Review of renewable energy development in Europe and the US

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1 Introduction

The DTI is currently undertaking a review of support for innovation in new and renewable energy technologies. The objective of the review is to ensure that policies are well integrated and coherent, and are providing appropriate support to the full range of technologies. ICEPT was asked by the DTI to undertake a brief literature review of international experience in the commercial deployment of renewable technologies. This report presents the main findings.

We recognise that renewables development is progressing around the world, from wind installation in India to bioethanol production in Brazil. However, the purpose of the paper is to provide case studies that could provide useful lessons for the UK. We therefore concentrate on 'peer' countries, with similar socio-economic conditions, and where 'new' renewable technologies have made a significant impact.

In the next section, a broad overview of progress with renewable technologies in Europe, the US and Japan is presented. From this first review, a number of countries are highlighted for more in-depth analysis. Additionally, the situation in the US is examined to contrast this with experience in Europe. Consequently, six country case studies are presented, and the structure of the remainder of the paper is as follows:

2 Progress with renewable technologies in Europe, the US and Japan
3 Country study – Germany
4 Country study – Spain
5 Country study – Sweden
6 Country study – Austria
7 Country study – Netherlands
8 Country study – USA
9 Key findings from the case studies

Each country case study addresses: current energy mix; the policy framework creating a market for renewables; progress with selected renewable technologies and, where possible, costs of the various renewables support programmes. In the final section, key findings from the six countries are drawn together and contrasted with the experience in the UK.

2 Progress with renewable technologies in Europe, the US and Japan

This section provides data on both absolute levels of installation growth and on percentage increase in capacity/output during the 1990s for all of the 'new' renewable technologies that were installed in that period in significant numbers. The technologies in question include wind power, photovoltaics (PV), biomass and solar thermal. The leading countries in terms of growth of each technology are identified. The policy mechanisms – both current and recent – to support renewables in all countries are also outlined.

2.1 Market growth rates and installed capacities

2.1.1 European countries

The European Environment Agency (EEA) recently reviewed the development of renewable technologies across Europe (EEA, 2001). This report provides an overview of both relative growth (percentage expansion) and absolute growth for five technologies - wind power, photovoltaics, solar thermal, biomass power, and biomass district heating - for the 15 EU countries for the period 1993 – 1999. This is the most up-to-date comprehensive review currently available. Whilst developments have continued in some countries in the last four years (e.g. wind in Germany and Spain), slowed in others (e.g. wind in Denmark, and more recently in Germany) and begun to accelerate in some (e.g. wind in the UK), the relative position of all countries remains broadly the same at the time of writing. More recent developments are noted where appropriate in the individual chapters. The main findings of the EEA report are reproduced in table 2.1.

The report also provides an overview of which countries achieved greatest success, in each of the five technologies on the basis of two criteria (EEA, 2001):

1. An absolute increase in that technology equivalent to at least 10% of the total EU-wide increase in renewable energy output over the period 1993–99.

2. A percentage increase in output greater than the average EU-wide percentage increase for that technology between 1993 and 1999.

	Photovoltaics		Solar thermal		Wind		Biomass power		Biomass district heating	
	1993–99		1993–99		1993–99		1993–99		1993–98	
	Absolute increase (GWh)	% increase	Absolute increase (ktoe)	% increase	Absolute increase (GWh)	% increase	Absolute increase (GWh)	% increase	Absolute increase (ktoe)	% increase
Austria	1.4	233	37.1	150	42.0		574.9	59	47.5	62
Belgium	0		0		4.9	60	140.3	238	0	
Denmark	0		3.7	100	1 994.8	193	316.0	189	-15.3	-8
Finland	0		0.2	8 270	45.0	1 125	2 697.0	47	20.2	33
France	0		4.2	30	32.5	928	223.0	18	9.0	113
Germany	32.0	1 070	54.4	260	4 854.0	720	258.0	61	0	
Greece	0		31.9	34	114.5	241	0		0	
Ireland	0		0.1	90	171.9	1 138	0		0	
Italy	5.3	50	3.7	70	398.6	9 059	241.3	812	3.2	58
Luxembourg	0		0		18.0		0		0	
Netherlands	5.3	757	4.0	140	471.0	270	0		0	
Portugal	0.5	100	2.9	20	112.0	1 018	179.0	20	0	
Spain	15.8	1 330	6.5	30	2 628.0	2 266	432.0	89	0.5	
Sweden	0		0.6	10	319.3	618	898.0	42	205.4	56
United Kingdom	1.0		4.8	90	678.0	310	0		0	
EU increase 1993–99:	61.3	358	154.1	65	11 884.5	502	5 959.5	50	270.5	39
10 % of EU increase 1993–99:	6.1		15.4		1 188.5		596.0		27.1	
Criteria thresholds used:	Higher than 6.1 GWh	Higher than 358 %	Higher than 15.4 ktoe	Higher than 65 %	Higher than 1 189 GWh	Higher than 502 %	Higher than 596 GWh	Higher than 50 %	Higher than 27 ktoe	Higher than 39 %

Data in shaded cells meet the selection criteria, that is:

- at least 10 % of the total EU increase;
- a percentage increase greater than that for the EU.

Blank cells indicate that the value for 1993 is equal to zero.

Biomass in power includes combined heat and power and refers to electricity output only;
biomass district heating refers to heat output from heat plants only, and data refer to the period 1993–98.

Source: Eurostat.

Table 2.1. – renewable energy technology expansion in EU countries (from: EEA, 2001)

In terms of the absolute increase in renewable energy penetration, for most of the technologies, only a few Member States contributed more than 10% (each) of the total new resource output for the EU over the six-year period 1993–99 (EEA, 2001:25):

- ***Two Member States (Germany and Spain) contributed 78% of the new total EU output from photovoltaics;***
- ***Three Member States (Austria, Germany and Greece) contributed 80% of new solar thermal installations;***
- ***Three Member States (Denmark, Germany and Spain) contributed 80% of new wind output;***
- ***Two Member States (Finland and Sweden) contributed 60% of new generation from biomass fuelled power stations (including biomass combined heat and power stations);***
- ***Two Member States (Austria and Sweden) dominated the increase in output from biomass district heating installations.***

The UK was not among the leaders in any technology in terms of absolute growth or relative growth for this period. Indeed, whilst things have improved somewhat since 1999, even now the UK lags far behind the leaders in all technologies. Whilst several countries started development earlier than the UK, others rapidly overhauled the UK, even with a late start. It remains to be seen whether the UK will catch up and overtake other countries as a result of the new measures that have been implemented recently. It is also important to understand the extent to which rapid expansion has been secured through generous levels of financial support. This may have brought industrial benefits, but it is unclear whether so doing was 'cost effective'. Did policies simply place a heavy burden on consumers and/or tax payers, or did well designed and well implemented policies help create new industries in a cost-effective fashion? To address this question requires further investigation and analysis of the costs of programmes, which is begun in this report for some of the country case studies, with initial comparisons being drawn in the final section.

2.1.2 The USA and Japan – PV and wind

Over a time period similar to that above, considerable progress was made in some areas in the US and Japan. Japanese efforts focussed to a very large extent on PV, whilst the US pursued a mix of federal and state level policies to support a range of options: wind, PV and biofuels. Both countries also have high per-capita spend on R&D into longer term options. The main points of note are as follows:

- Japan has the world's largest installed capacity of PV, currently in excess of 600 MW_p. Compared with the EU statistics above, Japan was world leader throughout the 1990s, with more than 200 MW installed by 1999, and with market growth in excess of 40% per annum.
- Japanese market growth in PV appears to be proceeding exponentially at present (Renewable Energy Policy Project – REPP, 1999; IEA, 2003a).
- The US has similar installed PV capacity to Germany, currently around 200 MW, and was world leader for much of the 1990s, until overtaken by Japan in 1996 and Germany more recently.
- It is notable that US production of PV greatly exceeds annual installation and roughly 2/3 of US PV is for export.
- The USA has around 4000 MW of wind energy installed at present – placing it roughly second in terms of nation states – similar to Spain and roughly 1/3 of German capacity. However, in terms of geopolitical regions, the Americas as a whole lag far behind Europe at present. Nevertheless the US is clearly one of the most important markets for wind machines (Windpower Monthly, 2003a; IEA, 2003b).

2.2 Policy frameworks

Countries use a mixture of arrangements to support renewables. A variety of policy instruments exist, including:

- Fiscal incentives, such as energy tax exemption;
- Special tariffs for renewable electricity, combined with a regulatory duty to purchase output, so called 'feed in laws';
- Tenders for tranches of renewable output, such as the UK's (superseded) NFFO scheme;
- Quota based schemes, such as the Renewables Obligation, sometimes called Renewables Portfolio Standard or 'RPS' schemes;
- Capital investment subsidy.

In the EU, Renewables policy is decided at nation state and regional government level, while the EU Directive on the promotion of renewable energy (2001/77/EC) sets specific overall targets for Renewables in each country. However, this Directive also specifies that, by 2005, proposals shall be presented to harmonize the different policies in its member countries, taking into account the effectiveness of policy measures used so far.

The situation in the US is also complex, as a range of federal and state level policies have been applied. The result is a mix of approaches, similar in many regards to the diversity seen between EU nations. The range of policies that are, or have been, used in different countries is shown in Table 2.2, below.

Country	**Capital subsidy**	**Feed in**	**Certificate/obligation (RPS)**	**Tendering**	**Fiscal**
Austria	✓	✓	H		✓
Belgium	✓	✓ some regions	✓		✓
Denmark	H	✓			✓
Finland	✓				✓
France	✓	✓		✓	✓
Germany	✓	✓			✓
Greece	✓	✓			✓
Ireland	✓			✓	✓
Italy	✓	H	✓		✓
Luxembourg	✓	✓			
NL	✓	✓	✓		✓
Portugal	✓	✓			✓
Spain	✓	✓			✓
Sweden	✓		✓		✓
UK	✓		✓	H	✓
USA	✓ (PV) H (wind)		✓		✓

Table 2.2. – Renewables policy mix in EU and USA in mid 2003 (✓ denotes existing policy, H denotes historical policy now replaced) (Sources: Bechberger and Reiche 2003; EEA, 2001)

2.3 Policy and deployment matrix

The following matrix (Table 2.3) provides an overview of policy mechanisms and success in renewables development. It appears that countries that have done best in terms of installation rates (see Table 2.1) have had a mix of policies that include investment subsidies, fiscal incentives and feed in laws. As yet, tendering and quota arrangements do not appear to have been so successful. However, the latter are very much in their infancy in the renewables arena and may yet prove a successful driver of development.

Country	Leading technology areas	Policy mix
Austria	High growth in biomass heat and power, solar thermal	Feed in law first on regional basis, now harmonized nationally (2003). Fiscal incentives + capital subsidy appear to have been key to biomass growth.
Belgium	Large relative growth in biomass power, from low base	Feed in law started regionally, now complemented by national RPS, fiscal and capital subsidies.
Denmark	Wind: largest manufacturer, highest proportion of electricity supply and largest installed offshore capacity in the world. Have also substantially increased biomass CHP. Recent onshore slow down due to site saturation. Continued growth offshore	Feed in laws, strong community investment incentives, joint ventures with former state utility and govt, fiscal incentives – high energy tax from which RETs get rebate. Also historical strong R&D support and capital subsidies. Move to RPS was under discussion but has been abandoned.
Finland	Largest absolute increase in biomass power	Fiscal (tax exemptions on biomass and wind) and capital subsidies (solar thermal).
France	Limited progress in wind development and biomass heat. Leading EU in biofuels growth.	Initially tendering, subsequently move towards feed-in tariffs. History of unfavourable connection terms. Favourable fiscal rates for biofuels earlier than many other states.
Germany	Largest installed wind capacity in world. Fastest wind installation rate in world. Largest PV capacity in EU. Recent slowdown in wind development reflects onshore saturation and reduced feed in tariff	Feed in laws rigorously defended and highly differentiated by technology. Both capital subsidy and high feed in rate for PV. Historically, incentives to encourage local ownership and availability of soft loans. Demand for PV grants outstripped available funds.
Greece	Modest progress in wind installation	Feed in, fiscal incentives and capital grants.
Ireland	Modest progress in wind installation	Tendering scheme and fiscal incentives.
Italy	Modest progress in wind installation	Feed in scheme, later complemented by RPS. Fiscal incentives and cap ex subsidies. History of difficulty in securing power connection for wind parks.
Luxembourg	limited resources and development	
NL	Strong growth in PV, solar thermal. Modest progress in wind installation	Initially a certificates scheme only. This is now supplementary to a feed-in tariff scheme (2003). Strong fiscal incentives and subsidies for households and SMEs.
Portugal	Modest absolute progress and high relative growth in wind installation	Feed in laws, fiscal advantages.
Spain	Massive growth rate in wind installation, now second only to Germany in EU capacity. Equally strong growth in PV installation, also second to Germany	Feed in laws, regional level capital subsidies and favourable loans for wind.
Sweden	Strong growth in biomass district heating and CHP. Some progress in wind installation, including offshore	Historically capital subsidies available for wind and biomass. RPS scheme just implemented. Energy tax exemption.
UK	Modest progress in wind installation, consents for onshore recently accelerated, ambitious offshore wind plans under development	Competitive tendering (NFFO) now replaced by RPS scheme & energy tax exemption. Limited capital subsidies available. History of planning obstacles for wind power.
USA	Considerable success in wind installation in many states and notable success with PV in some states.	Initial impetus for wind was capital subsidy available in California in late 1980s. Since this was withdrawn the main mechanism for wind has been a federal production tax credit. Stop-start nature of this produced 'boom and bust'. RPS schemes delivering wind capacity now in several states. Capital subsidies available in some states for PV.

Table 2.3. – Technology/policy matrix for EU and USA (Sources: EEA, 2001; Reiche, 2002)

2.4 Choice of case studies

In deciding on which countries to analyse in more depth, we took into account both the above discussion of relative success in different countries and the preferences of the DTI in matching this report with the existing and on-going work in the Renewables Innovation Review. It is clear that Denmark, Germany and Spain stand head and shoulders above the rest of Europe in terms of their success in promoting wind power, and Germany and Spain are in a similar outstanding position with regard to PV. These three have also been most successful in developing a domestic industry, with the Danish wind industry a particularly notable case in point. However, with the Danish policy framework already under investigation by the DTI, we chose to focus on the latter two countries - wind and PV in Germany, and wind power alone in Spain.

We therefore provide case studies of Germany (Section 3), covering wind and PV, and Spain (Section 4), covering wind.

Austria, Sweden, Denmark and Finland have all made progress with biomass. Sweden is one of the few countries with a certificate based (RPS) support scheme and with some experience with dedicated biomass forestry and agriculture.

We therefore explore further the Swedish experience with biomass through a case study (Section 5) and briefly review Austria (Section 6) to provide a comparison.

Finally, the Netherlands have some experience with certificate schemes and are also notable for their diverse policy mix in promoting renewables. Recently, they have moved towards feed-in tariffs.

Given these factors, the final EU case study is of the Netherlands (Section 7).

The USA has as yet to develop a coherent nationwide renewables strategy and the approach has been described as one of “stop and go”. Nevertheless, an interesting mix of regional, state and federal policies has developed over the recent years which includes capital grants, RPS and tax credits.

We provide a brief study of the impact of the various policies on renewables development in the US (Section 8).

