberalised markets also view the FIT as an excessively heavy-handed intervention at a time when less, not more, government interference in energy markets is considered desirable (Komor, 2004; Santokie, 2006). The advantage of the FIT, argue its proponents, is that it recognises and distinguishes between RE technologies that are at different stages of development and have different generation costs (Gipe, 2003; Klein et al., 2006). Moreover, the FIT does not squash competition, they say, because, in the interest of keeping construction costs low, developers try to buy the cheapest and best turbines and thus have driven the cost of technology down (Hvelplund, 2001a, b). The pricing differential also encourages RE development in a range of geographic locations (Menanteau et al., 2003). In contrast, the least-cost criterion of the RPS often implies that all development happens in a concentrated area (for instance, where the wind blows strongest). Because the price is guaranteed, the FIT allows non-traditional developers into the RE market, such as households with solar panels and co-operatively owned wind turbines (Gipe, 2003). The RPS is felt to be too prohibitive to smaller players because of its price criteria and competition from bigger players. Fixed prices over medium- to long-time horizons are also thought to create a market certainty needed to attract investment and grow the industry (Sawin, 2004). These arguments are reviewed in Section 4 based on evidence from the case countries.

3. Factors influencing policy

The range of influences on any particular policy is vast and often involves an elaborate web of inter-relationships in which policy ideas, structures and processes overlap (Doern and Phidd, 1992). Few policies can be understood without examining the circumstances in which they are formulated since "the political machinery and the policy makers at any point in time, work within a framework which greatly restricts the alternatives they consider and the range of innovations they make" (Simeon, 1976, p. 555). Policy choice is also determined by the objectives of the decision makers of the day—it is on this basis that policy is usually evaluated (Brewer and deLeon, 1983). A common difficulty with performing evaluations is the ambiguity of policy objectives, changing priorities and different commitments made depending on those priorities (Brewer and deLeon, 1983; Howlett and Ramesh, 2003). In this section, RE policy objectives, as stated by the three case countries, are presented and suggestions made about how progress towards each may be measured.

3.1. Policy objectives

The motivations for and objectives of RE policy are strikingly similar across most countries and this is certainly true for the three case studies. Increasing the share of RE in the electricity mix helps each country meet its RE targets, as set out by the European Commission. Although this tends to be the overarching objective of developing renewables in Europe, there are specific benefits that countries wish to attain through this approach and most countries support the development of RE for the following reasons (DTI, 2003, 2006; DEA, 2005a, b; BMU, 2006b):

- Ensuring security of supply (reducing dependence on fossil fuels and creating diversity of supply).
- Reducing greenhouse gas emissions (and other environmental effects of the energy sector).
- Fostering innovation and broadening industrial capabilities (e.g. to improve export potential, skills and enhance competitiveness).
- Increasing local and regional benefits (e.g. through job creation, manufacturing, economic development).

Priorities vary from one country to the next, but all three countries in this analysis have stated these as motivations behind their respective RE policies. Also stated is that these objectives should ideally be met in the most cost-effective manner (DEA, 2006a; DTI, 2006).

3.2. Energy security

Motivations for supporting RE have come full circle in recent years. Policies and programmes introduced in the late 1970s and 1980s were spurred by uncertainties regarding the availability and high price of conventional energy sources, especially oil. In some countries, this was combined with a strong resistance to nuclear power which made the search for alternative sources of power all the more pressing. Although RE policy was largely motivated by environmental considerations in the 1990s, today energy security is again a principal consideration (DTI, 2003; DEA, 2005a, b; BMU, 2006b). Depending on a country's energy resource base (indigenous vs. imported, renewable vs. non-renewable), promotion of RE for reducing import dependency has more or less urgency. Among the three case countries, Germany is the most dependent on imported energy sources although it is largely self-sufficient in coal for electricity production, which accounts for half of the supply (BMU, 2006c). The UK recently reached its production peak in oil and natural gas (NG). This will affect the electricity sector, where 40% of supply is generated from NG (DTI, 2005). Denmark is the most energy self-sufficient country, but relies on imported coal for almost half of its electricity supply (see Table 1). All three countries are motivated to reduce their dependence on fossil fuels. Progress towards energy security and self-sufficiency can be measured in several ways, but in the context of RE it is usually assessed on the basis of RE penetration—the total amount and proportion of electricity supplied by RE.

Table 1
Overview of the case-study countries

	DK	DE	UK
Overview (2005 unless indicated)			
Population	5.4 million	82.5 million	60.1 million
GDP (€ million)	208,546	2,241,000	1,790,671
Electricity supply mix	46.1% coal, 24.7% natural gas, 24.5% renewables, 4.1% energy from waste, 4% oil	51.1% coal, 27.6% nuclear, 9.6% natural gas, 4.1% hydro, 6.5% other renewables, 0.9% oil	40% natural gas, 33% coal, 19% nuclear, 3.5% renewables, 2.5% imports, 1% large hydro, 1% oil
Renewable electricity produced (TWh in 2004)			
Biomass	2.26	8.30	7.32
Hydro[a]	0.03	19.95	5.07
Wind	7.39	29.52	2.23
Geothermal	0.00	0.00	0.00
Solar PV	0.00	0.62	0.00
Total	9.68	58.39	14.52
Installed wind capacity	3122 MW	18,428 MW	1353 MW
RE target (% of electricity supply by 2010)	29%	12.5%	10%
Renewable electricity policy (1990–2005)[b]			
Principal support (FIT/RPS)	✔ FIT (since 1993)	✔ FIT (since 1990)	✔ RPS (called the renewables obligation—RO) (since 2002)
Additional measures			
Investment support (e.g. subsidies, grants)	✔ Investment subsidies	✔ Investment support for small generators (esp. for solar PV)	✔ Subsidies and grants for micro-generation (e.g. PV); support for off-shore wind
Sales or energy tax exemption	✔ Income tax exemptions for small-scale wind generation (up to 7000 kWh)		✔ Tax exemption for electricity from RE (Levy Exemption Certificate)
Tradable Green Certificates (TGC)			✔ TGC part of RO scheme
Public loans/financing		✔ Low interest loans	
Tender process	✔ Tender schemes for off-shore wind		✔ 1990–1998 the non-fossil fuel obligation (NFFO) was used to support RE
Other	R&D support, grants for decentralised energy offices, net metering	R&D support, eco-tax on conventional electricity	R&D support

Sources: DEA (2004), DTI (2005), Reiche (2005), BMU (2006a), BMU (2006c), DEA (2006b), Eurostat (2006), and Resch et al. (2006).

[a]This figure includes large hydro: 12.58 TWh in DE and 4.56 TWh in the UK. DK has only small hydro.

[b]This is a summary of the main policies to have influenced RE development between 1990 and 2005; not all are ongoing.

3.3. Protecting the environment

Addressing environmental impacts has long been an objective of energy policy in many countries—from smog alerts in London in the mid-1950s to acid rain and forest die-back in central Europe in the 1980s to increasing warnings about climate change (in the 1990s to the present). Recognising the energy sector as a major culprit, governments have introduced measures to reduce these impacts. The type of policy and the degree of intervention can vary significantly from one country to another and appears to be largely influenced by awareness of and the perceived severity of the problem in question. All three case countries have committed to reducing their carbon dioxide (CO_2) emissions through the Kyoto process and consider RE development as a major part of the strategy for meeting this objective (DTI, 2003; DEA, 2005a, b; BMU, 2006a). Opposition to nuclear power (especially after Chernobyl) has also been a motivation for RE development in some countries, especially Germany and Denmark among the case studies. CO_2 emissions and reduction levels are the most widely used indicators of environmental protection in the energy sector these days and it is the value that will be compared in this analysis.