3 Country study – GERMANY

3.1 Introduction

This study focuses on the development of wind and PV power in Germany. German policies appear to have delivered two remarkable success stories over the last two decades, in terms of very rapid market growth and significant increases in installed capacity. Germany is now the world leader in installed wind capacity and second in installed PV capacity behind Japan. Germany was also one of the first countries to introduce a so-called feed-in tariff to promote renewable technologies, a policy which is now widespread in Europe. To set the German scene in a UK context; German wind capacity is currently more than 25 times larger than that of the UK, and in recent years *annual* capacity growth has exceeded UK *total* capacity more than fourfold. All these factors make Germany an interesting country for further study.

The case study is structured as follows:

3.1. Introduction
3.2. Current German primary energy mix for electricity production
3.3. Policy environment
3.4. Progress with the development of each technology
3.5. Costs of each programme
3.6. Recent changes
3.7. Conclusions

3.2 Current primary energy mix for electricity production

Germany's electricity generation after the Second World War (WWII) relied mainly on just two fuel sources: coal and nuclear. In 2001, they still constituted a little more than 80% of total electricity production (Figure 3.1). However, in an agreement between the government

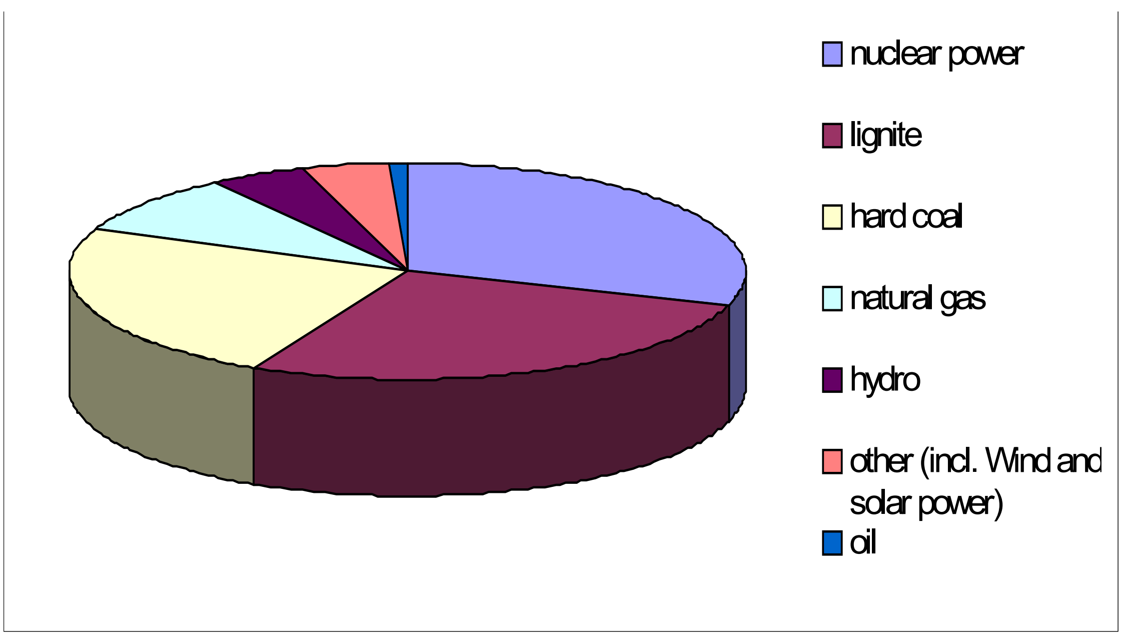


Figure 3.1: German Electricity Production by fuel source, 2001 (Source: Bundesministerium für Wirtschaft und Arbeit (BMWA) 2002)

and the main utilities in Germany it was recently agreed to phase out the use of nuclear power in Germany by about 2020. Furthermore, many coal plants are close to retirement and need replacement over the next decades.

Renewable energy sources accounted for approximately 6.8% of total electricity production Germany in 2001, rising to approximately 8% in 2002. The largest contribution among 'new' renewables to electricity production came from wind power and biomass (BMWA 2002).

3.3 Policy environment – 'The Market'

Historical development

Market formation for renewable technologies in Germany started at the beginning of the 1990s. Following a period of research and development, the government decided to create a framework to aid the market formation of renewable energy technologies. With respect to wind and PV the main policies at that time were as follows (Jacobsson et al. 2002; Johnson and Jacobsson 2000):

- The "1000-roofs programme" provided capital grants for the installation of roof-top mounted PV systems. Eventually, 2200 grid-connected roof-mounted installations were supported in this way, providing 5.3 MWp of installed PV capacity.

- A 250 MW wind programme began in June 1989 as the "100 MW Wind Programme" before being extended in 1991. The programme was directed to individuals, state owned corporations and private partners, and state owned authorities and institutions with investment subsidies of up to 25% for a maximum of €46,016.

- The "Stromeinspeisegesetz" (Electricity Feed-in Law EFL), introduced on 1 January 1991, mandated electricity suppliers to connect Wind and PV installations to their grid and purchase the electricity at 90% of the domestic market price, nearly 17pf/kWh (8.6€cent). This was well below the full costs of electricity generation from PV installations but represented a significant amount for wind installations. It came on top of the respective investment subsidy programmes mentioned above.

Current policies

The EFL was replaced in April 2000 by the "Erneuerbare Energien Gesetz" (Renewable Energy Law, REL). It guaranteed a premium price for electricity that was fed from Wind and PV installations into the grid, independent of the prevailing electricity prices. As before, electricity suppliers were mandated to connect such systems and purchase all electricity produced. Coupled with the REL was a specific target of reaching 12.5% renewable electricity supply by 2012 and 50% renewable electricity by 2050. Whilst the REL is the primary driver behind development of most renewables, a variety of additional measures are also in place. We describe each of these below (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit – BMU 2002).

Current tariffs and measures 1. PV

At the inception of the REL the price for PV electricity was set at 50.62€c per kWh for systems starting operation in that year and guaranteed for 20 years at that level. From 2002, the price is being reduced annually by 5% for new installations. Thus, PV installations starting operation in 2002 received a tariff of 48.10 €c per kWh guaranteed for 20 years. In 2003, the tariff is set at 45.70€c per kWh. A system of transfer payments between the regional

grid operators ensures an equal sharing of the cost burden as some regions in Germany due to their geographical conditions are more attractive for PV as others. As an exit strategy, the obligation to pay the tariff for photovoltaic electricity ends when the total installed capacity in Germany reaches 1000 MW (BMU 2002).
Also for the time period 2000 – 2003 only, the '100,000 roofs Programme' was introduced. It provided capital grants in two ways:

- Firstly, direct subsides of up to 50% of capital and installations costs for a typical roof-top mounted PV system
- Secondly, through the government-owned banks Kreditanstalt für Wiederaufbau (KfW) and Deutsche Ausgleichsbank (DtA), soft loans with reduced interest rates for investments into PV projects. The DtA and KfW also provided soft loans for new wind projects at reduced interest rates (BMU 2003a).

Additionally, there is a so-called 'market stimulation programme' that provides investment subsidies for a range of renewable energy technologies, including wind and PV. It is scheduled to run over a longer time period, until at least 2006.

Current tariffs and measures 2. Wind
In order to take account of the varying wind conditions at different locations in Germany the tariffs paid to wind generators are organized on a complex sliding scale based upon various reference wind sites. In 2000, the tariff guaranteed under the new feed-in law was set at 9.10 €c/kWh for the first five years. After five years, wind turbines that did not achieve 150% of reference output continued to receive the high rate, while those that exceed it subsequently earn 6.19 €c/kWh. The payments are guaranteed for a total 20-year time period. Off-shore projects benefit from a longer initial contract period – the higher initial tariff is guaranteed for the first nine years.

Since 2002 tariffs are being reduced by 1.5% per year to encourage technological development and reduce the opportunity for excess profits (BMU 2003a).

Another important law for wind power developments is the building law. In order to limit the opportunities to block a new development, the law has been amended to give wind the status of a 'preferred development'. Full details of the legal arrangements in this area are beyond the scope of this small study.

Feed in tariffs and EU law
The German system has been challenged under EU trade and industrial policy rules. Immediately after its enactment, the REL was legally challenged on two grounds. Firstly, it was alleged that it constituted an illegal subsidy and secondly that it inhibited trade, since only domestic renewables projects were eligible for support. However, the ECJ ruled that the REL did not constitute a subsidy since it did not involve the transfer of government resources and that secondly it was not inhibiting trade since all investors, whether foreign or domestic were eligible for support, as long as they invested in Germany. Furthermore, it noted that the EC-Treaty of Amsterdam included environmental protection as one of the aims of the EU. Even if a trade obstacle had been found, the REL would still have been legal; because of the overriding principle of environmental protection. Thus, in the foreseeable future, it is unlikely that the REL will be challenged on legal grounds again (Meier 2003).

3.4 Progress with each technology

This section provides a brief background on the development of wind and solar energy technology in Germany. This allows us to analyze the impact of the above policies on the wind and PV market.

3.4.1 PV

Support for PV electricity commenced with research and development (R&D) programmes in the 1970s and 1980s. Knowledge build-up, dissemination and network-creation were the key characteristics of this phase of development (Jacobsson et al. 2002). Resources for these programmes were largely provided by Federal budgets to universities, companies and research institutes. Markets were virtually non-existent apart from demonstration projects funded by the government.

This changed when the 1000-roofs programme and the EFL were introduced in 1990/1991. Both measures combined created a short-term boom in the PV market. Between 1990 and 1995, annual installed capacity grew by a factor of ten, from 0.59 MWp to 5.10 MWp and cumulative capacity rose from 1.5 MWp to 17.8 MWp. Output from PV systems increased from 2 GWh in 1991 to 12 GWh in 1995.

In the wake of this development a number of local and regional initiatives in the PV market were also notable. The utility 'Bayernwerk' introduced a green pricing scheme with investment in a 50 kWp solar plant. Over 100 people paid about 20 pfennig (10.1 €c) per kWh to obtain shares in this scheme. Utility 'RWE' introduced a green tariff in 1996 which eventually attracted about 15,000 customers. These initiatives were important in so far as the infant market that developed up to 1995 was in danger of breaking down in the absence of further promotional initiatives. These schemes helped keep the market going, and by 1999 15.6 MWp of PV systems were installed, bringing the total stock to 69.5 MWp.

With a political change in the government in 1998, federal activities in the promotion of PV were reinforced. The new REL and 100,000 roofs programme reinforced the PV market in Germany and led to a second, even larger boom in PV installations. Between 1999 and 2002 the cumulative installed capacity rose from 69.5 MWp to 260 MWp and annual installed capacity increased from 15.6 MWp to 83 MWp. Annual output jumped to 176 GWh (Jacobsson et al. 2002, BMU 2003a).

Cost Curves for PV in Germany

It is a central element of the strategy behind the REL to give long-term stability to investors while at the same time slowly reducing the level of support, thus taking account of the technological learning curve. The legislator explicitly states that "the degressive allowances-system for electricity from new installations is intended to continuously improve the economic efficiency of the production process and the running costs and to induce the consequent exploitation of innovation potentials" (BMU 2002: 4 – *author's translation*).

In Table 3.1. below turnkey prices (excluding VAT) in EURO per Watt (W) are given for the most installed reference system in Germany, a typical roof mounted 2 - 3 kW PV system. The figures are the result of an inquiry made by 'Photon', a PV-journal in Germany, about system prices with an installed capacity in the range of 1 to 5 kW.

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Price EUR/kWp	10 230	9 920	9 250	8 390	7 720	7 060	6 540	6 190	6 540	6 400	5 600

Table 3.1: German trends in system prices for a roof mounted 2 - 3 kWp PV system

3.4.2 Wind power

As with PV, the development of wind power in Germany can be divided into two phases – firstly, research, development and experimentation and secondly market up-scaling. Between 1977 and 1991, the German government funded about 46 R&D projects with a variety of companies and academic institutions to develop a variety of wind turbine designs (single, double or triple bladed, horizontal or vertical design) at various scales (from 10 kW to 400 kW). This timeframe is characterized by knowledge accumulation with no one design yet emerging as the clear winner. Sales in the domestic market were very limited, with accumulated capacity only reaching 19.67 MW in 1989. The boom in California in the 1980s, when tax incentives were offered for renewables projects, provided the main export market.

Market upscaling really took off with the EFL and the accompanying 100/250MW support programme. These measures led to an unprecedented period of growth in the German wind turbine market. Annual capacity growth rose almost forty-fold from 41 MW in 1990 to 505 MW and 1,568 MW in 1999. Cumulative capacity increased more than sixty-fold from 68 MW in 1990 to 1,137 MW in 1995 and 4,445 MW in 1999.

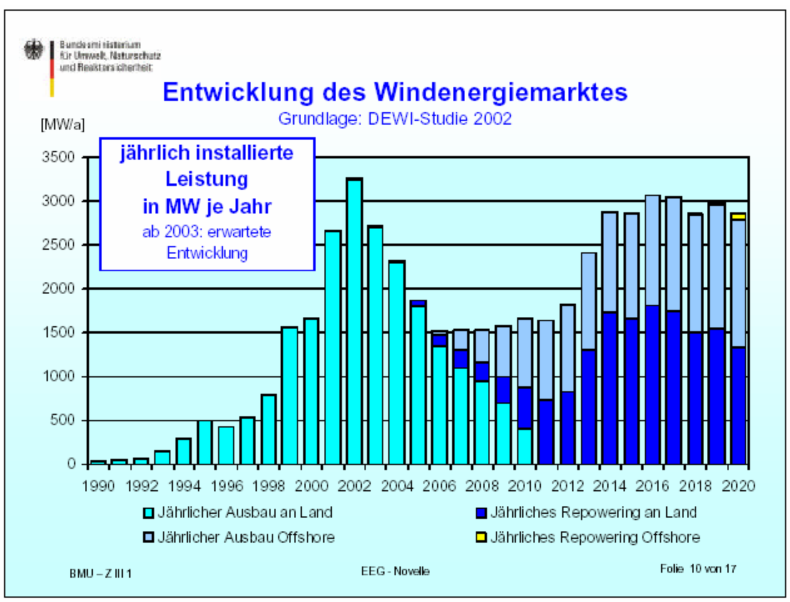


Figure 3.2: historic and projected wind capacity growth by installation type

At the end of 2002, cumulated installed capacity reached 12,001 MW with an annual addition of 3,247 MW. The growth rate in wind power in the 1990s never fell below 30% pa and between 1996 and 2002 the average rate was 40% pa. As a consequence, the onshore market will soon approach saturation, with available sites being the major limiting factor for future development. However, off-shore wind farms are planned and the first plant is expected to go online around 2006. The expected future path in the wind market in Germany is shown in the graph above (Figure 3.2.). Here, the light blue columns that dominate on the left show the annually installed wind power capacity on land up to 2002. From 2003, the graph shows the expected annually added capacity in the market. The dark blue area represents "repowering" of existing sites with new turbines, while the blue/grey area shows the expected off-shore market and the yellow top on the far right marks the beginning of the first off-shore repowering (Johnson and Jacobsson 2000; BMU 2003b).

Cost curves in the wind industry

The graph (figure 3.3.) below shows relative reductions in the capital costs of wind power installations in Germany. It is an indexed overview with 1990 serving as the base year = 100% (Bundesverband Wind Energie – BWE 2003).