3.4. Fostering innovation

The energy sector is a major source of revenue in many economies. Raw materials have, of course, been a source of trade for millennia, but energy conversion processes and technologies are more specialised, allowing greater value added and incorporating a range of skills, thereby diversifying the skill set of a nation and its industrial base. Conversion of RE streams to electricity is no exception. RE is still a relatively new technological branch where major advances remain to be made. Countries that can foster innovation and commercial development in this sector are expected to find increasing markets to serve (especially given the previous two objectives). This will have additional effects: creating new industries that can lead to job creation and access to new markets, as well as enhancing competitiveness and export potential (DEA, 2005a, b; BMU, 2006e). To these ends, measures to support RE are also often encouraged and implemented by multiple government departments. Renewables development can meet multiple objectives, potentially forming an important part of industrial as well as trade, labour and development policy. Innovation is a difficult objective to measure outright, but it is possible to assess technological development on the basis of employment created in a particular sector, size of the export and internal market (turnover), and contribution to gross domestic product. Although all three case studies mention innovation and competitiveness in the context of RE policy, different emphasis has clearly been given to achieving this objective and how it is measured. Job creation, export potential and know-how are clearly evident in recent German policy documents and were important factors in Danish policy through the 1990s (Douthwaite, 2002; BMU, 2006b).

3.5. Promoting local and regional development

Building on the previous objective, RE policy can be used to stimulate economic activity in particular parts of a country or region by specifying certain areas for development. Economically depressed regions in need of activities to create employment and income may try to attract RE development by establishing attractive conditions for developers, requiring local content and in other ways supporting the sector through incentives and R&D funds. In this way, a region may try to lure not just plant development (e.g. wind farms) but also parts and skills needed in those plants (Ortega and Pérez, 2006). In the case countries, Scotland stands out as one region that has received particular attention in this regard (Scottish Executive, 2006). Development at this level can be assessed by many of the same criteria mentioned under innovation but disaggregated to the region in question. The assessment here is done only nationally, so no indicators of progress are included for this objective.

3.6. Meeting the least-cost criterion

Common to all countries is that the development of RE does not create an excessive financial burden on energy consumers or tax payers. All countries, including the three case studies, wish to develop their RE sector at the least cost, while providing the greatest benefit. A typical indicator to measure this objective is the cost per unit of electricity generation. To reflect the full cost, this figure should include the cost of generation plus the support costs.

3.7. Determinants of policy

Progress towards particular objectives, like those described above, is usually a motivator for policy making, but there are several factors that inform those objectives in the first place and influence policy decisions (Bell, 2000). Broader socio-political, ideological, institutional and structural influences determine what problems are important enough to be considered in the first place, which solutions are acceptable, and the rules and procedures that are followed to reach a particular outcome. Although often interdependent, these variables can broadly be categorised as the setting, distribution of power, prevailing ideas, institutional frameworks and process of decision making (Simeon, 1976). Also important are the resources available and committed to achieving a particular objective, as well as the interaction of various policies working towards (or away from) the stated goals. In other words, policy is developed in a particular context (history, culture and politics) that will affect what issues are given priority and how they are addressed. Although countries may introduce the same policy mechanisms, the outcome can vary because of the context.

4. Case studies

Denmark, Germany and the United Kingdom are the selected case studies in this work because of the type of policy framework each has implemented, the length of experience with their respective frameworks (Table 1) and their contrasting contextual circumstances that help raise a range of issues important for consideration by others in pursuit of effective RE policy. All three countries are highly industrialised nations and therefore share many contextual factors (for instance, industrial and political institutions, many energy production and consumption trends, and adherence to environmental and social standards). As members of the EU, they are all influenced by decisions and directives issued from Brussels. However, they also differ in important ways, especially regarding their energy policy history, ideology, the locus of power in decision making, institutional arrangements and other factors discussed below. The lessons that emerge from this analysis are therefore of particular relevance to EU member states and countries at similar stages of development, but lesson drawing is not limited to countries with those commonalties. Many considerations for effective RE policy raised here will apply to a range of national circumstances.

4.1. Denmark: bottom-up–top-down action

Initial interest and support for RE in many countries can be traced back to the first oil crisis of 1973 and Denmark was no exception. With no (known) indigenous fossil-fuel resources, and an early decision (resulting from steady public pressure) not to build nuclear power plants, the Danes' options for self-sufficiency were limited. Consequently, there was an active discourse over Denmark's energy future from the mid-1970s onward (Hvelplund, 2005; Haaland, 2006). It is one of the few countries in the world that actively, and in a sustained way, supported RE development from the late 1970s, through the 1980s and 1990s to the present. Where other countries' programmes waxed and waned, the Danes were persistent in pushing this sector. Energy security, self-sufficiency and efficiency have remained the principal objectives of energy policy throughout this time. To meet these ends, successive national energy plans were developed in dialogue with various groups. The wind sector managed to be included on this agenda because of an organised grassroots movement (Hvelplund, 2005).

The Danish experience is interesting because it is one of the few countries that put in place systematic measures to balance the relationship between conventional (i.e. fossil fuel) energy industries and so-called "alternative" suppliers, which was developed in dialogue with a range of actors. Starting with reforms in the 1980s, "systematic public interference in the monopoly market [helped to break] its 'barrier to entry' institutions and open[ed] the door for the wind power technology" (Hvelplund, 2005, p. 95). Comprehensive energy plans were developed periodically (every 2–5 years since 1976), publicising objectives and the means to achieve them (Hammer, 2006). Among the measures introduced to support RE were a FIT, an investment subsidy, tax exemption for wind power and establishment of a public wind-power test station (Meyer, 2006). Important in Denmark was the early acceptance of RE as a complementary source of energy rather than as an alternative. Moreover, resources were balanced between lobbyists of the different options. Funds to empower independent lobbyists were allocated by Parliament for technical pilot projects, energy offices and independent research centres (Hvelplund, 2005). As experience with wind and other RE was gained and new participants entered the market, an advocacy coalition that initially started with a few wind enthusiasts was able to grow into a veritable influence, continually pushing its collective agenda. The balance in Parliament in which small parties also have power played a role in enabling various policy measures to be experimented with (Hvelplund, 2005).

A small group of wind-power enthusiasts grew into an organised interest group (the organisation for RE-OVE) creating continual pressure on the government to accept (and eventually provide support for) this technology, especially through the cooperative model. Public ownership was directly encouraged through a generous tax allowance (for own generation) and later complemented by a FIT. The FIT compensated developers for the environmental attributes of the power, thereby making it possible for the investments to be profitable. The local ownership helped create widespread support for RE, especially wind, because benefits were distributed across a wide group of people (Meyer, 2006; Maagard, 2006).

Central to the diffusion of wind energy in Denmark was the FIT (Hvelplund, 2005; Maagard, 2006). It obligated utilities to purchase wind-generated electricity at a rate that equalled 85% of the price paid by consumers. Introduced in 1993, the FIT was the stimulus needed for widespread wind development and allowed projects to move beyond wind enthusiasts to a bigger share of the population (Hvelplund, 2005). Other policies complemented the FIT, including a direct subsidy and tax exemption to private turbine owners, a 30% investment subsidy and tax-free electricity generation up to 7000 kWh (Meyer, 2006). These policies combined with early investment in R&D and thoughtful land-use planning to encourage widespread participation in turbine investment (Komor, 2004). Although support levels, and thus developments, varied over time, a certain stability was achieved.

The Riso Research Centre wind-power test station was established in 1986 to provide quality assurance of turbines sold to the public. Through collaboration among the public testing centres, research institutes and the private sector

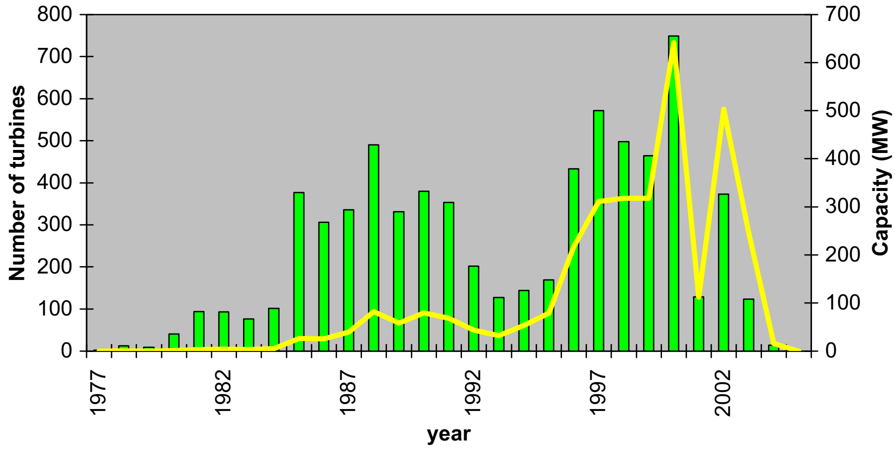

Fig. 1. Installed capacity and turbine installations in DK, 1977–2005 (*Source*: Meyer, 2006).

over the last 25 years, Denmark has been able to refine turbine and power-system design. The Danes have built up a knowledge base that remained unrivalled for many years, achieving cost reductions of 80% to produce 1 kWh of wind power (Hvelplund, 2005; DWIA, 2006). Important factors in this success were available capacity in industry to pursue RE development, independence in research and a motivated public.

Explicit support for wind energy changed in 2001. Under a new government, there has been a shift away from direct support for RE to a free-market (neo-liberal) approach in the energy sector in Denmark. The FIT was modified in 2001 and wind generators are now paid the market price, set by the Nordic Power Exchange, and an environmental premium of 0.10 DDK/kWh (approx. 0.013 €/kWh).[1] This premium is felt to be too low to continue growth in this sector (DWIA, 2006). The effect of these policy changes is clearly evident in the pace of development in Denmark over the last 5 years (Fig. 1).

Support was also cut for certain R&D activities, hence introducing a period of uncertainty for RE developers and researchers. The government initially planned to introduce a certificate trading mechanism, which it believed to be a more efficient means to develop RE, but those plans have been put on hold until the certificate market becomes more robust (Nielsen, 2006). Centres of research that played an important role in the development of wind power in the past have lost funding and are struggling to continue their activities (Maagard, 2006). This immediate effect on industry activities underlines the need for continued stability in this sector until it is able to compete on a more even basis with conventional energy sources. This has raised many questions about how things will continue and whether Denmark's new approach will also serve as a model to be emulated or prove to be an example of what not to do.

[1]This is known as a premium-price FIT compared to with a fixed-price FIT that existed in Denmark before.

4.2. RE policy 'made in Germany'

As a response to the first oil crisis, Germany, like so many countries, began to consider RE and supported the sector through R&D funding, starting in the mid-1970s. The main effort went, however, into fuel switching away from oil towards more coal and nuclear energy (Lauber and Mez, 2004). An RE tariff was introduced in 1979 to stimulate demand for renewable electricity, obliging electricity distribution companies to purchase RE produced in their supply area based on avoided costs, much like the PURPA rules in the US. However, it was a less-generous support mechanism than the US model, resulting in only limited development (Lauber and Mez, 2004). Beyond R&D, little support was provided to the RE sector until the late 1980s and even those funds dwindled every year. What remained was kept in place as a concession to dissenters of the coal and nuclear path (Jacobsson and Lauber, 2004).

The Chernobyl nuclear accident in 1987, combined with growing alarm about climate change around the same time, marked the beginning of a new energy policy era in Germany (Lauber and Mez, 2004). Public opposition to nuclear power was as high as 70% within 2 years of the Chernobyl disaster and a public climate-change commission in 1991 recommended deep cuts in CO_2 emissions (30% by 2005 and 80% by 2050). The need for a fundamental change in energy policy was first articulated at this time (Reiche, 2004). This helped propel development of the first policies to stimulate an RE market in Germany in the late 1980s: a wind and solar promotion programme offering a substantial subsidy and the creation of a legal basis to require utilities to pay higher costs for RE (Mez, 2007). Meanwhile, the idea of a FIT (a compensation for RE generation) was gathering momentum, mainly by outsiders but also from within the governing party at the time. Government support for RE was lukewarm for many years and enthusiasm for it at the political level was not widespread until the late 1990s (Lauber and Mez, 2004).

The first electricity FIT bill was passed and became law in 1990. "[It] required electric utilities to connect [RE] generators to the grid and to buy the electricity at rates of 65 to 90 percent of the average tariff for final customers" (Lauber and Mez, 2004, p. 3). The rationale was to create a level playing field between RE and conventional electricity generation, which reflected the external costs of fossil fuel and nuclear energy. Combined with the subsidy programme, the first FIT was a great boost for the wind sector, helping to expand the market from 20 MW in 1989 to more than 1000 MW in 1995 in electricity (Grotz, 2005). By this time opposition to the FIT was also growing, especially by the utilities which had underestimated the impact of the law when it was first introduced. There were concerns about the level of support, especially to wind, and the uneven cost burden given that RE developments were concentrated in certain parts of the country. Of concern to RE developers was the decline in electricity prices after the electricity market in Germany was liberalised. Since the feed-in rate was pegged to the electricity price, RE developers lost revenue (Butler and Neuhoff, 2004). Minor modifications to address some of these concerns were made to the FIT law in 1998, but in 2000, under a new government involving the Green Party in the coalition, it was completely overhauled.

The Feed-In Law was repealed and replaced by the Renewable Energy Sources Act in 2000. The FIT was retained as the central feature, but RESA stipulated revised rates to RE generators and long-term contracts. Rather than expressing compensation rates as a percentage of average tariffs, the new rates were fixed for 20 years (no duration was stipulated in the previous law). Tariffs varied by type of technology and, in the case of wind, by location of the turbine (i.e. determined by wind speeds). The rates were also set to decline over time to account for technologies moving up the learning curve. Several other new features were introduced, including a nation-wide equalisation scheme to distribute the costs incurred by grid operators across the country, and the option for utilities to be paid the FIT for their own RE generation (Lauber and Mez, 2004). RESA was amended in 2004, changing some of the rates (reductions for some off-shore wind and small hydroplants but an increase for on-shore wind, solar PV and geothermal plants), including medium-sized hydroplants (up to 150 MW) and providing support for biomass plants (Grotz, 2005). Further rate revisions were made in 2006 (Table 2).

The FIT in Germany has been supplemented by a number of other measures aimed to bring technologies up the learning curve. R&D investment has grown significantly since its beginnings in the 1970s (from €10 million in 1974 to almost €2 billion between 1990 and 1998) (Lauber and Mez, 2004). There are low-interest loan programmes, planning privileges for wind projects, training programmes geared towards RE installations in various professions and public information campaigns. The solar industry has been helped along through an expanded solar roof programme (starting with 1000 roofs in 1989 and upgraded to the 100,000 Roof Programme in 1999). The German government implemented an ecological tax reform in 2001 that introduced a tax on the consumption of electricity and raised the level of tax on fossil fuels (except coal). Used mainly to reduce GHG and as pension fund contributions, some of the revenues were also used to subsidise RE (Reiche, 2004). The cost of the FIT, about 0.056 €-cents/kWh, is, however, covered by electricity consumers.[2]

Table 2
German feed-in rates under RESA, 2006

	FIT (€-cents/kWh, 2006)	Duration (years)	Annual degression (% in FIT reduction)
Hydro	6.65–9.67	30	0
Biomass	8.15–21.16	20	1.5
Geothermal	7.16–15.00	20	1.0 (as of 1 January 2010)
Wind (on-shore)	5.28–8.36	20	2.0
Wind (off-shore)	6.19–9.10	20	2.0 (as of 1 January 2008)
Solar PV	40.6–56.80	20	5.0–6.5

Source: DENA (2006).