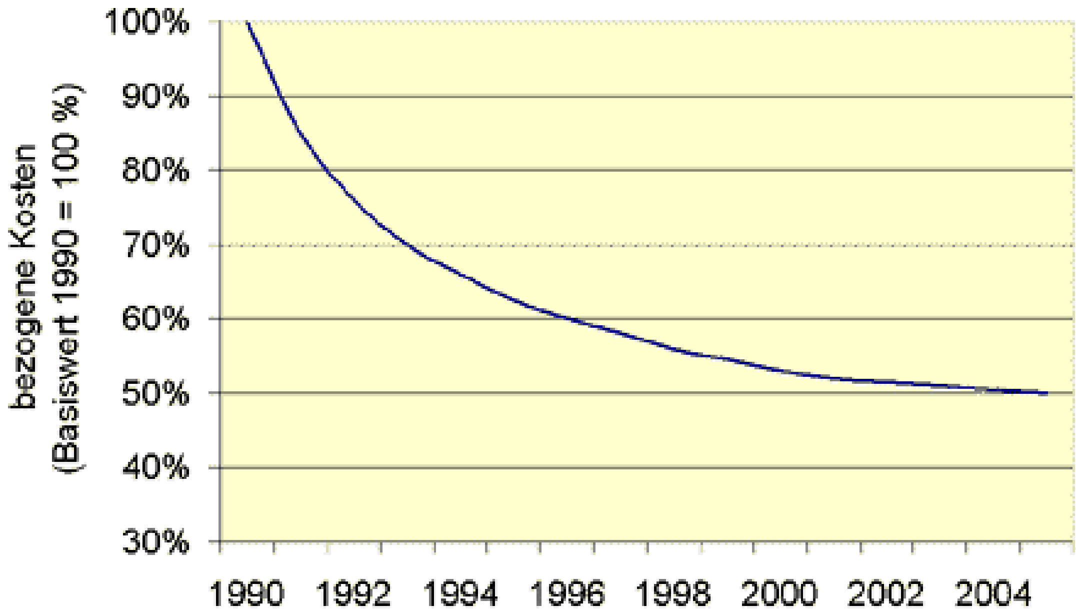


Figure 3.3: relative change in costs of German wind power installations 1990 - 2004

3.4.3. Summary Statistics

The statistics below summarize the information presented above (Sources: Johnson and Jacobsson 2000, Jacobsson et al. 2002, BWE 2003, IEA 2003c, BMU 2003a).

Year	Annual installed capacity (in MWp)	Cumulative installed capacity (in MWp)	Total output (in GWh)	Cost of reference PV System (in €/kW)
1991	1.01	2.5	2	n/a
1992	3.1	5.6	3	10.230
1993	3.28	8.9	6	9.920
1994	3.54	12.4	9	9.250
1995	5.35	17.8	12	8.390
1996	10.1	27.9	18	7.720
1997	14	41.9	27	7.060
1998	12.01	53.9	37	6.540
1999	15.6	69.5	48	6.190
2000	44.3	113.8	71	6.540
2001	64.2	178	116	6.400
2002	82.6	260.6	176	5.600

Table 3.2: PV cost and price trends summary

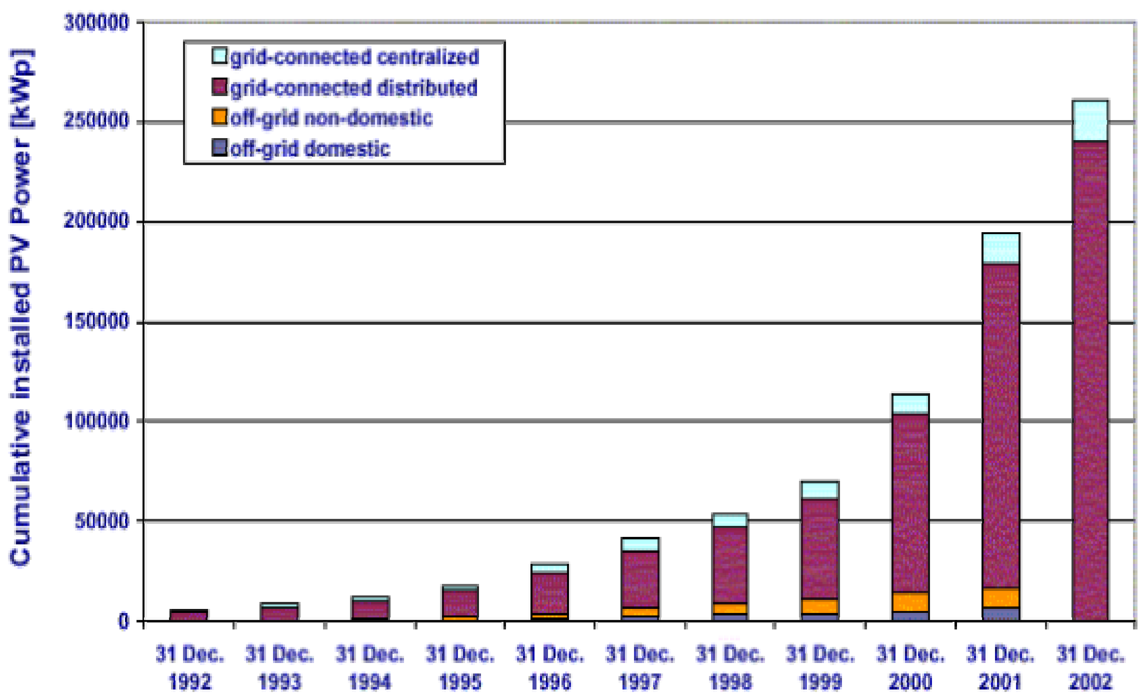


Figure 3.4: PV capacity growth by application

Year	Output (in GWh)	Annual installed capacity (in MW)	Cumulative installed Capacity (in MW)
1991	140	42	110
1992	230	74	183
1993	670	155	334
1994	940	309	643
1995	1800	505	1137
1996	2200	428	1546
1997	3000	534	2082
1998	4489	793	2875
1999	5528	1568	4445
2000	9500	1665	6095
2001	10456	2659	8754
2002	17200	3247	12001
2003	n/a	2608	14609

Table 3.3: Wind Power capacity growth in Germany

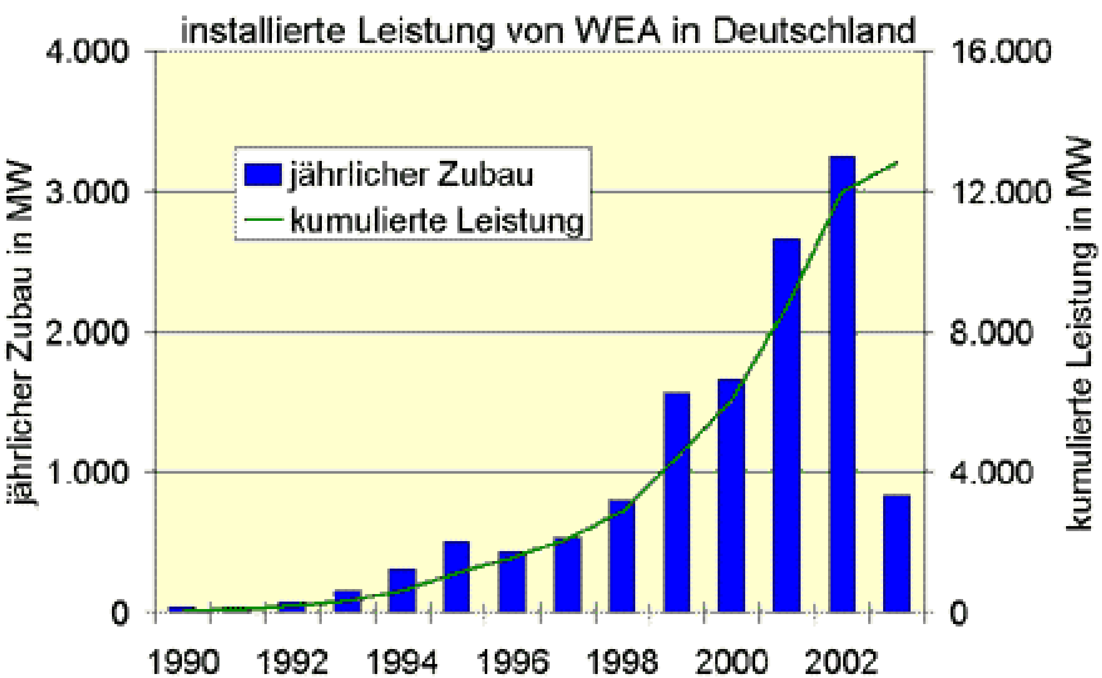


Figure 3.5: Annual and cumulative wind capacity in Germany (in MWp)

3.5 Costs of promotion programmes

With the information presented so far, it is possible to briefly provide some information on the cost of the support programmes given to wind and PV electricity. Two things are important here. Firstly, the specific costs of the support programmes and secondly, the overall impact of the REL on the German electricity price level.

PV costs
For PV, two sources of costs are considered here. Firstly, the capital grants "1000-roofs" and "100,000-roofs" programmes, secondly, the two feed-in laws described above.

Numbers for the 1000-roofs programme were not found in the short time available. However, it can be assumed that given its minor scale (5.4 MWp installed) the numbers are relatively small as compared to the following calculations.

The 100,000 roofs programme had a budget as follows:

In 2000: €102.26 million
In 2001: €153.39 million
In 2002: €204.5 million
In 2003: about €230 million.

Total 2000-2003: €690.05 million

The feed-in law tariff for PV electricity paid 90% of the prevalent electricity price for households between 1991 and April 2000. The average value for that time period was 8.6€cent per kWh. Taking the output statistics provided above, it is also possible to calculate the total amount of money involved. The feed-in law represents a cost borne by electricity consumers, it did not involve direct government subsidy.

Cumulative output between 1991 and 1999 was 162 GWh, thus cumulative payment of tariffs should be in the region of €13.9m. The new tariffs of the modified feed-in law were enacted on 1 April 2000. Total output in that year was 71 GWh but it can be assumed that new capacity was timed to take advantage of the new, higher tariffs. However, no monthly output figures were available for that year so assuming a quarter of that capacity (January-March) was produced under the old rules, and three quarters (April-December) under the new rules will slightly underestimate the value for that year. The figure under these assumptions amounts to tariff payments of €28.48m in 2000. Output in 2001 was 116 GWh and 176 GWh in 2002, thus cumulative output for these years was 292 GWh, with tariffs being €0.5062 in 2001 and €0.4810 in 2002. **Tariff payments for these years consequently total €143.38m. The total sum for the years 1991-2002 is about €185m with the mentioned caution for the year 2000.**

Wind costs
It has not been possible in the short time period to find figures for the 100/250 MW support programme from 1989. The budget for the market promotion programme, which funds wind power projects along with other renewable energy projects, is as follows:

2002 - €150m
2003 - €190m
2004 - €200m
2005 - €220m
2006 - €230m

Total 2002 – 2006: €960m

It was impossible to identify the percentage of wind power projects under this scheme, so the sum going into wind power cannot be presented.

Stromeinspeisegesetz/REL
The tariff from 1991 – April 2000 was about 8.6€cent/kWh. Despite the more complex model in place with the new REL, the average price paid out to wind remained at about that level. Thus, the total amount of tariff payments can be calculated as follows:

Cumulative out put for the period 1991 – 2002 is 56153 GWh. Note that of this, only 5980 GWh was produced between 1991 and 1996, while the remaining 50173 GWh were produced in the period 1997-2002. **Total tariff payments under the above assumptions for the period 1991 – 2002 would consequently be €4,829,158,000 (€4.8 bn) undiscounted. Payments in 2002 alone for some 17.2 TWh amounted to about €1.4 bn**.

Overall effect
The effect of the feed-in tariff system on overall electricity prices can be described as fairly modest. The specific additional costs of the REL are calculated from the difference of the market electricity price and the average tariff paid under the REL rules. The result is spread over all electricity consumption to find the additional cost per kWh of electricity consumption that can be attributed to the REL. Due to the overall increasing volume of renewable electricity, these costs rose from 0.2€cent/kWh in 2000 to 0.36€cent/kWh in 2002.

Scenarios by the Federal Economic Ministry expect a slow increase in market prices for electricity, due to the financing requirements of replacement power plants for the existing ageing coal and nuclear plant. The expected price development is reflected in Figure 3.6. on the next page, which shows a band of expected market prices for base- and peak-load electricity. Also, in these scenarios, it is expected that the external environmental costs of new power plants will be internalized to some extent through the European Carbon Trading scheme, which is reflected in the upper band of the expected price scenario (BMU 2003b).

Figure 3.7 (next page) shows the expected development of the specific additional costs in nominal (blue curve) and real (red curve, assumed 2% inflation rate after European Central Bank prognosis) terms. The Federal Ministry expects the specific additional costs on the electricity price to peak at about 0.45€cent/kWh in 2010. The reasons for the initial price increase are the continuous expected expansion of renewable electricity in Germany. Subsequently, it is expected that wind power and biomass will no longer rely on the REL price, due to the tariff reductions in the REL, assumed cost savings and the general expectations about the market electricity price above (BMU 2003b).

A final way to express the costs of supporting renewables is to calculate the additional costs for each household. This is done by multiplying the specific additional costs per kWh (as outlined above) by the average household consumption of electricity. Assuming an average consumption of 3400kWh per annum, **the additional costs per household are about 12€ per household per annum**.

Wind power is assumed to be closest to market competitiveness. Given the cost reductions of wind turbines, reductions in the tariffs for wind electricity and general wholesale price increases, it is expected that wind will no longer rely on the REL by about 2015. This is expected to be followed by small-scale hydro schemes and biomass. **By the year 2020, only PV and geothermal energy is projected to rely on the REL.**

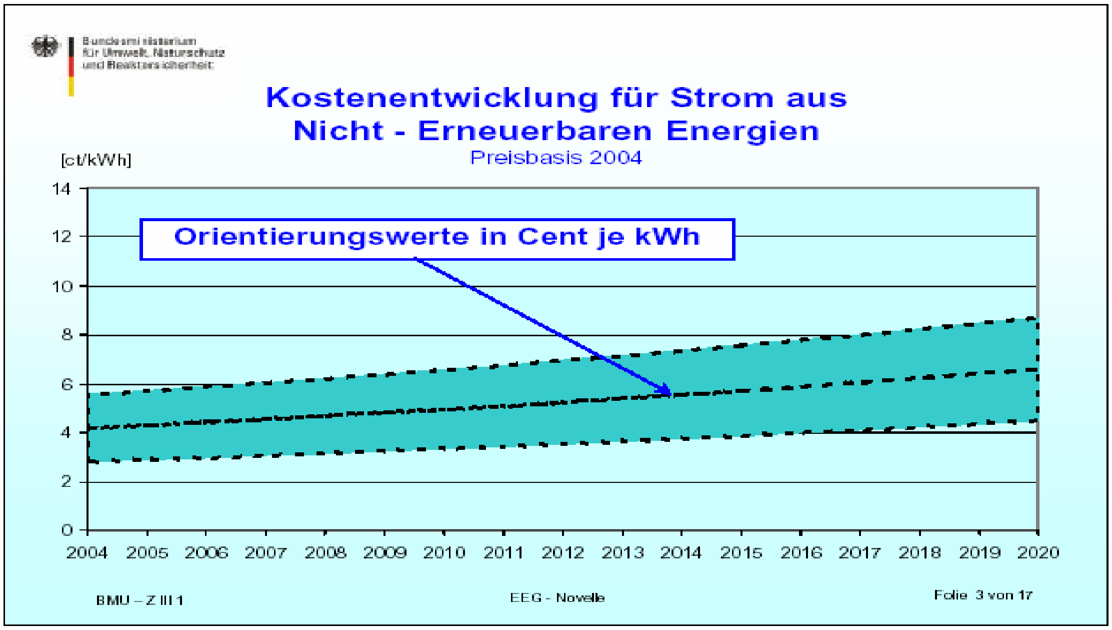


Figure 3.6: Projected base- and peak-load electricity prices to 2020 (in €cent/kWh – Source BMU 2003b)