Although the single most-important reason for RE success in Germany is put down to the FIT, it is clear that several factors have been at play in enabling RE diffusion and policy development (Krazat, 2006; Schurig, 2006). The FIT model evolved over time, in which RE support was building, mainly within civil society. Few anticipated the impact the FIT would have in Germany, but because of its success in terms of installed capacity, manufacturing and job creation, it has survived three changes of government. In 1998, the Red–Green coalition (SPD/Grünen) came to power, modifying and strengthening the FIT principle and enacting it in national legislation. The CDU/CSU and SPD coalition was elected in 2005. Despite criticism of the FIT by the CDU/CSU while in opposition (Lauber and Mez, 2004), the policy's success at job creation (a major concern in Germany for some time) means that it is not likely to see any great changes under the present leadership (Krazat, 2006).

The institutional arrangements, especially regarding who holds the responsibility for the RE, are also a factor in Germany's RE success (Reiche, 2004; Krazat, 2006). Before 1998, responsibility for the RE policy rested with the Ministry of Economics (Wirtschafts Ministerium). It introduced the FIT, but did not develop a strategic framework from which the industry could evolve; there was a lack of policy cohesion and commitment to the sector. By many accounts, this changed when the RE portfolio was transferred to the Ministry for Environment, Nature Conservation and Nuclear Safety, which has

[2]Mechanisms within RESA, especially the FIT, make up about 3% of the cost of private households electricity bills (~0.56 €-cents/kWh out of a total cost of 18.6 €-cents/kWh) (BMU, 2006e).

developed a package of support for the sector (Reiche, 2004).

Viewed at a glance, the German case suggests that a strategic approach to RE development was followed. A closer look reveals that it was not commitment to renewables but the success of policy that carried the country forward to its lead position today. Over time, this "encouraged the rise of an advocacy coalition capable of influencing the institutional framework" (Lauber and Mez, 2004, p. 617). Eventually, the economic and industrial development (with the knock-on benefits of jobs and turnover) could not be denied and the model is now being actively promoted around the world.

4.3. 'Pick no winners': the UK approach to re-development

RE support in the UK did not begin in a significant way until the early 1990s. Although there had been some R&D support for new technologies to address energy security issues in the late 1970s, with hydrocarbon resources in the North Sea, an abundance of coal and little public opposition to nuclear energy, there was little pressure on the government to find alternatives. Climate change, although a recognised problem, did not receive formal commitment as early as in Germany or Denmark, and, in any case, broader energy trends (a shift from coal to gas under the Thatcher government) helped to reduce emissions in the 1990s (Eichhammer et al., 2001). R&D activities did not translate into much actual RE development on the ground and so it was not until the introduction of the Non-Fossil Fuel Obligation (NFFO) that the RE sector began to emerge in the UK. But even NFFO was not, at least initially, implemented as an intentional RE support mechanism, but rather was introduced as a means of subsidising the nuclear industry that was struggling under the UK's electricity market reforms (privatisation). Renewables were added as an afterthought to help pass the legislation (Mitchell and Connor, 2004).

NFFO was a competitive bidding system that provided a price premium to eligible technologies. The bidding was held in five rounds between 1990 and 1998. Rules and prices changed several times during this period to address certain shortcomings of the policy. Among those were a lack of competition in initial rounds, a rush for high-wind sites that resulted in backlash from the public and exclusion of higher-priced technologies that limited the diversity of developments. In total, 3270 MW of RE was commissioned under NFFO, but only 1000 MW had been installed by the end of 2003 (Butler and Neuhoff, 2004). Not all projects were completed due to planning constraints and because bids had been made too low to allow development. Because of the least-cost basis on which NFFO was conducted, biomass projects, especially land-fill gas and energy-from-waste, as well as on-shore wind power, dominated the plants built (Mitchell and Connor, 2004). In 1997, when the Labour party took office, an extensive energy review was carried out. There were numerous changes, but the one most relevant to this discussion was the introduction of the RO in 2002. It reversed the rules of the NFFO by placing the "obligation on suppliers to purchase and supply a certain amount of *generated electricity* not a contract for generation from specific projects" (Mitchell and Connor, 2004, p. 1939, emphasis in original).

The quota started at 3% of total annual supply in 2002/2003, increasing around 1% each year (the 2010/2011 target is 10.4%). Although envisaged to run until 2027, targets have only been set to 2016 (at 15.4%) (DTI, 2006). If suppliers fail to meet the annual obligation, they are required to pay a buy-out price of £30/MW/h (Butler and Neuhoff, 2004). The buy-out price sets the price cap on RE supply, intended to limit the cost of RE to the consumer. To encourage and reward compliance, buy-out funds are recycled back to suppliers who meet the quota. RE suppliers are issued a renewable obligation certificate (ROC) for every kWh of (eligible) renewable electricity they produce, and these ROCs can be bought and sold to meet the obligation. In this way, the RO has a built-in tradable certificate component. What the RO does not include is any requirement on the type of RE purchased (with the exception that large hydroplants are not eligible) and no stipulation on the price or duration of a contract (Mitchell and Connor, 2004). Each contract is negotiated on an individual, usually least-cost, basis between the utility and the RE generator, or the utility may choose to self-generate. "Suppliers offer different lengths of contract depending on the price they pay per kWh" (Mitchell and Connor, 2004, p. 1939). Medium- and long-term uncertainty about the price of renewable generation means that most contracts are negotiated only for a few years since no one wants to be locked-in in case prices fall. This creates uncertainty and brings with it risks for developers who know neither the volume nor the price at which they will be able to sell their power. In a 2006 energy review, many with links to the RE industry and/or with an interest in environmental protection spoke out critically about the RO, noting in particular that its design leads to under-achievement of the targets (Carbon Trust, 2006; Greenpeace, 2006). In 2005, only 3.9% of electricity was generated from RO-eligible sources rather than the targeted 4.9% (DTI, 2006). Another major concern was that, as a support mechanism, the RO only works for on-shore wind and some biomass plants and does nothing to promote emerging technologies like off-shore wind, solar, wave and tidal (Mitchell, 2006; Parr, 2006).

The UK does support a spectrum of RE technologies in other ways. Three programmes stand out: the Low-Carbon Building Programme with a £80 million (€119.3 million) fund over 2 years for a range of micro-generation technologies; the Marine Deployment Fund with a budget of £50 million (€74.5 million) to support emerging ocean energy technology (essentially R&D support) and exemptions from the Climate Change Levy (a carbon tax) for commercial and industrial customers if they employ RE in their operations (DTI, 2006).[3] The first two of these policies are recent announcements, having been changed from other forms of support. This has been a further frustration of the industry, which must now adjust to new rules and eligibility criteria (Parr, 2006).

The UK has not been nearly as successful as Germany and Denmark in encouraging RE development and has not achieved many of the objectives set out for the sector. Policy choice is certainly one consideration for this failure since the RO does not provide the price and market security needed for investment. But there are other factors at play that contribute to the uncertainty in the UK market. The frequent change in policy is considered a problem: from NFFO (which itself underwent a series of revisions) to the RO and more recently funding designations and criteria changes for the micro-generation sector (Parr, 2006). Under these circumstances, developers have a hard time planning, let alone committing, to develop; stability is one of the key criteria of the industry. Mitchell and Connor (2004) put these policy wobbles down to a "lack of clarity and agreement over the reasons for and goals of RE policy … [which] has dogged and constrained the design, success and cost of RE policy" from the beginning (1936).

Although the RO is working towards specific RE targets, there does not seem to be, despite government reminders of the objectives outlined in Section 3, the same level of commitment to the achievement of these goals as in Germany and Denmark. Many RE development hurdles became evident through the NFFO experience, but little was done to address these prior to or through the RO. One concern the RO was intended to address but failed to achieve was a significant reduction in the cost of renewables (Mitchell and Connor, 2004). Planning constraints, one of the big bottlenecks in the British wind sector, were also not addressed, despite already causing problems and limiting development under the final three NFFO rounds (Mitchell and Connor, 2004). There has been activity in recent years (and months) to address the planning problems, but the resources available to address that problem are considered inadequate (Armstrong, 2006).

The UK planning debacle is, in large part, caused by a small number of RE (especially wind) dissenters who have managed to yield incredible influence over local councillors who ultimately make the decisions about which projects can go ahead (Armstrong, 2006). RE did not have nearly the same level of bottom-up enthusiasm and support as it received in Denmark and Germany. Although climate change has become a central motivation for pursuing RE in the UK, other energy options, most notably nuclear, are felt to be able to achieve that goal. Discussions about the future role of nuclear energy for meeting the UK's CO_2 reduction targets in the face of growing energy demand have thus intensified recently.

The market-based ideology in the UK has played a central role in RE policy choice and explains some of the problems that emerged (Mitchell, 2006). Through the 1990s, when Denmark and Germany were experimenting with various RE support mechanisms, the UK was busy privatising the electricity sector, trying to get the rules right to allow that market to function. Limited resources were committed to the RE question beyond NFFO. The RO was chosen as the main RE support mechanism because it was felt to be the least intrusive mechanism and expected to produce the lowest-cost RE. What it was intended to avoid was picking technology winners since it was felt that this was for the market to decide. The consequences of that approach are evident from the results, in which there has been a shortfall in generation, higher costs (than in other countries) and lack of diversity in supply. Hence, not only has the UK avoided picking technology winners, but it would also seem it has not chosen a policy winner either.

5. Comparing policy performance

Policy tends to be judged and evaluated on the basis of whether it meets its intended objectives. Evaluation "centres on determinations of the distance existing between goal and experience, the speed with which this distance is either being closed or is opening, and the breadth and fairness of coverage those in need and holding these goals have realised" (Brewer and deLeon, 1983, p. 329). Effectiveness is one criterion for evaluating policy since it most directly relates policy goals to policy outcomes (Dunn, 1994). In this section, progress towards policy objectives will be assessed by comparing the three countries on the basis of the indicators suggested in Section 3. However, this can provide only indicative evidence of policy effectiveness since there are many factors that affect policy outcomes. Contextual factors, changing objectives, priorities and actors, and resource constraints all affect policy performance. Moreover, it is difficult to judge progress towards a goal when no specific targets have been set. Most policy objectives are expressed in vague and ambiguous terms, making it difficult to say with certainty whether they have been achieved (Brewer and deLeon, 1983; Wildavsky, 1987); this holds with most objectives in the case studies. The most that can be said is that a trend towards or away from the objective is evident.

Four of the indicators outlined in Section 3 are examined here: level of RE penetration, contribution to CO_2 reduction, employment effects and cost of RE development. In the present analysis, it is impossible to attribute the policy outcomes to a single policy or another factor. Rather, they are the cumulative result of RE policy in the three countries since the late 1980s. It is difficult to isolate the effect of a particular policy mechanism since none operates in a vacuum; each is affected by other policies and influences (Pal, 2001). Consequently, the results say less

[3] Currency conversions were calculated using the on-line conversion tool, Universal Currency Conversion available at www.xe.com. These were calculated on 25th October 2006, at which time £1 = €1.49, €1 = US$ 1.27 and 1 Danish Kroner (DKK1) = €0.13.

about a particular policy mechanism than about the overall national approach. It is, however, possible to begin to identify particular features of the national approach to provide lessons for other countries.

5.1. RE penetration

In absolute terms, Germany is the world leader in wind and solar energy production. It is also among the leaders in terms of new biomass developments (REN21, 2005). Germany achieved 18,428 MW of installed wind capacity in 2005, while solar PV installations reached nearly 1400 MW (600 MW were added in 2005 alone). This means Germans met 10.2% of their electricity needs from RE sources in 2005 and are expected to achieve the national target of 21% by 2010 (BMU, 2006a).

On a proportional and per-capita basis, Denmark is the leader in installed RE generation, with the majority of that from wind power. Denmark ranks fifth in the world in terms of installed capacity, but is one of the smaller countries in the world (only 5.4 million people compared with Germany's 82 million and the UK's 60 million). In 2005, Denmark produced 3122 MW of wind-generated electricity, and met about 20% of the country's electricity demand from this power source. Denmark is expected to achieve its 2010 renewable electricity target of 30% (REN21, 2006; DEA, 2006b). Danish wind development after 2001 suffered under policy uncertainty. Both in terms of added new capacity and annual turnover, there were declines from 1999 onwards which saw the sharpest drop between 2003 and 2004 (Fig. 1) (DEA, 2006b; DWIA, 2006).

The UK has not been nearly so successful in developing its RE sector, and within that sector only wind and energy-from-waste are active market participants. The current level of new installed RE capacity in the UK is about 1700 MW, representing 3% of the UK electricity mix in 2004 (and 3.9% in 2005). Wind power capacity reached 1353 MW in 2005. The majority of RE capacity was added during the NFFO era, with 700 MW attributable to the RO. Given the design of the RO, the UK is expected to continue falling short of its RE target, failing to meet its 10.4% by 2010 national (and EU) target (DTI, 2006; Mitchell, 2006). Discussions are underway about how to modify the RO to provide support for emerging technologies (DTI, 2006).

5.2. CO_2 reduction

Each case country has a CO_2 reduction target under the Kyoto Protocol, negotiated within the EU burden-sharing agreement. The Kyoto targets require 30%, 20% and 12.5% reductions by 2012 in Denmark, Germany and the UK, respectively, and each country has also set long-term indicative targets in the 50–70% reduction range by 2050. Germany and the UK have already come some way to meeting their respective targets: in 2004, the Germans reduced their emissions by 17.5% (over 1990 levels) and the UK by 14%. The Danes were not so successful, with a reduction of less than 2% (EEA, 2006). Only some of these reductions can be attributed to RE. In the UK, for instance, most of the reductions come through fuel-switching from coal-fired to gas-fired electricity in the 1990s, while the Germans have been able to make substantial reductions through the restructuring that followed reunification (Eichhammer et al., 2001). The German Environment Ministry does, however, attribute a saving of 58 million tonnes CO_2 through renewable electricity production in 2005, which represents about a quarter of the reductions in that year (Table 3) (BMU, 2006f).

The role of RE for reducing CO_2 emissions in the power sector is complicated by the range of fuels that are

Table 3
Progress towards policy objectives

Energy indicators (2004 data unless indicated)	DK	DE	UK
(All) RE as % of electricity (2005)[a]	20%	10.2%	4%
CO_2 reductions between 1990 and 2004	−1.2 million tonnes	−215 million tonnes	−108.2 million tonnes
Kyoto targets in brackets	−1.8% (−21%)	−17.5% (−21%)	−14% (−12.5%)
CO_2 reductions through RE		58 million tonnes	
Job creation			
Number employed in RE sector		157,000	8000
Wind sector only	20,000	70,000	4000
Cost (€/MWh) (average to maximum support level)			
Wind	58–62	70–105	110–120
Biogas	80–105	95–115	110–120
Biomass	75–95	110–140	120–125
Hydro	n/a	90–120	85–120
Solar PV	50	550–700	300–500

Source: DTI (2004, 2006), EC (2005), BMU (2006a), DWIA (2006), and EEA (2006).
[a]This includes all renewable electricity, not just new sources, and so covers large hydro and other RE that may have been developed under a variety of policies and circumstances.

displaced by RE and by the way conventional power plants are operated (Gallachóir et al., 2006). In Denmark for instance, RE often offset hydropower from Sweden and Norway and so the CO_2 reduction potential is much lower than a displacement of coal-generated electricity. But, even in the case of a coal base load, RE does not replace coal on a kWh to kWh basis given how base-load plants are operated (White, 2004; Gallachóir et al., 2006). As a result, it is important to recognise that RE may have limited impact on CO_2 emission reductions in most countries in the short term. However, the sector is expected to play an increasingly important role in CO_2 reduction strategies as the penetration level and the range of sources brought on line increase (Uyterlinde et al., 2005).