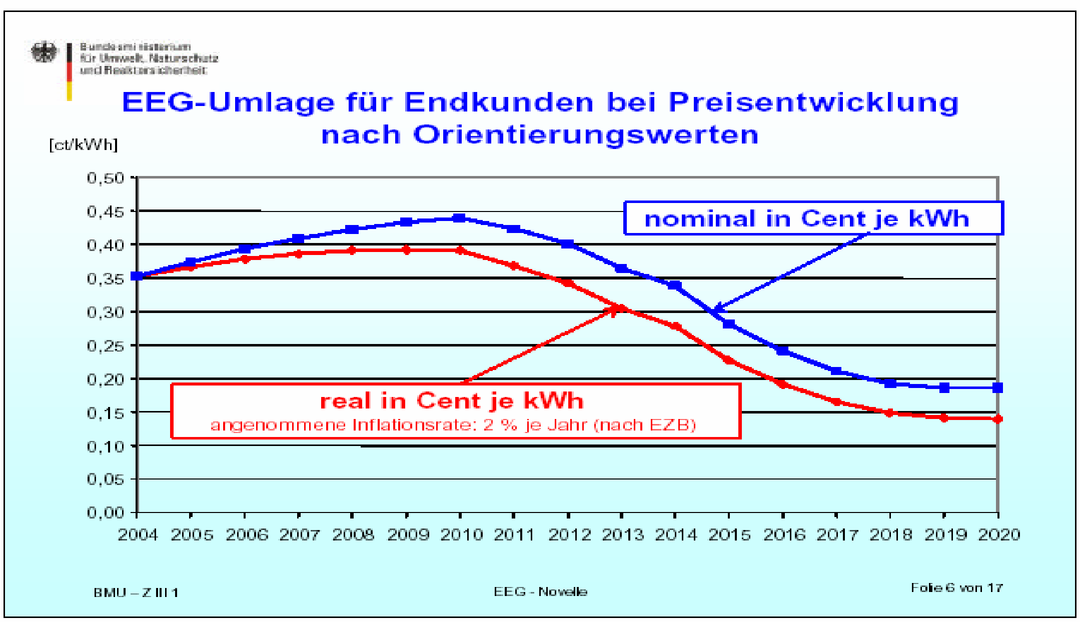


Figure 3.7: Projected specific additional cost burden of renewables support (in €cent/kWh- Source BMU 2003b)

3.6 Recent developments

There are currently a number of adjustments to the REL under discussion. One criticism of the REL was that it gave incentives to build wind parks in areas with low wind speeds. Secondly, it was alleged that wind parks in good sites still made excess profits despite the continuous tariff reductions over the last five years. Thus, in a proposal by the Federal Environment Ministry, two changes to the way wind is financed under the REL were proposed. Firstly, the feed-in tariff paid after five years of operation is lowered by 0.5 €cent/kWh. Currently, these stand at 6 €cent/kWh, thus the new tariff would be 5.5 €cent/kWh. Secondly, wind parks that did not achieve at least 60% of the reference site output after five years were only guaranteed the continuing higher tariff for ten additional years instead of the fifteen years granted at the moment.

While on-shore wind incentives are to be reduced as described above, off-shore wind would actually receive a boost from the revised REL. The higher initial tariff paid for wind would be guaranteed for 12 years instead of 9 years in the current plans.

For PV, the main objective for the government was to find an adequate replacement for the 100,000 roofs programme which ends in December 2003. The current proposal looks at the feed-in tariff to replace the function of this programme. It is envisaged that on top of the 43.7 €cent/kWh paid in 2004, an additional 15.6 €cent/kWh is paid for systems up to 30kW capacity, and 11.6 for systems above 30kW installed capacity. On top of this, an additional 5 €cent/kWh is paid if the PV systems are installed in the novel area of building-integrated PV systems. (BMU 2003c).

As all of these proposals are subject of controversy at the time of writing, the final outcome is uncertain.

3.7 Conclusions

Germany has been the most successful European country in terms of installing new renewable energy capacity. This is exemplified by its world-leading position in the wind energy market and its European leadership in the PV market. The most important policy tools contributing to this success were capital grant schemes, soft loans and feed-in tariffs, although planning regulation also played an important part. The combined costs of its capital grant and soft loan programmes are hard to quantify in total but are likely to be in the region of €1bn over the past 3 years. The additional costs of electricity due to the feed-in tariffs are currently in the region of 0.35 €cent/kWh, which means that the average household pays about €12 a year through its electricity consumption for the support of renewable electricity.

Box 3.1 - Financing of wind parks in Germany – the role of communities

The financing of wind parks in Germany mostly comes from private sources. In 2002, more than €1 bn was invested in this way. One factor that makes this kind of investment particularly attractive is the relatively high certainty of returns on investment at relatively low risks. The combination of guaranteed feed-in tariffs with a physical wind potential analysis of prospective sites allows a straight forward calculation of returns at high certainty. Typically, there are three main mechanisms of finance:

- Small projects with just a few turbines are often financed by individuals or small groups with the contribution of soft loans and other state subsidies. The total investment costs are typically less than €2 m. This type of project has been typical for farmers with land in windy areas who were looking for another source of income.
- Large-Scale wind parks need a larger sum of investment and are typically financed in either of two ways:
    - Companies specialising in wind park developments together with banks offer shares in closed mutual funds that finance the project 100%.
    - Private individuals raise money through the sale of shares in a limited partnership that develops the wind project on its own

The first and last form of finance are probably most important for the involvement of communities in renewable projects. In the case of small projects, families or a small farmers' village have come up with the investment. Benefits were shared locally which tended to increase local acceptance, and reduce planning and other objections (ie so called 'NIMBY' objectors were greatly reduced compared to other countries).

In the second case, a project type called 'Bürger Wind Park' (citizens' wind park) is of interest. Shares in limited partnerships can be made available for small capital contributions thus allowing small scale investors to participate – banks typically require minimum investments of €10,000 – €20,000. Also, the legal structure bears only small risks to the individual while it allows full participation in the benefits.

The example below illustrates the structure of one such project, the 'Citizen's Wind Park Butendiek', an off-shore wind project which is currently under development in the North Sea (Bürger Windpark Butendiek 2003).

Citizens' Wind Park
Butendiek is a small town on the North Sea, about 150 miles north of Hamburg. Eight local citizens, all of which had some knowledge/interest in wind projects, formed a limited partnership in 2001 to start exploring the possibility of developing an off-shore wind park in the North Sea. In 2002, a prospectus offered shares in the partnership to raise an initial €5 m in order to finance the exploration of the area and complete a planning application with the authorities. The minimum capital contribution was €250 and over 8,000 people signed shares in this project. A main feature of the project was that it was only promoted in the local area, hence 55% of the investors came from the local

region and a further 25% from the Northern Land (federal state) of ‘Schleswig –Holstein’ where Butendiek is situated.

The steering group of the project consists only of locals, thus, in the investment decisions on behalf of the investors, the impact of the project on the local economy plays a major part. Several milestones of the project have now been reached with planning permission granted and the choice of the turbine manufacturer made. The contract for the turbine manufacturer went to the Danish company ‘Vestas’, mainly due to the fact that it is one of the few companies with off-shore experience. However, parts of the turbines will be manufactured locally and the central monitoring office will be located nearby.

Community benefits
In relation to private investment funds, the involvement of local communities is rather limited. However, since local councils can at least significantly delay the development of a wind park, they can often negotiate concessions from the developer in form of community investments. An example is given below from the wind park ‘Ahlerstedt’ (Horbelt 2003).

A wind park consisting of 25 turbines was planned near Ahlerstedt, a small town about 30 miles west of Hamburg. The area is rural and mainly used for agricultural purposes, thus those farmers that offered to lease the land were very much in favour of the project, but the wider community felt that they had to bear the burden of the intrusion of the wind park into the landscape without getting any of the benefits. Thus, a majority in the local council vowed to stop the project by ‘all legal means possible’. However, in negotiations with the farmers who were to lease the land, it was agreed that they would voluntarily contribute 5% of the rent into a fund that would sponsor local community projects. With this concession, the opposition in the region dropped and the project went ahead. Now, about €10,000 is annually contributed to variety of community groups.

4 Country Study - SPAIN

4.1 Introduction

Spain has the second largest installed wind energy capacity in the world, the result of extremely rapid growth in the second half of the 1990s. A domestic industry has also been fostered. Spain's success with wind development has been attributed to a combination of favourable geographical locations for wind power and strong regional authorities' involvement in its development. As with other EU countries currently at the forefront of wind development, Spain operates a feed-in tariff. This case study considers the main drivers of Spanish wind development.

The case study is structured as follows:

4.1. Introduction
4.2. Primary energy mix for electricity generation in Spain
4.3. Policy environment – 'the market'
4.4. Progress with the development of each technology
4.5. Conclusions

4.2 Primary energy mix for electricity generation in Spain

Spain is an energy resource poor country. Its coal is of low-quality and Spain has neither gas nor oil reserves. Thus, it depends to a high degree on energy imports. Being hit especially hard by the oil crises in the 1970s, it embarked early on a programme of energy efficiency and promoting renewable energy (Dinica 2002).

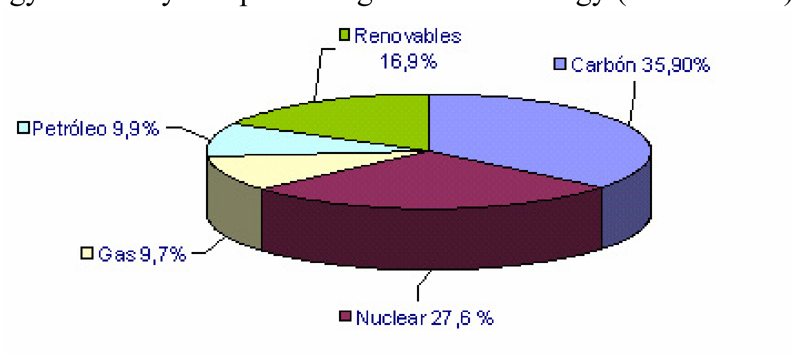


Figure 4.1: Share of Spanish electricity generation mix in 2002

Figure 4.1 shows the Spanish electricity mix in 2002. Coal and nuclear were the two biggest contributors with 35.9% and 27.6% respectively. Oil and gas each supplied about 10%, while renewables had a share of 16.9%. The largest sources of renewable electricity are large-scale hydro power stations, built in the wake of the oil crises in the 1970s and 1980s. Of the 'new' renewable technologies, wind and biomass are the biggest contributors (Asociación de Productores de Energías Renovables - APPA 2003).

4.3 Renewables Policy – 'The Market'

In 1991, Spain published the National Energy Saving and Efficiency Plan (PAEE), which aimed to increase the share of renewables in the overall energy mix significantly until 2000. This was replaced by the Renewable Energy Development Plan - 'Plan de Fomento de las Energías Renovables' (PFER) in 1999, which set new targets specifically aimed to increase the share of renewable energy to 12% of gross inland energy consumption by 2010. An important feature of this plan is that responsibility to distribute the funds and provide a planning framework was transferred to each autonomous region (Dinica 2002).

The PAEE and the PFER provide for capital grants, which are particularly beneficial for PV projects (see box on page 31). With the introduction of the PFER, each autonomous region had to implement its own promotion scheme, thus the grants available can vary by region. Furthermore, the Institute for Energy Saving and Diversification (IDAE), a government agency, provides subsidised loans to cover capital costs of PV systems.

Besides the capital grants, the main incentive to invest into renewable technology is feed-in tariffs. Since 1994, Spain has operated a system of feed-in tariffs for renewable electricity, which were significantly extended with the PFER in 1999. While renewable electricity producers have to pay to connect to the nearest grid access point, the grid operator is mandated to purchase all renewable electricity then fed-into the grid. Contracts are set for five years without an explicit guarantee of renewal. However, investors seem to attach little risk to this factor and as yet there have been no conflicts over contract renewal.

The producer can choose between two options for the feed-in tariff: (1) electricity is sold for a fixed tariff paid for each kWh produced (directly analogous to the German system); or (2) the electricity is sold on the Spanish Electricity Pool and the producer receives a bonus on top of the pool price from the feed-in tariff system. Both bonuses and tariffs are set by government annually. The requirement is that the bonus, when combined with the estimated pool price, will fall into a price band of 80% to 90% of the average electricity selling price for all consumers, except for solar where the law enables the government to set higher levels. The various tariffs and bonuses are distinguished by different renewable technologies as outlined in Tables 4.1 and 4.2 below. (Dinica 2002, APPA 2003).

	1999	2000	2001	2002
Wind	3.16	2.87	2.87	2.89
Small hydro	3.27	2.98	2.98	3
Energy Crops	3.04	2.76	2.76	2.78
Other Biomass	2.82	2.55	2.55	2.57
S.PV <5 KW	36	36	36	36
S.PV >5 KW	18	18	18	18
Solar Thermal	0	0	0	12
Others	3.27	2.98	2.98	3

Table 4.1: Evolution of RES-E premiums in Spain (in €cent/kWh (APPA 2003))

	1999	2000	2001	2002
Wind	6.62	6.26	6.26	6.28
Small hydro	6.73	6.36	6.36	6.38
Energy Crops	6.50	6.15	6.15	6.17
Other Biom.	6.28	5.94	5.94	5.96
S.PV <5 KW	39.6	39.6	39.6	39.6
S.PV >5 KW	21.6	21.6	21.6	21.6
Others	6.73	6.36	6.36	6.38

Table 4.2: Evolution of RES-E fixed prices in Spain (in €cent/kWh (APPA 2003))

In 2002, the majority of contracts chose the bonus option as investors expected the return from this model to be slightly higher than from the fixed tariff.

Recent changes
For 2003, the government tabled proposals to lower the tariffs for wind after the premium paid on top of the market price exceeded the 80-90% price band set by the government. The new proposals cut the premium by 8% from 2.897 €cent/kWh to 2.664 €cent/kWh, while the fixed tariff was lowered by one per cent from 6.443 €c/kWh to 6.377 €c/kWh. These proposals only affect new contracts in 2003.

	Tariff 2003 (€c/kWh)	Bonus 2003 (€c/kWh)
Wind	6.21	2.66
Small hydro	6.49	2.94
Energy Crops	6.85	3.32
Other Biomass	6.05	2.51
Solar PV <5 KW	39.6	36
Solar PV >5 KW	21.6	18
Solar Thermal	-	12
Others	6.49	2.94

Table 4.3: RES-E prices in Spain for the year 2003 (in €c/kWh – APPA 2003)

4.4 Progress with Technologies

4.4.1. Wind
Spain has significant potential for wind power extensions due to its geographic location. A total of almost 5000 km of coastline and exposure to the Atlantic Ocean render it among the windiest places in Europe. The feed-in tariff laws described above led to a significant boom in wind power in Spain. Especially since the amendments in 1999, capacity has been extended on a significant scale. As the graphs below demonstrate, Spain's growth rate for wind has been tremendous, with only one brief pause in 2001 when slow grid extensions could not keep pace with the growth in the market.