5.3. Industry, innovation and employment

The German and Danish RE sectors are considered major pillars of industrial development and job creation. The German RE industry employed more than 150,000 people in 2005, with nearly 80,000 working in the wind sector. This is a tripling of jobs in the RE sector since 1998. Investments in the sector have also grown steadily during the last few years and totalled more than €9 billion in 2005 (BMU, 2006a).

The Danish wind industry has also been remarkably successful at fostering economic activity. About 20,000 people are employed in the Danish wind industry in Denmark and, with a 40% share of the global wind turbine market, many additional jobs have been created abroad (DWIA, 2006). According to the Danish Wind Industry Association (2006), half of the 40,000 MW wind energy installed around the world is produced from turbines built by Danish manufacturers. Annual turnover in the industry reached its highest point in 2000 with €380 million. The policy uncertainty in Denmark in the last 5 years shows in the turnover trends, which fluctuated wildly between 2000 and 2004 and reached a 20-year low in 2004 (DWIA, 2006). This is attributed to a sharp drop in domestic sales in this period.

The RE sector in the UK has also seen significant growth since 1990, with most activity in the wind, biomass and energy-from-waste sectors. The total monetary value of the RE sector (adjusted for imports) was €433 million in 2004. Eight thousand people were employed in the industry, with half of these involved in the wind sector (DTI, 2004). The UK export industry is small, making no significant contribution to the international RE market at present.

Although no numbers are available to quantify the contribution, it is worth noting that Germany and Denmark have been able to market not only their technologies but also their policy approach. The German Environment Ministry (BMU) is facilitating a network of countries and jurisdictions that have begun to implement a FIT (or are interested in doing so) to share experiences with those emulating the German approach (Büsgen, 2006). In this regard, it has been able to achieve another objective, one which states that not only technology innovation is important but so are new policy instruments, institutions and changed behaviours (translated from BMU, 2006b, p. 46). The Danes, too, have been exporting their policy know-how for many years and have been an international showcase for RE, CHP and energy efficiency for many years (Hammer, 2006).

5.4. Cost of RE

For some time, the RPS was widely considered the least-cost approach to RE development. The FIT was thought to be an expensive mechanism that did not stimulate sufficient competition within or across industry to bring costs down. Several recent policy assessments show, however, that the UK RO as well as other European quota systems produce renewable electricity at a higher cost than the FIT (EC, 2005). This was found to hold for wind, biogas and small-scale hydroplants; in each case, the UK paid more for these developments than Germany or Denmark, despite generation costs being comparable in all three countries. Generation costs do vary in the case of wind power when different wind regimes are considered and averaged. Germany, with a less favourable wind resource than the other two countries, has the highest average price of generation. Generation costs range between 50 and 60 €/MWh in DK and UK and between 58 and 85 €/MWh in Germany. Of the three countries, Denmark provides the lowest level of support for wind power and the UK the highest. The UK RO has been calculated to produce wind energy at an average price of 110 €/MWh (and a maximum of 122 €/MWh) under current arrangements (EC, 2005). This includes the following costs: a buy-out price, a recycled premium (from short-fall penalties), a levy-exemption certificate and the cost of the energy itself (Mitchell and Connor, 2004). In Germany the average price is 80 €/MWh and 105 €/MWh maximum, while Denmark provides an average of only 57 €/MWh (max. 61 €/MWh) (EC, 2005).

The higher support costs in the UK are explained by the higher risks involved for developers and the high ROC price (Resch et al., 2006). Because of the need to secure contracts in a competitive market, the RO creates the following risks identified by Mitchell and Connor (2004): price risk (beyond the short-term contract, the price is not known and subject to fluctuation); volume risk (uncertainty about the sale of power in the future); and market risk (generation value varies according to market rules). So, although competition may help address the cost of generation, it has done little to ensure low-price RE development. Indeed, the uncertainty of the RO has driven up the support costs and has resulted in more expensive wind development in the UK than in any other European country (EC, 2005). Nor do the higher support levels in the UK translate into more wind energy development.

Generators under a FIT system incur none of the same risks because they are "not required to negotiate contracts, participate in bidding or obtain complicated permits"

(Jacobsson and Lauber, 2004, p. 9), yet this has not stifled competition of production. Hvelplund (2005) notes that the Danish system "motivated the producers to lower their production prices as they were in a situation where more windmills could be sold if prices of wind turbines decreased" (p. 95). This contributed to the cost reduction in wind-power production from 14 €-cents/kWh in 1985 to 8 €-cents/kWh in 1991 to around 4 €-cents/kWh in 2004 (for coastal sites) (Hvelplund, 2005, p. 94).

6. Discussion

A number of factors help explain the results presented above—some vary among the case countries and others are common to all three. Several underlying principles can be drawn out to provide important lessons for other jurisdictions. Policy choice and design, combined with political commitment, citizen engagement and acceptance of RE as a legitimate player in the energy sector, are all important considerations for those serious about developing this sector.

6.1. Commitment and clarity

Time and again, a clearly stated government commitment is named as the most critical element in transforming the RE market. Policy framed around specific goals and targets is more likely to achieve results than vague support for "more RE development"; at the very least it can be measured, assessed and policy needs identified. All three countries established targets for RE, but the UK did this later than the others and showed less commitment to its objectives.

Early government commitment to fostering alternative sources of energy, combined with a meeting of bottom-up and top-down approaches, is often named as the key to initial success in Denmark. The Germans, although slower off the mark, adopted a similar approach, although initiated even more from the grass roots. German commitment initially did not come from within the political system but from civil society. This points to the importance of nurturing public and private sector support, if it does not exist already. Commitment is needed from all sectors of society.

6.2. Policy features and design details

Policy choice and mix are important—the FIT has shown that it can be effective for meeting multiple objectives, but the policy alone is not enough. How it is designed and implemented and how it interacts with other policy are thought to be critical to its success. The Danish and German cases certainly point to the importance of a fixed-price mechanism to provide the long-term security needed to attract and retain investment, but those countries also nurtured RE development for a much longer time than the UK and introduced a broader palette of support measures. Although it is premature to assign RE success in Germany and Denmark to the FIT without a full analysis of its effects in isolation, the FIT experiences point to several advantages. It can be used to encourage development in a range of locations, thereby fostering regional development. The FIT is also open to a range of technologies and project sizes, so it is more inclusive, spreading the benefits to a range of participants.

Viewed as more market-friendly because price is not predetermined, the RPS, as implemented in the UK, provides little certainty about the price paid to generators or about the duration of a contract. This stalls investment and limits the diversity of technologies supported. It also limits the type of participants in the market to large players who can achieve economies of scale. The RPS, as applied in the UK and several other countries, has also been found to be the more expensive approach to RE deployment, dispelling the assumption that it is the least-cost approach. Although the UK has introduced other policies to support smaller and less commercial RE, none has been in place long enough to assess the impact. Policy continuity is important.

The ephemeral nature of policy in the UK and more recently in Denmark has been shown to be detrimental to RE development. As an emerging sector, assurances about market conditions are still needed to foster participation from a range of players. Yet, clinging to an ineffective policy is also undesirable. The UK's recent consideration of policy modification that would band the RO to accommodate less mature technologies is a case in point. Many in the RE sector agree that a fundamental overhaul of the policy is not desirable at this point, but that modifications are needed.