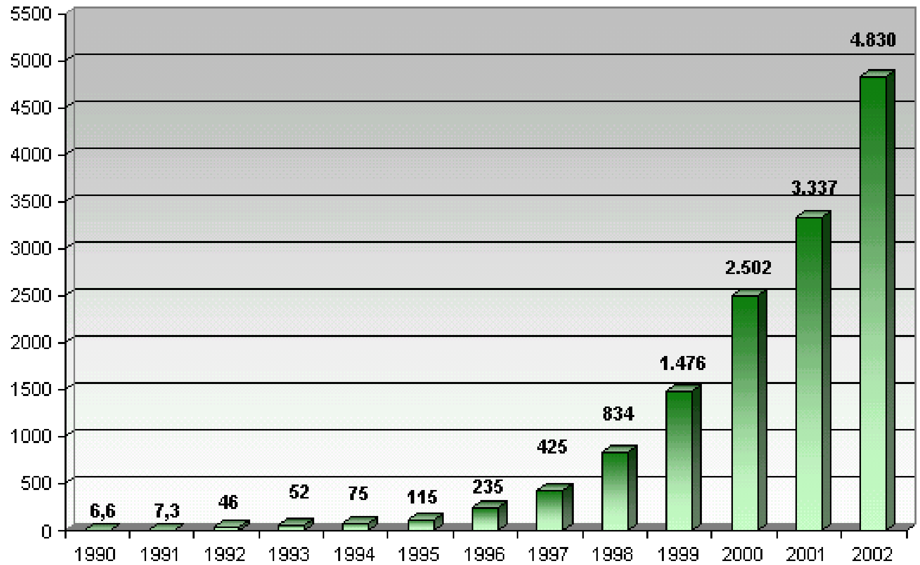


Fig. 4.2. Cumulative installed capacity for wind in Spain (in MWp – source: APPA 2003)

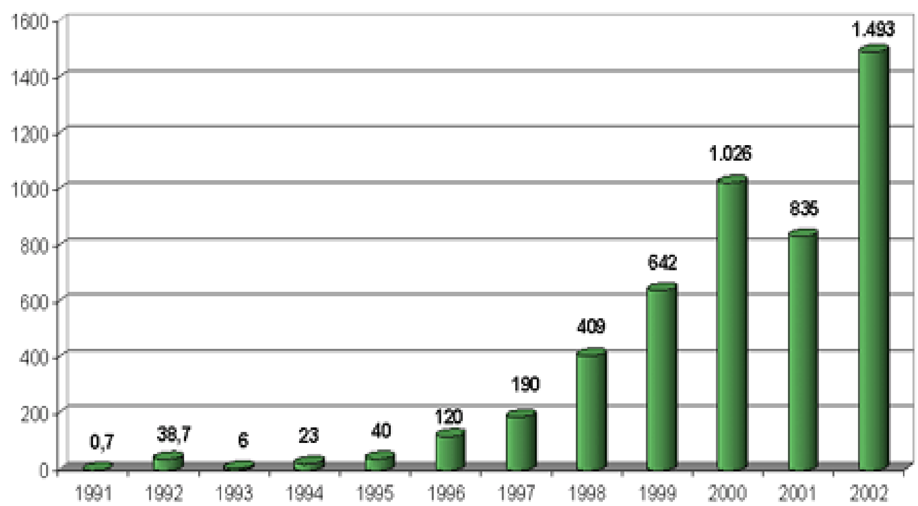


Fig. 4.3. Annual installed capacity for wind in Spain (in MWp – source: APPA 2003)

Year	Growth rate (per cent)
1996	87.2%
1997	105.6%
1998	62.9%
1999	46.9%
2000	107.2%
2001	31.5%
2002	44.7%
Average 1996 – 2002	69.4%

Table 4.4. Growth rates in wind capacity in Spain (source BWE 2003)

4.4.2 Role of autonomous regions

The local autonomous regions are an important feature in the development of wind power. Many have set their own local targets and actively support projects in their areas. This is often coupled with support for domestic turbine manufacturers. This might explain why three Spanish companies, Gamesa, Made and Ecotecnia, share over 76% of the Spanish market between them. Also, the regional planning avoids some of the problems seen in other countries where local authorities obstructed wind development plans announced on a national level. Although these still occur on a local level they are much less frequent than for example in the Netherlands (see chapter 7).

The involvement of local regions in wind park planning usually means that the developer has to make some sort of concession towards the affected community. Thus, opposition to wind development has often been mitigated by charging royalties for land leases or other local services. These could be either one-off payments or a percentage of the returns from a wind park. Also, investors have been required in the past to invest into local infrastructure projects such as recreational sites, libraries or education sites. However, similar increases in land-rent fees have been demanded by private land owners and it has been argued that these deals have often been negotiated in secrecy rather than openly with all relevant stakeholders.

A major bottleneck for wind development in Spain is the poor grid quality. This is aggravated by the fact that renewables investors have to pay themselves for the connection of their development to the nearest grid access point. Often, the windiest sites are in sparsely populated areas with a poor grid infrastructure which leads to significant grid upgrading costs. The EU Directive on the promotion of renewable energy 2001/77/EC provides for grid operators to ensure equal and fair access to their grid for all technologies, which should alleviate the situation to some extent but substantial investment is necessary in Spain to upgrade the infrastructure (Dinica 2002).

4.5 Conclusions

Due to its limited domestic natural resources, Spain heavily depends on fuel imports. This led to an early interest in energy efficiency measures and renewable energy development. Whilst large-scale hydro power still is the dominant renewable electricity source, wind power especially has seen impressive growth rates over the last decade. Besides geographical location, factors that contributed to this success included the early introduction of feed-in tariffs covering the cost of wind installations and giving long-term investment security; and the involvement of local communities in the planning and development of wind projects.

Box 4.1 ICO-IDAE Finance for Renewable Energy and Energy Efficiency Projects in Spain 2003: Preference Finance for solar heating and photovoltaic solar energy under 100 kWp (Source: ICO 2003)

Introduction
This box outlines the main features of a government financed preference finance scheme, operated by the Instituto de Crédito Oficial (ICO) -Official Credit Institute- and Instituto para la Diversificación y Ahorro de la Energía (IDAE) - Institute for Energy Saving and Diversification

Resources available:
The resources available for 2003 amount to 179,700,000 euros. From this amount, IDAE provides funds worth 34,700,000 euros to discount interest rates for all types of renewable energy and energy efficiency projects, as well as direct support for solar heating and photovoltaic solar energy projects under 100 kWp.

Beneficiaries:
Any private or public individual or corporation.

Investments to be financed:
Any investment projects in new fixed assets for the exploitation of renewable energy sources or the improvement of energy efficiency: including installations, equipment and costs needed to set up these projects (engineering, insurance, transport, etc.). The civil engineering work, if required, cannot represent over 20% of the total investment to be financed.

New aspect of this line of finance:
The new element of this line is based on the firm institutional boost for thermal and photovoltaic solar energy under 100 kWp. The support programmes that IDAE has been running for these two technologies have been integrated into one single financial tool. This integration responds to sector demands and the need to support users, both in procedural aspects such as deadlines, access to public grants and in solar energy. The finance line maintains public economic support for solar energy technologies, reinforcing it by providing preference funding. These funds are designated for the part amortization of loans and interest rates discounts, the number of grants is the same as for 2002.

Types of projects supported:
Energy efficiency:
- Saving.
- Industry replacement.
- Energy efficiency in buildings.
- Energy efficiency in Public Lighting.

Renewable Energy:
- Wind power under 4MW for self consumption.
- Biomass.
- Mini-hydro under 1MW.
- Thermal, photovoltaic and thermoelectric solar energy.

- Biogas energy use.
- Energy valorization of waste.

Maximum investment to be financed:
The maximum amount that can be financed will generally be 70% of the eligible cost of the project. Solar energy technologies - thermal and photovoltaic under 100 kWp will be awarded maximum finance of 96% and 89%, respectively.

Amortization period:
Loans will be over 5, 7 or 10 years, as elected by the beneficiary, with a maximum of 2 years payment holiday. Solar projects have a unique payment holiday period of 7 years.

Maximum amount:
Each investor can apply for loans up to 6,310,500 euros per annum.

Interest rate and IDAE discount:
The interest rate is variable, fixed to the Euribor for 6 months plus one percentage point, minus the IDAE discount, which is 2 percentage points for energy efficiency projects and 3.5 percentage points will be discounted for renewable energy projects. Hence, the final interest rate for the beneficiary will be Euribor-1 % for energy efficiency projects or Euribor-2.5 % for renewable energy projects.

Charges:
ICO communicates the interest rate in TAE, and collaborating banks cannot make the following charges: opening of account; for report; availability charge

Processing:
The funds will be facilitated through the banks that have signed the agreement.

Documentation:
The beneficiary has to submit the project report, and proof of up-to-date tax and national insurance payments. Once all this information has been submitted to the bank, it will be passed on to ICO and then to IDAE, which will assess whether the operation is eligible for finance or not.

Guarantees:
Each bank will analyse the loan application and will set the guarantees that must be given, according to the financial position of the applicant the feasibility of the project. The guarantees given might include the following: Mortgage; Personal; Mancommunity or solidarity guarantees; Mutual Insurance Company

Compatibility:
All the grants awarded will adhere to EC Regulations regarding public grants in the European Union.

5 Country study – Sweden

5.1 Introduction

Sweden has placed a high priority in its renewables support policies on the use of biomass in electricity generation and heating. Sweden is number two in biomass electricity output in Europe and number one in the use of biomass for heating purposes. It is one of the few countries beginning to use dedicated crops for this purpose. This case study will consequently examine the factors that led to the wide dissemination of biomass technologies in Sweden.

The case study is structured as follows:

5.1. Introduction
5.2. Primary energy mix in Sweden
5.3. Policies – 'The Market'
5.4. Progress with biomass technology
5.5. Conclusions

5.2 Background

Sweden's energy supply has undergone drastic changes over the last thirty years. Up until the end of the 1970s, it was dependent to a large degree on oil, accounting for 80% of total supply at one point. Following the oil price shocks, Sweden developed a nuclear power programme and diversified its fuel base into gas, coal, and, since the 1990s, increasingly biomass. Today, Sweden's electricity sector is dominated by three fuel sources, hydro power (55%), nuclear power (39%) and thermal power (6%), one third of thermal output is fired with biomass fuels. Annual electricity output varies somewhat with annual rainfall but the Scandinavian interconnectors balance these variations. Nuclear power currently faces an uncertain future. In 1980, a referendum voted for the phase-out of nuclear power and the government has committed itself to such a programme with the timeframe being determined by the availability of clean and affordable replacement fuel sources. Electricity prices are very low compared to most countries. Industry prices are around 2-3 €cent/kWh and households only average 4-5€cent/kWh (Körner 2002).

Sweden supports the development of a range of renewable sources of electricity, including wind and biomass. However, with a low cost and very low CO_2 electricity mix, Sweden has placed greater emphasis on the development of renewables, especially biomass, for the heat and (to a lesser extent) the transport sectors. In 2000, biomass contributed 89 TWh of primary energy, a 19% share of the total supply of 474 TWh. 67% of this is used in industry, especially pulp and forestry industries. 21% is used in district heating systems (of which half are CHP plants). The remaining fractions were used in small-scale boilers in one- and two-family dwellings (see Figure 5.1.).

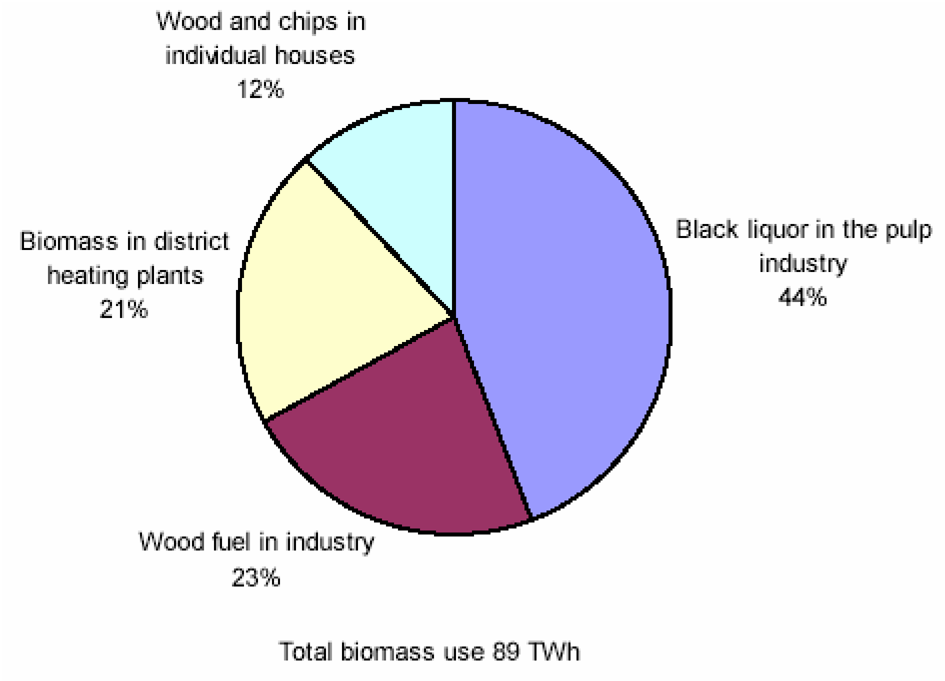


Figure 5.1: Biomass use by sector in Sweden (Source Johansson 2002:5)

An important factor in the development of biomass use in Sweden has been the integration of the biomass industry in other sectors. The largest source of biofuels is the forestry industry which makes use of the large forests in Sweden. Its largest customers are the pulp and paper and the wood manufacturing industry. So far, industry residues have been the major source of biofuels but logging residues and, increasingly, dedicated logging for biofuels are developing as further sources. The second source of biofuels is agriculture, but supplies so far have been very small. However, in a recent government commissioned study, the potential for biofuels supply from Sweden has been estimated to be several times the current level. Biomass currently supplies 89 TWh – or 320 PJ – of energy. But the potential supply has been estimated at between 680 PJ – 860 PJ. Thus, Sweden could become a major biomass exporter should the European and international market for such fuels develop further (Johansson and Lundqvist 1999; Roos et al. 1999).

5.3 Policies – 'The market'

The main policies used in Sweden to support renewables include the taxation of fossil fuels, capital grants and the support of research and development (R&D).

Energy and environmental taxation is a central energy policy instrument. Up until the early 1980s, Sweden's heating system was almost entirely dependent on oil imports. With the aid of high energy taxes on oil consumption, this has now been drastically reduced, while the use of biomass, coal and electricity increased. In 1990, an additional carbon tax of 0.25 SEK/kg CO_2 was introduced (€0.028) while the energy tax was reduced by 50%. In subsequent years, the CO_2 tax was further increased while the energy tax diminished and numerous exemptions were made for Swedish industry and the Northern parts of

Sweden. Furthermore, taxes on sulphur and nitrogen dioxide were introduced, which affected especially the relative prices of coal and gas. Renewable energies are exempted from the energy tax, the CO_2 tax and the SOx tax, but the energy and carbon tax are not levied on fuels used in electricity production, instead general electricity consumption and nuclear electricity generation are taxed separately.

This complex fiscal system has prompted fuel switching in all sectors – both in the interests of diversity, and for environmental goals. Because electricity production is exempt from several charges anyway, these measures did not significantly boost the competitiveness of renewables in the electricity sector. However, they have had a large impact on relative prices in the heating and industry sectors, providing a significant incentive for biomass fuels. The CO_2 tax level translates into approx. €0.39-0.64/kWh, and the SO_x tax into approx. €0.11-0.21/kWh. This is a sizeable incentive that has contributed to the diffusion of biomass. A number of coal fired CHP plants have changed to fire biomass as a direct result of the introduction of these taxes and their effect on the cost of coal fired CHP (Bauen et al. 2003).

The main taxes applicable in 2002 as described above are summarised in Table 5.1. Costs of different fuels in 1999 are shown in Figure 5.2.