6.3. Creating a balance between competing sources

The dialogue about alternative energy paths needs to be opened and funding distributed more equitably among various options. Independent research and an openness to alternative models are important in allowing renewables to break into the mainstream, as shown in the Danish case. As long as the sector is treated as an alternative rather than as a legitimate, mainstream form of energy generation, it will not move beyond the sphere of tinkerers and treehuggers. This requires levelling the playing field between RE and conventional electricity sources. This includes, principally, addressing administrative barriers, allowing grid access, encouraging financing and bringing the public on-side (Ragwitz et al., 2006). All these have been cited as particular problems in the UK approach.

Recognising and internalising positive and negative externalities inherent in the energy sector is an important place to start. By penalising negative consequences and rewarding positive attributes of energy options, a balance can begin to be established between the two. From here the process of dismantling entrenched mindsets can begin, allowing new coalitions to form and participate in an RE-oriented framework. The Danes have shown that partnerships that provide financial, technical and policy support are crucial for initial and ongoing development.

7. Conclusion

Renewable electricity development has taken different paths across countries, underpinned by different policy frameworks. There has, however, been a convergence to two main support mechanisms, the FIT and the RPS, and much debate surrounds the effectiveness of these two for achieving multiple objectives. The Danish and German experiences with the FIT and the British experience with the RPS provide important lessons for other countries that are in the process of developing policy for the RE sector. The evidence from these three countries suggests that, given appropriate design features, the FIT is more cost effective at getting RE developed. Denmark and Germany have more than 10 years' experience with the FIT and are world leaders in the field of RE development. These countries are closest to meeting their RE penetration targets and have been able to achieve a number of other objectives, especially industrial development and job creation, and, in the case of Germany, CO_2 emission reductions. Although other factors have been important in determining policy choice and implementation in these countries, the particular design features of the FIT allow it to address the needs of the sector. The RE industry needs, above all, adequate compensation that takes technological status into account (i.e. different rates for different technologies), access to the grid and social acceptance. The FIT in Denmark and Germany has shown that this can be provided by providing different feed-in rates, guaranteeing grid access and enabling a range of societal players to participate in the market. The RPS, on the other hand, as shown in the UK case, does not provide the same level of certainty, nor does it differentiate between technological learning curves. The result is that development has been limited to a small number of technologies by few participants. Here, too, national context is important, but policy choice and design are considered key factors in the slower pace of RE development in the UK.

Momentum is building for RE development around the world as its benefits for energy security, environmental protection and economic development are recognised. Achieving all three goals, however, requires incisive policy design and implementation. Countries on the up-swing would be well served to heed the lessons emerging from leaders such as Denmark, Germany and Britain, focusing not on the contextual differences, but rather on the policy design features that have worked for meeting a range of policy objectives.

References

Armstrong, K., 2006. Director of Renewables Policy and Development, UK DTI, London. Personal communication, 18 May.

Bell, D., 2000. Political culture in Canada. In: Whittington, M., Williams, G. (Eds.), Canadian Politics in the 21st Century. Nelson Canada, Scarborough, Ontario.

BMU (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit), 2006a. Trends in Renewable Energies in 2005—Current Situation. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin, March.

BMU, 2006b. Erneuerbare Energien: Innovationen für die Zukunft. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin.

BMU, 2006c. Umweltpolitik: Erneuerbare Energien in Zahlen—nationale und internationale Entwicklung. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit. Berlin, May.

BMU, 2006d. Data and Facts Concerning Renewable Energy in Germany. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin.

BMU, 2006e. Innovation Durch Forschung: Jahresbericht 2005 zur Forschungsförderung im Bereich der erneuerbaren Energien. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin.

BMU, 2006f. Was Strom aus Erneuerbaren Energien Wirklich Kostet. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin.

Brewer, G., deLeon, P., 1983. The Foundations of Policy Analysis. The Dorsey Press, Homeward, IL.

Büsgen, U., 2006. International Feed-In Co-operation, presentation by U. Büsgen representative of the Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit at the REALISE Forum Final Conference. Berlin, Germany, 2–3 November 〈http://www.realise-forum.net/front_content.php?idcat=60&idart=1857〉.

Butler, L., Neuhoff, K., 2004. Comparison of feed in Tariff, quota and auction mechanisms to support wind power development. Cambridge Working Papers in Economics CWPE 0503, Cambridge-MIT Institute, Cambridge.

Carbon Trust, 2006. Policy Frameworks for Renewables: Analysis on Policy Frameworks to Drive Future Investment in Near and Long-term Renewable Power in the UK. Carbon Trust, London.

DEA, 2004. Annual Energy Statistics 2004. Danish Energy Authority, Copenhagen.

DEA, 2005a. Energy Strategy 2025. Danish Energy Authority, Copenhagen.

DEA, 2005b. Energy Policy Statement 2005. Danish Energy Authority on-line: 〈http://www.ens.dk/graphics/Publikationer/Energipolitik_UK/Energy_Policy_Statement_2005/pdf/Energipolitisk_redegoerelse_05_eng.pdf〉.

DEA (Danish Energy Authority), 2006a. Danish energy policy. Available on-line: 〈http://www.ens.dk/sw12333.asp〉 (accessed 11 December 2006).

DEA, 2006b. Danish Energy Agency-Annual Energy Statistics. Danish Energy Agency website: 〈http://www.ens.dk/sw16508.asp〉 (accessed 20 October 2006).

DENA, 2006. Renewable Energies — The German Experience. Presentation prepared by Jens Altevogt of the Deutsche Energie-Agentur (DENA) supplied to the author 14 June 2006, Berlin.

Dinica, V., 2005. United Kingdom. In: Reiche, D. (Ed.), Handbook of Renewable Energies in the European Union: Case Studies of the EU-15. Peter Lang Verlag, Frankfurt.

DTI, 2003. Energy White Paper: Our Energy Future—Creating a Low Carbon Economy. Department of Trade and Industry, London, England.

DTI, 2004. Renewables Supply Chain Gap Analysis. Department of Trade and Industry, London, July.

DTI, 2005. Digest of United Kingdom Energy Statistics 2005. Available on-line: 〈http://www.dti.gov.uk/energy/statistics/publications/dukes/2005/page19311.html〉 (accessed 20 October 2006).

DTI (Department of Trade and Industry), 2006. The Energy Challenge: Government Report on the Energy Review 2006. Department of Trade and Industry, London, July.

DWIA, 2006. Danish Wind Industry Association website: 〈http://www.windpower.org/en/industry.htm〉 (accessed 20 October 2006).

Dobuzinskis, L., Howlett, M., et al. (Eds.), 1996. Policy Studies in Canada: The State of the Art. University of Toronto Press, Toronto.

Doern, B., Phidd, R., 1992. Canadian Public Policy: Ideas, Structure, Process. Nelson Canada, Scarborough, Ontario.

Douthwaite, B., 2002. Enabling Innovation: A Practical Guide to Understanding and Fostering Technological Change. Zed Books, London.

Dunn, W., 1994. Public Policy Analysis: An Introduction. Prentice-Hall, Inc., Eaglewood Cliffs, NJ.

Eichhammer, W., et al., 2001. Greenhouse Gas Reductions in Germany and the UK: Coincidence or Policy Induced? An Analysis for International Climate Policy. German Environment Ministry, Berlin Available on-line: 〈www.isi.fraunhofer.de/e/ublikation/wallfall/co2report-isi-e-final.pdf〉.

Ekins, P., 2004. Step changes for decarbonising the energy system: research needs for renewables, energy efficiency and nuclear power. Energy Policy 32, 1891–1904.

European Commission (EC), 2005. The Support of Renewable Energy Sources. European Commission Report: COM (2005) 627. Brussels.