Type of tax	Tax level	Comments
Energy tax	Varies for fossil fuels for stationary applications between, 10 and 70 SEK/MWh. The energy tax for petrol and diesel is significantly higher.	No tax on fuels used in industry or for power generation.
Carbon tax	General level 0.63 SEK/kg CO_2 (USD 230 /tonne C). Equals to 140-210 SEK/MWh.	No tax is applied to fuels used for power generation and the level for industry corresponds to 0.18 SEK/kg CO_2. For energy intensive industries there are special tax reductions rules.
Sulphur tax	30 SEK/kg S (USD 3/kg S)	Applied to heavy fuel oils, coal and peat. If sulphur is removed from the exhaust gases tax may be partially refunded.
Nitrogen oxide charge	40 SEK/kg NO_2 (USD 4/kg)	Applied to heat and power plants that use more than 25 GWh fuel/y. The charge is refunded to each production unit in proportion to its production of useful energy (heat and electricity).
Tax on nuclear electricity capacity	Equivalent to 0.027 SEK/kWh_e (USD 0.003/ kWh_e)	
Electricity consumption tax	0.12-0.18 SEK/kWh_e[a] (USD 0.011-0.016/ kWh_e)	No tax on electricity used in the industrial sector
Value added tax	25%	Applied to all energy consumed

[a] The lower level is applicable in northern Sweden and the higher in the rest of the country.

Table 5.1. – summary of energy taxes in Sweden, 2002 (source Johansson et al. 2002:9)

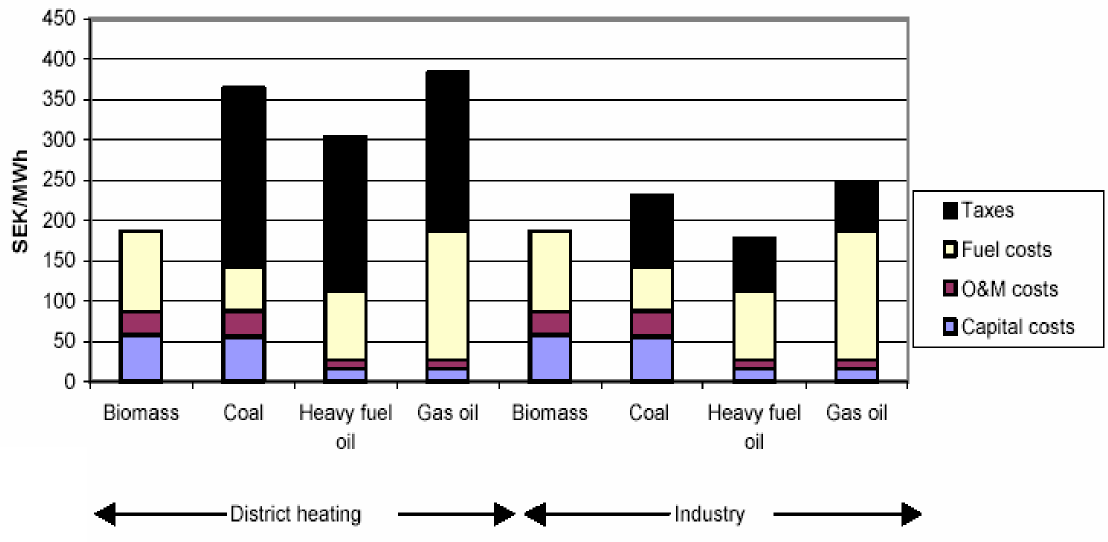


Figure 3.1. Heat production costs for new plants (Swedish National Energy Administration, 2000b). The calculations are based on taxes applicable in 1999, levels which have been decisive in the development of biomass use. Since 1999 the carbon tax on fuels for district heating has increased by 75%, while taxes on fuels used in industry have not changed.

Figure 5.2: Heating costs for different fuel sources (Source Johansson et al. 2002:10)

Besides the cost advantage through the taxation system, biomass has benefited from investment grants to increase the up-take of biomass technologies in electricity and heat production. Grants of initially 4,000 SEK/kWp (400 USD/kWp), reduced to 3,000 SEK (300 USD/kWp) in 1997, or a maximum of 25% of the investment costs led to the installation of 25 new biomass plants for electricity generation, all of which were CHP plants, in the period 1991 – 2002, with a total installed output of 4.4 TWh/year in 2000 (Johansson et al. 2002). Total Swedish electricity production in 2000 was 145 TWh..

The extension of biomass in district heating has often been led by local municipalities. Strong environmental awareness coupled with the possibility to pass on higher costs to the consumers in a monopoly market aided this development. Also, since 1998, a local investment programmes made grants available to municipalities to convert heating systems to renewable energy sources. In the period 1998 – 2000, a total of 269 projects received 1,218m SEK (about 136.2m €) for these purposes (Johansson et al. 2002).

A further government activity to underpin biomass is the support of R&D in that area. Notably, most of the government funded projects are not concerned with general or fundamental groundwork but with applied studies that aim to assist the market introduction of new technologies in agriculture, the boiler market and alternative transport fuels. The annual budget in these areas was 131m SEK (about €14.6m) in 2000 (Johansson et al. 2002).

5.3.1 Other renewables and the RPS market

As electricity prices remain low and pressures for change in the electricity supply structure are relatively modest, Sweden has not been at the forefront of developing other renewables such as wind power. Installed capacity is currently a little over 300MW. That said, Sweden has been one of the leading off-shore wind developers – with an early development of 10.5MW at 'Utgrunden' off Öland and about 500MW in the planning/development stage (Windpower Monthly 2003b).

In summer 2003, a Green certificates market started operation in Sweden. The target of the government is to increase electricity production from renewable sources from currently 7.4% (large scale hydro is excluded in the scheme) to 16.9% in 2010 (see table 5.2. below – Energimyndigheten (STEM) 2003).

Year	Mandated Share of Renewables
2003	7.4%
2004	8.1%
2005	10.4%
2006	12.6%
2007	14.1%
2008	15.3%
2009	16%
2010	16.9%

Table 5.2: Swedish renewables obligation targets (Source STEM 2003)

Eligible sources are wind, solar, geothermal, biofuels, wave and small hydro. Green certificates are issued for every MWh of renewable electricity produced, certified by the Swedish Energy Agency. These are then sold on, either bundled with the electricity or separately on a certificates market. The quota obligation obliges consumers to have a percentage of their electricity consumption, shown in table 5.2, as 'renewable' through certificates. In practice, the suppliers will handle the quota, and can charge their customers for the electricity certificates. The electricity supply company will charge their customers the green certificates as a separate item on the electricity bill, but large electricity users can engage on the open market in choosing their electricity supply and certificate trading. There is a buy-out price which will be at 150% percent the average certificate price during the year but no more than 175 SEK/certificate (19.50€). Initially, there is also a guaranteed minimum price at which certificates can be cashed in at the government, 60 SEK (6.7€) in 2003 and 50 SEK (5.6€) in 2004, so that electricity producers are ensured that all their certificates can be sold at a cash value. Excess certificates can be banked for an unlimited timeframe for future use. Figure 5.3 summarises the system:

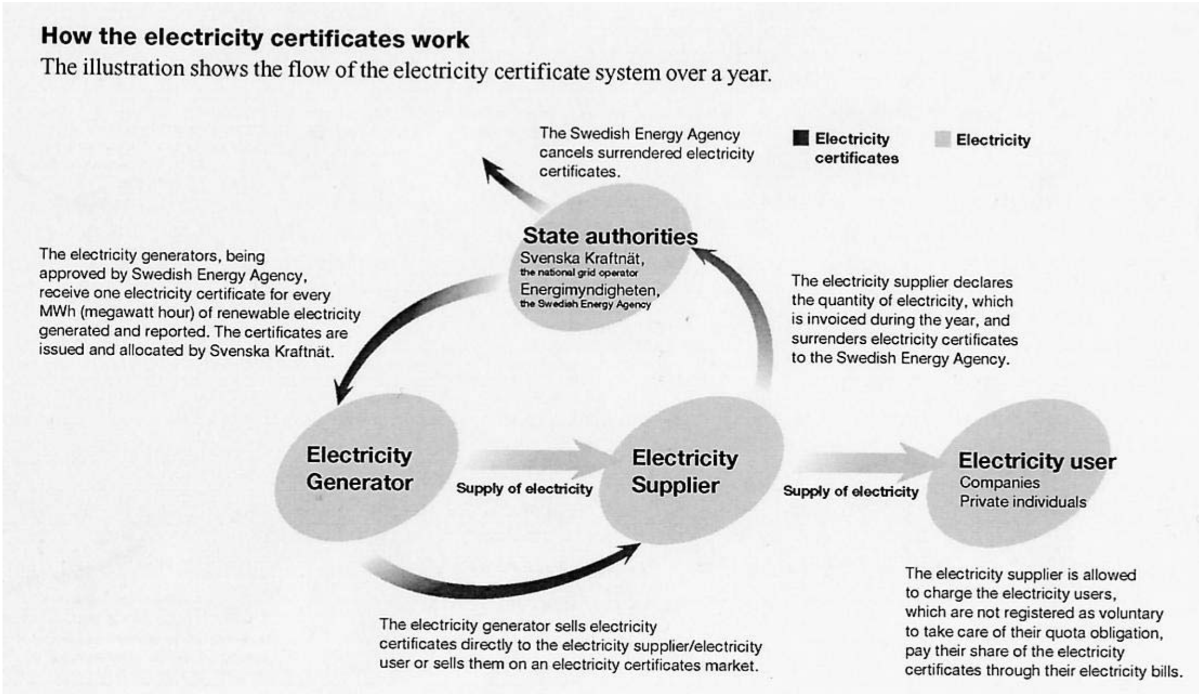


Figure 5.3: Functioning of the Swedish certificates market (Source: STEM 2003:2)

As yet, there is no feedback about the most recent experience with the certificate system. However, the level of support seems to be relatively low when compared with other European countries (Price boundaries per kWh: €0.005 min, €0.0195 max). Still, it can be expected that biomass and wind power will benefit from the new scheme.

5.4. Progress with biomass technologies

The most important renewable technologies in terms of penetration of the Swedish energy market are the various sorts of biofuels. The structural advantage of a large forestry industry, coupled with the above-described support programmes have led to a rapid extension in heating applications and co-generation of electricity and heat.

Tables 5.3 and 5.4 on the next pages summarize the contribution of each renewable technology source to electricity and heat production.

	1990	1995	1998	1999	2000	2001	2002E	Average annual percent change 90-01
Total Electricity	**74900 e**	**70683**	**78404**	**74953**	**83419**	**83196**	**72191**	**1.0**
Hydro	73033	68160	75040	71713	78619	79192	66680	0.7
of which: Pumped Storage	530	58	40	22	35	47	25	-19.8
Geothermal	-	-	-	-	-	-	-	-
Solar Photovoltaics	-	-	-	-	-	1	1	-
Solar Thermal	-	-	-	-	-	-	-	-
Tide, Wave, Ocean	-	-	-	-	-	-	-	-
Wind	6	99	317	358	457	481	560	49.0
Industrial Waste	-	-	166	107	101	176	146	-
Municipal Solid Waste Renew.	103 e	116	166	130	239	268	355	9.1
Municipal Solid Waste Non-Renew.	-	-	-	-	-	-	-	-
Solid Biomass	1758 e	2278	2694	2636	3971	3053	4429	5.1
Gas from Biomass	-	30	21	9	32	25	20	-
Comb. Renewables Non-Specified	-	-	-	-	-	-	-	-
of which:								
Electricity Only Plants	***73039***	***68259***	***75357***	***72071***	***79076***	***79674***	**..**	***0.8***
Hydro	73033	68160	75040	71713	78619	79192	..	0.7
of which: Pumped Storage	530	58	40	22	35	47	..	-19.8
Geothermal	-	-	-	-	-	-	-	-
Solar Photovoltaics	-	-	-	-	-	1	..	-
Solar Thermal	-	-	-	-	-	-	-	-
Tide, Wave, Ocean	-	-	-	-	-	-	-	-
Wind	6	99	317	358	457	481	..	49.0
Industrial Waste	-	-	-	-	-	-	-	-
Municipal Solid Waste Renew.	-	-	-	-	-	-	-	-
Municipal Solid Waste Non-Renew.	-	-	-	-	-	-	-	-
Solid Biomass	-	-	-	-	-	-	-	-
Gas from Biomass	-	-	-	-	-	-	-	-
Comb. Renewables Non-Specified	-	-	-	-	-	-	-	-
CHP Plants	***1861 e***	***2424***	***3047***	***2882***	***4343***	***3522***	**..**	***6.0***
Geothermal	-	-	-	-	-	-	-	-
Industrial Waste	-	-	166	107	101	176	..	-
Municipal Solid Waste Renew.	103 e	116	166	130	239	268	..	9.1
Municipal Solid Waste Non-Renew.	-	-	-	-	-	-	-	-
Solid Biomass	1758 e	2278	2694	2636	3971	3053	..	5.1
Gas from Biomass	-	30	21	9	32	25	..	-
Comb. Renewables Non-Specified	-	-	-	-	-	-	-	-

Table 5.3. Electricity production from renewable sources in Sweden (Source: IEA 2003d)

	1990	1995	1998	1999	2000	2001	2002E	Average annual percent change 90-01
Total Heat	**24434 e**	**81708**	**90219**	**103478**	**105506**	**111030**	**116826**	**14.8**
Geothermal	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-
Industrial Waste	-	-	608	507	508	381	378	-
Municipal Solid Waste Renew.	12448 e	14338	14277	15359	16659	14699	19095	1.5
Municipal Solid Waste Non-Renew	-	-	-	-	-	-	-	-
Solid Biomass	11986 e	53310	59700	71616	72330	83922	81085	19.4
Gas from Biomass	-	770	766	1062	1042	1125	1115	-
Waste Heat and Heat Pumps	..	13290	14868	14934	14967	10903	15153	..
of which:								
CHP Plants	***8518 e***	***43373***	***49980***	***58592***	***61108***	***65181***	***..***	***20.3***
Geothermal	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-
Industrial Waste	-	-	608	476	489	381	..	-
Municipal Solid Waste Renew.	4673 e	9863	10289	10674	10971	9749	..	6.9
Municipal Solid Waste Non-Renew	-	-	-	-	-	-	-	-
Solid Biomass	3845 e	30649	35781	43904	45737	50368	..	26.3
Gas from Biomass	-	381	414	503	589	491	..	-
Waste Heat and Heat Pumps	..	2480	2888	3035	3322	4192	..	..
Heat Only Plants	***15916 e***	***38335***	***40239***	***44886***	***44398***	***45850***	***..***	***10.1***
Geothermal	-	-	-	-	-	-	-	-
Solar Thermal	-	-	-	-	-	-	-	-
Industrial Waste	-	-	-	31	19	-	-	-
Municipal Solid Waste Renew.	7775 e	4475	3988	4685	5688	4950	..	-4.0
Municipal Solid Waste Non-Renew	-	-	-	-	-	-	-	-
Solid Biomass	8141 e	22661	23919	27712	26593	33554	..	13.7
Gas from Biomass	-	389	352	559	453	634	..	-
Waste Heat and Heat Pumps	..	10810	11980	11899	11645	6712	..	..

Source: IEA Country Submissions (2002).

Table 5.4. Heat production from renewable sources in Sweden (Source: IEA 2003d)

Biomass has made a particularly strong progress in the district heating sector, becoming the dominant fuel source, as shown in figure 5.5 below.

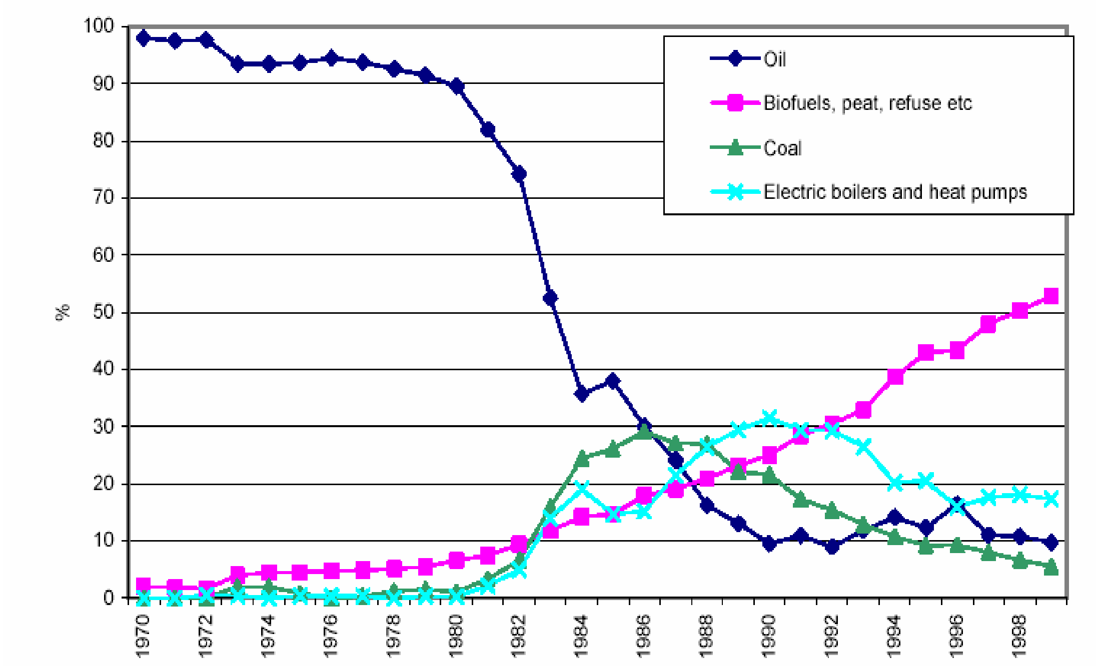


Figure 5.4: Fraction of total energy supply to district heating by fuel type (Source: Johansson et al. 2002:11)

The final point to note about Swedish biomass is that a sizeable fraction is sourced from purpose grown fuel crops. See Table 5.5 below.

Source	**Biomass supply in 2000 (in TWh)**
Logging residues	7
Fuel Wood	10.5
Industrial Residues	65
Imported Biomass	6
Agriculture	<0.5
Total	89

Table 5.5: Biomass feedstocks in Sweden (Source: Johansson 2002:6)

5.5 Conclusions

Many factors have influenced the success of biomass use for electricity including Sweden's cold climate, well-established urban district heating, vast areas of forest and correspondingly large related industries. Sweden's electricity sector currently only contributes 5% of the countries' total CO2 emissions and electricity prices are relatively low, thus pressures to develop renewable technologies in this area have so far been low. Historically, a range of fiscal measures to encourage fuel switching have had a profound impact on biomass use in CHP and heat markets, but offered limited incentives for renewable electricity. However, a nuclear phase out coupled with tougher-than-Kyoto national targets for CO_2 emissions reductions will encourage more attention to this sector.

The recent green certificates scheme aims to provide new incentives for renewable electricity provision.

Biomass already provides a sizeable fraction of industry and heat markets. It should continue to grow in the present policy framework. Apart from its domestic market, Sweden is also looking to new export markets that might develop with the more widespread diffusion of biomass technologies in Europe and internationally.

6 Country study – Austria

6.1 Introduction

Austria has seen rapid growth in biomass heating/CHP and solar water heating and is experimenting with a number of innovative biomass conversion options. It has also made some progress with wind power and PV, despite complex regional policy rules. This case study will therefore consider biomass use in particular, with an overview of the wider renewables policy framework

The case study is structured as follows:

6.1 Introduction
6.2 Primary energy mix for Austria
6.3 Policies
6.4 Progress with renewable technologies
6.5 Conclusions

6.2 Background

Austria's electricity supply is dominated by its hydro power stations, most of them large scale (bigger than 10MWp). In 2001, 68% of total electricity supply came from this source, while fossil fuels (oil, coal, gas) made up another 29.3%. The remaining 3.7% comes from 'new' renewables, i.e. wind, solar and biomass.

Overall energy consumption in Austria has a 25% share of renewables – about 40% of final energy consumption is in the area of warm water and district heating where oil and gas still dominate. Austria makes growing use of combined heat and power (CHP) plants which provided 1236 GWh of electricity and 4194 TJ of heat in 2001.

An important feature of the Austrian political system is its division of power between the different regional layers, i.e. national, regional and local government. This is important for energy policy, as some of the support schemes have been implemented on a local level, leading to different impacts across the different regions. While recent energy laws were enacted by the federal government, it required the regional, or 'Länder', governments to carry out the detailed implementation (IEA 2003d; Lauber 2002).

6.3 Policies – 'The Market'

There have been four main policies that supported the uptake of renewables – *capital grants, exemption from energy taxation, feed-in tariffs* and *quotas*.

Quotas were initially used when the Austrian electricity market was liberalised in 2001. Regional distribution system operators were required to purchase electricity from recognised eco-plants, up to an increasing share of their electricity sales to final consumers (2001: 1%; 2003: 2%; 2005: 3%; 2007: 4%). Purchase prices were regulated through feed-in tariffs. These, and the penalty price for not fulfilling the requirements, fell into the domain of Länder governments for detailed implementation (see below). The grid operators could resell these amounts of electricity to final consumers or to electricity traders. If the minimum percentage amount was exceeded, the grid operator was able to sell the excess amount to other operators of distribution grids. Qualifying eco-plants included wind, PV, geothermal energy, biomass, biogas, digester and sewage gas, as well as co-firing and multi-fuelled plants using high proportion of bio fuels, and combustion of wastes containing a high percentage of bio materials (Lauber 2002).

Separately, small hydro-power (<10 MWp) was supported by its own certificate and quota scheme. Each regional distributor had to prove that 8% of its electricity came from such sources, by providing the required amount of tradable certificates.

The main problem with this approach was that although the national government announced the headline target numbers, it was down to individual Länder to implement detailed legislation. This lead to a highly complex set of regional policies – nine different Länder laws, nine different decrees and about 100 different tariffs. The ratio between highest and lowest tariff varied 32:1 for PV and 8:1 for biomass. Subsequently, E-control, the electricity regulator, issued proposals to harmonize this system (Lauber 2002).

In January 2003, the previous arrangements were replaced by a system of uniform feed-in tariffs and Austria-wide renewable electricity targets. Peculiarly, the set-up, as will be described, will only be open to renewable energy projects that receive planning permission between 1 January 2003 and 31 December 2004. It is understood, that the government will subsequently review its progress made towards the goal of 78.1% of renewable electricity as set out in the recent EU directive and decide on future policies accordingly. All existing plants will receive payments according to the old individual Länder decrees (E-Control 2003a).

Under the new law, renewable energy projects will receive 13-year contracts that guarantee fixed prices for every kWh of electricity supplied. This is financed by a levy on electricity consumption by all electricity customers. The sum paid is listed in table 6.1. below.

Source	Tariff (in €cent/kWh)
Wind	7.8
Solid Biomass	10.2 – 16
Mixed Biomass/Waste	6.63 – 12
Biogas	7.73 – 16.5
Small Hydro	3.15 – 6.25
PV	47 – 60

Table 6.1: Austrian feed in tariffs by technology (Source E-Control 2003a)

The feed-in tariff for PV was only guaranteed for the first 15MW installed. This was surpassed in August 2003.

The feed-in tariffs are coupled with the specific renewable energy target for the year 2010 to reach a 78.1% renewables share in the electricity supply (as specified in the EU renewables directive). Of this, 62% is targeted to be covered by large-scale hydro, 9% by small-scale hydro (<10MWp), 2% wind, 2% biomass, 0.03% PV and 3% 'other' renewables sources. The feed-in tariffs are only paid to new installations in the time period Jan '03 – Dec '04 in order to evaluate the progress made towards the overall renewable electricity goal of 78.1%. Subsequent programmes will only be implemented on the basis of the evaluation of this first period (E-Control 2003a).

However, electricity is not the sole focus of Austrian renewables support, and biomass and other renewables make an important contribution to heat markets. There are several capital grant and soft loan schemes to subsidise investment costs of renewable energy projects. A major area of support is the federal funding of residential housing programmes. These are again administered by the Länder, some of which have put a high emphasis on energy efficiency and the use of renewable energy. In the province of Salzburg, for example, 48% of all new housing built in 2001 is heated with biomass, while an additional 63% have solar thermal water heating systems.

Furthermore, federal subsidies administered by the Kommunalkredit, a bank specialising in loans to communities and municipalities, provide up to 30% of the investment costs for a variety of renewables. Both heat and electricity are included, support is available for small hydro plants, modern biomass-based heating systems, biogas, sewage gas, solar thermal, PV and wind installations (Lauber 2002).

The tax system in Austria has affected the relative prices of renewable energies versus fossil fuels. Although not part of wider energy policy and mainly used on an ad-hoc basis to raise revenue, changes in the oil, gas and electricity consumption taxes over the past decade have improved the relative standing especially of biomass in the heating sector. Also, bio-diesel is exempted from the general gasoline tax which makes it cheaper at the pumps than conventional diesel (Lauber 2002).

6.4 Progress with renewable technologies

The table on the next page shows key energy data related to Austria and the share of the different renewable energy sources to total energy supply. The largest sources of renewable energy are large-scale hydro power plants and biomass. Total installed wind capacity was 139 MW at the end of 2002, while total solar capacity was 9 MW in the same year. At the end of 2001, there were 766MW of installed biomass capacity. About 500,000 small-scale boilers and stoves used woodchips and wood pellets as their fuel source for heating. 40% of the land area in Austria are covered by forest (IEA 2003d, Weiss 2002).

From recently released data, it seems that the new feed-in law has spurred a flurry of activity in the wind sector. Up until 30 September 2003, planning permission has been granted for 300 MW worth of projects, which represents more than double the current *total* of installed capacity. As mentioned before, the feed-in tariff for PV was only guaranteed for the first 15MW installed, which has already been reached in August 2003. This also means a more than doubling of the total installed PV capacity so far in less than 8 months (Windpower monthly 2003a, Schönbauer 2003).

Also notable is the growth in solid biomass use between up to 2001 which is largely due to the increased uptake of CHP plants. Here, increases in the oil and gas price due to increases in taxes and the general price level were important factors. Actual electricity output of CHP doubled in that period while heat production increased by about two thirds – in parallel with an increase in the use of biomass in these applications (see Table 6.2.).

Year	Total CHP plants (output in GWh)	CHP plants operated with Biomass (in GWh)	CHP plants operated with industrial residue (in GWh)	Share of Biomass and residue in CHP plants (in %)
1998	501	396	42	87.4
1999	921	801	42	91.5
2000	1089	972	28	91.8
2001	1236	997	153	93

Table 6.2: CHP and biomass CHP growth in Austria (Source: IEA 2003d)

Austria also has a number of demonstration plants with novel biomass technology, including plants in Güssing (gasification of biomass with steam in a novel fluidised bed system), Reutte (steam cycle CHPs) and Admont (organic Rankine cycle). It is argued that, from a technical standpoint, dedicated biomass production could still rise by a factor 10 or 20 without posing significant problems. Although currently no energy crops are planted on a significant scale, this is being undertaken now in the forestry area (Lauber 2002; Weiss 2002).

NET GENERATING CAPACITY OF RENEWABLE AND WASTE PRODUCTS (MW)

	1990	1995	1998	1999	2000	2001	2002E	Average annual percent change 90-01
Total Capacity	**11353**	**11856**	**12230**	**12486 e**	**12398**	**12404**	**..**	**0.8**
Hydro	10947	11304	11444	11648	11547	11550	..	0.5
of which: Pumped Storage	-	2975	3937	3568	3568	3568	..	-
Geothermal	-	-	-	-	-	-	-	-
Solar Photovoltaic	-	1	3	4	5	7	..	-
Solar Thermal	-	-	-	-	-	-	-	-
Tide, Wave, Ocean	-	-	-	-	-	-	-	-
Wind	-	1	27	35	54	69	..	-
Industrial Waste	-	-	-	-	-	-	-	-
Municipal Solid Waste	6	6	9	12 e	12	12	..	6.5
Solid Biomass	400	544	747	787 e	780	766	..	6.1
Gas from Biomass	-	-	-	-	-	-	-	-
Comb. Renewables Non-Specified	-	-	-	-	-	-	-	-
Solar Collectors Surface (1000 m^2)	434	1241	1876	2000 e	2100	2200	..	15.9

Source: IEA Country Submissions (2002).

Table 6.3: Renewable energy capacity in Austria (Source: IEA 2003d)

6.5 Conclusions

Austria's energy policy has so far been dominated by activity at a local level. National policy had to be implemented by regional 'Länder' government which varied in their enthusiasm for the promotion of renewable energy. While some adopted tough building standards and generous feed-in tariffs, others were more protective of local interests, e.g. in local gas supply companies. The biggest growth can be witnessed in the biomass sector which benefited from an expansion of conventional technology heating and CHP plants, driven by tax benefits, and a number of demonstration projects based on advanced technology. With the recent harmonized feed-in tariffs, interest in other technologies has been growing, with orders for wind and PV installations considerably up over the previous years.

7 Country Study – NETHERLANDS

7.1 Introduction

The Netherlands forms an interesting case study, not so much for the growth rates achieved so far in domestic renewables production but for their mixed and innovative policy approach to renewables promotion. A mixture of tax incentives, feed-in tariffs, a certificates market and voluntary agreements are all part of a package to support renewable energy. One area where this had notable success is the *demand* for renewable electricity. Due to the integration of renewable electricity imports into the green electricity market, this sector saw rapid growth in the last two years and at the beginning of October 2003, 2.2 million customers were under a green electricity supply contract, which represents a 32% market share for green electricity. This section focuses on the policy mix implemented in the Netherlands.

The case study is structured as follows:

7.1. Introduction
7.2. Primary energy mix for the Netherlands
7.3. Policy environment – 'the market'
7.4. Progress with renewable technologies
7.5. Conclusions

7.2 Primary energy mix for the Netherlands

Gas plays a central role in the Dutch electricity mix. Domestic gas reserves guarantee a high degree of supply security at least for the short to medium term. Domestic oil reserves similarly contribute to this, although to a much smaller extent in the electricity sector. The situation for nuclear power is currently highly uncertain but the current timetable sees the last operating nuclear reactor shutting down in 2007. The last coal mine closed in 1974. The geographic location and a good infrastructure with harbours in Rotterdam and Amsterdam offer coal imports at low prices. Thus, coal still has an important role in the electricity mix. However, this will decline due to tough environmental standards on emissions and the cheap supply of gas in the medium-term. One option is also the co-combustion of biomass and coal, as will be discussed further below. The main 'new' renewables in the Netherlands are biomass and wind.