EEA, 2006. Annual European Community Greenhouse Gas Inventory 1990–2004 and Inventory Report 2006: Submission to the UNFCCC Secretariat. European Environment Agency website: 〈http://reports.eea.europa.eu/technical_report_2006_6/en/EC-GHG-Inventory-2006.pdf〉 (accessed 15 October 2006).

Eurostat, 2006. Eurostat website — database: 〈http://epp.eurostat.ec.europa.eu/portal/page?_pageid=1996,45323734&_dad=portal&_schema=PORTAL&screen=welcomeref&open=/&product=EU_MAIN_TREE&depth=1〉.

Gallachóir, B., et al., 2006. Comparing primary energy attributed to renewable energy with primary energy equivalent to determine carbon abatement in a national context. Journal of Environmental Science and Health—Part A 41, 923–937.

Gipe, P., 2003. Electricity Feed Laws Power European Renewables in Solar Today (November/December). Available on-line: 〈http://www.wind-works.org/FeedLaws/SolarTodayReaders_ForumND03.pdf〉, p. 58.

Greenpeace, 2006. Response to the Department of Trade and Industry's Energy Review Consultation Document. Greenpeace, UK, April.

Grotz, C., 2005. Germany. In: Reiche, D. (Ed.), Handbook of Renewable Energies in the European Union: Case Studies of the EU-15 States, second ed. Peter Lang Verlag, Frankfurt.

Haaland, T., 2006. Greenpeace Denmark, Copenhagen. Personal communication, 16 June.

Hammer, T., 2006. Danish Energy Authority, Copenhagen. Personal communication, 21 June.

Howlett, M., Ramesh, M., 2003. Studying Public Policy: Policy Cycles and Policy Subsystems. Oxford University Press, Don Mills, Ontario.

Hvelplund, F., 2001a. Political prices or political quantities? New Energy 5 (2001), 18–23.

Hvelplund, F., 2001b. Renewable Energy Governance Systems. Institute for Development and Planning, Aalborg University, Aalborg, Denmark.

Hvelplund, F., 2005. Denmark. In: Reiche, D. (Ed.), Handbook of Renewable Energies in the European Union: Case Studies of the EU-15. Peter Lang Verlag, Frankfurt.

Jacobsson, S., Lauber, V., 2004. The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. Energy Policy 34 (3), 256–276 (February 2006).

Klein, A., et al., 2006. Evaluation of Different Feed-in Design Options: Best Practice Paper for the International Feed-in Co-operation. Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Berlin (November).

Komor, P., 2004. Renewable Energy Policy. iUniverse, Inc., New York.

Krazat, M., 2006. Systemanalyse Zentrum für Sonnenenergie- und Wasserstoff-Forschung, Stuttgart. Personal communication, 29 May.

Lauber, V., 2004. REFIT and RPS: Options for a Harmonised Community Framework in Energy Policy, vol. 32. pp. 1405–1414.

Lauber, V., Mez, L., 2004. Three decades of renewable electricity policies in Germany. Energy and Environment 15 (4), 599–623.

Maagard, P., 2006. Director of Nordic Folkcentre for Renewable Energy. Hurup Thy, Denmark. Personal communication, June.

Menanteau, P., Finon, D., Lamy, M.L., 2003. Prices versus quantities: choosing policies for promoting the development of renewable energy. Energy Policy 31 (8), 799–812.

Meyer, N., 2006. Learnings from Wind Energy Policy in the EU, with Focus on Denmark, Sweden and Spain. Draft Paper from the GIN Wind Stream Conference, Cardiff, July.

Mez, L., 2007. Renewables in electricity generation: Germany as pioneer? In: Eberlein, B., Doern, B. (Eds.), Governing the Energy Challenge: Canada and Germany in a Multilevel Regional and Global Context. University of Toronto Press, Toronto (forthcoming).

Mitchell, C., 2006. Principal Research Fellow. Warwick Business School, Warwick University, Oxford, UK. Personal communication, 15 May.

Mitchell, C., Connor, P., 2004. Renewable energy policy in the UK 1990–2003. Energy Policy 32 (17), 1935–1947.

Nielsen, S., 2006. Danish Energy Agency, Renewable Energy Department, Copenhagen. Personal communication, 21 June.

Ortega, J., Pérez, E., 2006. Spanish renewable energy: successes and untapped potential. In: Mallon, K. (Ed.), Renewable Energy Policy and Politics: A Handbook for Decision-Making. Earthscan, London, pp. 215–227.

Pal, L., 2001. Beyond Policy Analysis: Public Issue Management in Turbulent Times. ITP Nelson, Scarborough.

Parr, D., 2006. Chief Scientific Officer, Greenpeace, UK. Personal communication, 16 May, Oxford, UK.

Ragwitz, M., et al., 2006. Interim Report of the Project Optres: Assessment and Optimisation of Renewable Support Schemes in the European Electricity Market. Frauenhofer Institute, Karlsruhe, Germany, January. Available on-line: 〈http://www.optres.fhg.de〉.

Reiche, D., 2004. Rahmenbedigungen für eneuerbare Energien in Deutschland: Moglichkeiten und Grenzen einer Vorreiterpolitik. Peter Lang Verlag, Frankfurt.

Reiche, D. (Ed.), 2005. Handbook of Renewable Energies in the European Union: Case Studies of the EU-15. Peter Lang Verlag, Frankfurt.

REN21 (Renewable Energy Policy Network), 2005. Renewables 2005 Global Status Report. World Watch Institute, Washington, DC.

REN21, 2006. Renewables Global Status Report—2006 Update. World Watch Institute, Washington, DC.

Resch, G., et al., 2006. Potentials and Cost for Renewable Electricity in Europe—The Green-X Database on Dynamic Cost-resource Curves. Report (D4) of the OPTRES Project. Energy Economics Group, University of Vienna, February. Available on-line: 〈http://www.optres.fhg.de〉.

Santokie, F., 2006. Market perception of co-ordination of support schemes: stakeholders viewpoints and expectations presentation by F. Santokie, Head of Renewables Markets Europe, Natsource Europe Ltd. at the REALISE Forum Final Conference, Berlin, Germany (2–3 November) 〈http://www.realise-forum.net/front_content.php?idcat=60&idart=1857〉.

Sawin, J., 2004. Mainstreaming Renewable Energy in the 21st Century. World Watch Institute, Washington, DC.

Schurig, S., 2006. Head of the Climate and Energy, Greenpeace Germany. Personal communication, 12 June, Hamburg, Germany.

Scottish Executive, 2006. New fund to encourage sustainable energy. News release 05/09/2006. Available on-line: 〈http://www.scotland.gov.uk/News/Releases/2006/09/05101636〉.

Simeon, R., 1976. Studying Public Policy. Canadian Journal of Political Science IX (4), 548–580.

Uyterlinde, M.A., et al., 2005. The Contribution of Renewable Energy to a Sustainable Energy System, vol. 2 in the CASCADE MINTS Project. Energy Research Centre of The Netherlands, Amsterdam. Available on-line: 〈http://www.ecn.nl/library/reports/2005/c05034.html〉.

White, D., 2004. Reduction in Carbon Dioxide Emissions: Estimating the Potential Contribution from Wind-power. Commissioned and published by the Renewable Energy. Foundation, London December.

Wildavsky, A., 1987. Speaking Truth to Power: The Art and Craft of Policy Analysis. Transaction Books, New Brunswick, NJ.

Yin, R., 2003. Case Study Research: Design and Methods, third ed. Sage, London.

Zisler, S., 2006. Market Perception of Co-ordination of Support Schemes: Stakeholders Viewpoints and Expectations presentation by S. Zisler, Vattenfall Europe at the REALISE Forum Final Conference, 2–3 November, Berlin, Germany 〈http://www.realise-forum.net/front_content.php?idcat=60&idart=1857〉.