Energy Source	Percent of Total use (2000)
Gas	57%
Coal	23%
Oil	7%
Nuclear	4%
Derived Gasses	3%
Waste (non-renewable fraction)	2%
Renewable Energies	4%

Table 7.1: Share of energy sources in the Netherlands 2000 (Source: Reiche 2002)

7.3 Policy environment – 'The market'

7.3.1 Historical development

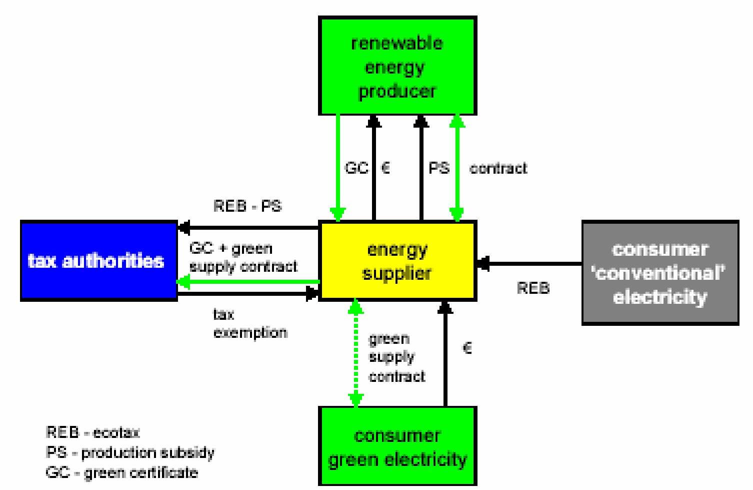
The Netherlands have a tradition of mixed approaches to energy policy, including capital grants, tax incentives, feed-in tariffs, and voluntary agreements. This sections focuses on the situation in the Dutch electricity market after market liberalisation in July 2001. It can be characterised as one of realizing low-cost carbon abatement solutions. Promotion of a domestic industry and innovation were an issue but did not succeed as planned due to numerous obstacles described below. The main focus in the electricity market was on the demand side and on voluntary approaches.

The Dutch Electricity Market was liberalized in July 2001. When designing regulation for the new market, green electricity was given a specific advantage over other electricity sources. The market for small households will only be fully opened up to competition in January 2004, thus individual customers are not yet able to choose their electricity supplier freely. They can, however, change their electricity supplier now, if they opt for a green electricity product. Thus green electricity suppliers have a 2 ½ year lead over their competitors before the market is fully liberalized in 2004.

This is complemented by a Green Certificates Scheme, which was also implemented in July 2001. In order to guarantee authenticity and ensure market transparency, electricity from renewable sources, encompassing wind, PV and biomass, qualifies for these certificates. (Since 2002, no hydro power, large or small, qualifies.) Imported renewable energy is also eligible, and is actually currently delivering the majority of the Dutch green electricity. The problems associated with this are discussed further below.

A financial incentive of the green certificates scheme stems from the exemption from the Regulatory Energy Tax (REB – 'ecotax') of the suppliers of certified green electricity. The current eco tax amounts to 6 €cent/kWh. A share of the income from the REB is paid directly to the producers of green electricity, 2 €cent/kWh in 2002. The Dutch REB was introduced in 1996 on the final consumption of electricity and gas, in order to promote energy conservation and renewable electricity, this being exempt from the tax (Reiche 2002).

The relationship between the different support schemes and, in particular, the flows of money involved are shown in Figure 7.1 on the next page. Renewable electricity producers receive income firstly through the production subsidy (PS) and secondly through the sale of their electricity, accompanied by Green certificates (GC) to the energy supply company (bundled system). Both are regulated through a contract between producer and supplier. The supplier can then use the certificates to claim tax exemption for the amount of green electricity sold to its customers as specified in its green supply contracts. Regular electricity customers pay the REB eco-tax which is passed on through the supply companies to the tax authorities minus the production subsidy given to the green electricity producers.



Relation between the Dutch green certificate system and the ecotax

Figure 7.1: Dutch certificates and taxation interactions (van Sambeek and van Thuijl, 2003)

Both domestic production and imported renewable electricity have been eligible for the production subsidy and green certificates support. In case of imported electricity, certain conditions had to be fulfilled. In 2002, electricity from the following countries was eligible: Austria; Norway; Finland; Sweden; Germany; UK.

The combined eco-tax exemption and production subsidy add up to 8 €cent/kWh and enabled the suppliers to offer green electricity at the same price as conventional electricity. This has provided a boost for the green electricity market in the Netherlands. Thus, the number of green electricity customers has increased from about 250,000 in 2001 to approximately 1.4 million in January 2003 (van Sambeek and van Thuijl 2003; Meier 2003) and 2.2 million customers in October 2003 (ECOFYS 2003).

The IEA (2000:42), in its country report on the Netherlands, reports that: "…consumers in the Netherlands are very willing to pay for additional supply of renewable energy, e.g. through mechanisms such as green electricity pricing. This willingness to pay higher prices for renewables is such that the renewables objective can in principle be met and even exceeded by 40-50 per cent in 2010…". Although non-green and green electricity are often offered at the same price, transaction costs of comparing offers and switching electricity providers could still provide a barrier to uptake of green electricity supply in principle. Certainly in the UK, where some suppliers now offer green electricity at no extra costs, the uptake is modest. Thus, the greater willingness to pay for green electricity could have played a significant role in overcoming these non-price market barriers. When the electricity market fully opens up to competition in January 2004, it is possible that a price differential between conventional electricity and green electricity will again be offered. Under these circumstances, the 'greater willingness to pay proposition' can be examined more fully. In any case, for the moment, available supply of green electricity, rather than missing demand, is the main bottleneck.

7.3.2. Recent changes

An amendment has been introduced to the market set-up described above, which has been in operation since the beginning of 2003. In the wake of these changes, the emphasis will move away from a merely demand-orientated system to one supporting both demand for and supply of renewable electricity.

A major problem with the previous set-up of the Dutch electricity market was the large amount of imported electricity. Firstly, the government had to bear the costs of foregone tax revenue which amounted to about €205m in 2001. Secondly, the large amount of imported electricity meant that the Netherlands' domestic market did not grow very fast and thus the Netherlands were in danger of failing their targets for renewable electricity under the 2001 EU directive and the Kyoto Protocol. From a European perspective, this is aggravated by the fact that most of the imported electricity came from existing plants that – in the absence of the higher-value Dutch market – would have operated under their national renewable support scheme. In this sense, the Dutch scheme only led to a redirection of electricity flows instead of realisation of additional capacity abroad. By way of an example, the major source of imports is biomass from mostly Scandinavian countries. There is a large supply of biomass power available at prices up to around €20/MWh. Under the current scheme, they would be eligible in the Netherlands for support of up to €80/MWh and even the new rules, discussed below, will not totally eliminate this source of green electricity from the Dutch market (van Sambeek and van Thuijl, 2003).

7.3.3 Changes in the policy framework

The main points are that the tax exemption will be reduced from 6 €cent/kWh to 2.9 €cents/kWh, while a feed-in tariff (called MEP feed-in-tariff) is introduced at the same time, which will only benefit domestic green electricity producers. The feed-in tariff will be determined annually by the government, but the total level of support consisting of the tax exemption plus the feed-in tariff will be kept constant and guaranteed by the government for a period of 10 years, once plants enter into contracts and start operation. The flows of electricity and payments in the new system are outlined in figure 7.2. below:

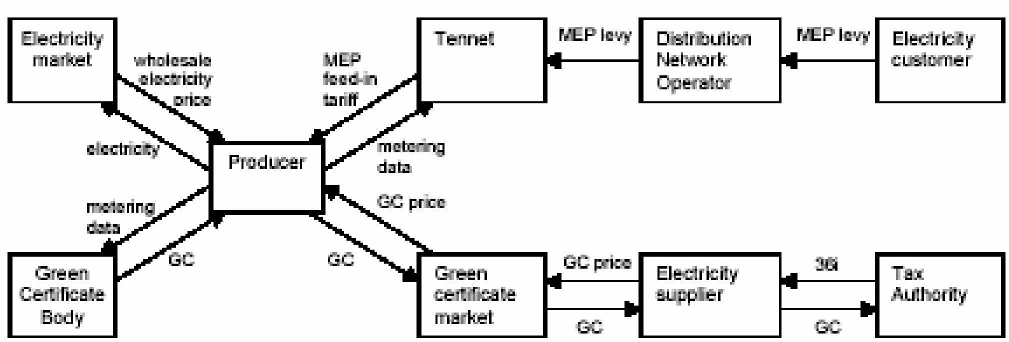


Figure 7.2: Power and financial flows under revised certificate and tax rules (Source: van Sambeek and van Thuijl, 2003)

There are now three sources of income for green electricity producers: the wholesale price of electricity; the feed-in tariff as specified for each renewable technology (see Table 7.2. below); and the Green certificate market. TenneT, the wholly government owned transmission system operator, agrees the contracts with the green electricity providers over the feed-in tariffs. These are financed by the new MEP levy on all electricity consumers (details below). Importantly, the feed-in tariffs are only available to domestically produced green electricity. The Green certificate market is operated much as before, but the eco-tax is reduced from 6 €cent/kWh to 2.9 €cent/kWh in 2003. This effectively reduces the market value of the certificates to a maximum of 2.9 €cent/kWh. The certificates market is open both to domestic and imported green electricity.

This system effectively decouples the electricity market from the green certificates market. While green electricity now competes with all other sources of electricity on the open market, its support is determined by the value of the tax exemption (in the case of imported renewable electricity) or the combined value of the tax exemption and the feed-in tariffs (in the case of domestically produced renewable electricity).

Table 7.2. below provides an overview over the different feed-in tariffs available for different technologies. In order to contain the costs of the programme, the government has set an upper limit of 7 €cent/kWh.

Technology-energy source	MEP feed-in tariff	Ecotax exemption	Total support
Landfill gas and digestion	0	2.9	2.9
Pure biomass	4.8	2.9	7.7
Mixed streams[9]	2.9	0	2.9
Onshore wind[10]	4.9	2.9	7.8
Offshore wind	6.8	2.9	9.7
Stand-alone bio-energy installations < 50 MW_e	6.8	2.9	9.7
Solar photovoltaic	6.8	2.9	9.7
Wave energy, tidal energy	6.8	2.9	9.7
Hydropower	6.8	0	6.8

Table 7.2: MEP feed-in tariffs for renewable electricity in the Netherlands (€cent/kWh – Source: van Sambeek and van Thuijl, 2003)

The values for the different technologies above were determined by calculating the financial gap between the cost of each type of renewable electricity and the value of the electricity on the wholesale market. The level of the MEP feed-in tariff per category is determined by subtracting the value of the eco-tax exemption from this financial gap for each type of renewable electricity generation. Biomass was divided between pure biomass material and mixed streams. The tariff for pure biomass was calculated assuming a long-term international market price for biomass material of €4/GJ. The price for on-shore wind is only guaranteed for up to 18,000 full-load hours during the contract period of ten years. This is intended to minimize free-riding on above-average windy sites. The financial gap for off-shore wind, PV, wave, tidal and hydro is assumed to be beyond the 7 €cent/kWh upper limit set by the government, and, in the case of PV, substantially above that limit. Consequently, the feed-in tariff is set at the maximum possible, but it is not expected that it will substantially influence the up-take of these technologies in the short-term. It is noticeable that the levels of support shown above are now above what Germany or Spain is paying for on-shore wind and biomass.

The budget for the feed-in tariff programme is estimated to be €258m in 2002, rising to €316m in 2006. The MEP feed-in tariffs are financed through an annual MEP levy on all connections to the electricity grid in the Netherlands. It is collected by the distribution network operators and consequently passed on to TenneT. To calculate the costs of the levy per household, the total amount of the tariffs is divided by the number of connections to the electricity grid. This will mean a levy of about €34 in 2002, rising to about €40 in 2006 (Sambeek and Thuijl, 2003).

7.3.4 Figures for the market

Green certificates show the flow of renewable electricity. The two main sources of electricity in the Netherlands are biomass and wind. However, three quarters of renewable electricity is imported, mainly from Biomass and Hydro sources.

Source	**2002**	**2003 (up to 30 Sept 03)**
Wind – NL (GWh)	880	866
Wind – Imports (GWh)	0	227
Biomass - NL (GWh)	1,250	835
Biomass - Imports (GWh)	4,275	5,800
Hydro – NL (GWh)	0	0
Hydro – Imports (GWh)	3,850	500
Total – NL (GWh)	**2,130**	**1,701**
Total - Imports (GWh)	**8,125**	**6,527**

Table 7.3: Sources of renewable power in the Netherlands (Source: CERTIQ 2003)

7.3.5 Supplementary policies

Having described the principal incentive structure in the Dutch electricity market, some supplementary policies are now briefly outlined. These serve to illustrate the point that the Dutch approach to energy policy is probably one of the most diverse in Europe.

Tax incentives: Banks offer green funds, the returns of which have been free of income tax for private persons. As a result, these financial institutions are able to offer loans for green projects at a discount. In 2001, 1.4bn Guilders (approx. €635m) were invested in such funds, one third of which was in renewable energy projects.

Capital Subsidies: Greenpeace offers, through the project 'Solaris', PV systems for private homes at half the market price, made possible due to co-operation with the quasi-governmental Netherlands Agency for Energy and the Environment (NOVEM), and Shell Solar.

Voluntary agreements (or 'covenants'): Voluntary agreements (or 'covenants') are made between the government and specific industries. Most notable is an agreement between the coal energy producers and the government, signed in 2000. Its intention is to make coal plants as efficient as gas plants by the year 2010. To reach that goal, coal plants will have to co-combust biomass. The aim is to reduce CO_2 emissions from coal plants by 40% between 1990 and 2010 with this measure (Reiche 2002).

7.4 Progress with each technology

This section will briefly outline the development of wind and biomass in the Dutch market where possible. The wind industry had, in the 1980s, a real success story and was tipped the future market to watch out for at that time. However, the high expectations did not materialise subsequently.

7.4.1. Wind

In the 1980s, the Netherlands, similarly to Germany, experimented with a number of different design approaches. The government funded R&D in conjunction with academic institution an companies. Despite some problems with early demonstration projects, the Netherlands had essentially a home-grown wind industry in the 1980s. This got a further push in 1985 when the government announced an aspirational target of 1000 MW installed wind capacity by 2000. A market formation programme involving investment subsidies and further R&D led to a market expansion from 5.5 MW cumulative installed capacity in 1985 to 33 MW in 1989. As the programme had a focus on cost-reductions and efficiency improvements, it favoured larger turbines over small ones, thus guiding the technology selection at that stage. At the end of 1989, Holland had a promising market with a number of domestic companies, while, for example, in Germany the wind industry was still in a phase of 'variety creation', experimenting with different designs.

Since, by 1990, the share of wind in the Dutch electricity market was still far away from the 1000 MW target, the government decided to continue to rely on the investment subsidy. Also, a new electricity law, partially opening the market, favoured the development of wind power in the Netherlands. Consequently, the main electricity distributors formed a joint-procurement project and announced a 250MW 'Windplan' over five years. However, these efforts failed to deliver the intended results, for two main reasons. Firstly, in 1993, the 'Windplan' project was suddenly dissolved, as some of the companies questioned the benefits of joint procurement and its impact on technology development. Secondly, and more importantly, with the growth of the wind industry, turbine planning and siting problems became a real issue. The basic problem was that, although the federal government announced the overall plan of 1000 MW of wind capacity by 2000, it was the responsibility of the local authorities to grant the building permits. These were reluctant to grant planning permission, since they saw few real benefits for their local communities. The government attempted to resolve the problem by striking an agreement with the provincial authorities over the distribution of the wind sites, but these authorities had no real power over building and environmental permits, which were granted by the local authorities who were not included in the deal. A number of commentators identified a Not-in-my-backyard (NIMBYism) attitude as a major problem. Overall, the failure to resolve this ongoing struggle meant that the market formation never materialised in its envisaged form. Although it was, in principle, possible for the government to impose directives for land usage on local authorities in cases of 'national interest', these were not used. When the government finally removed the investment subsidy in 1996 and started to experiment with other measures, market expectations collapsed and the market remained flat in subsequent years at a stable 30-50 MW added capacity a year. Only the boom in green electricity after the market liberalisation in July 2001 sparked another boom in the wind market. The Tables below summarize this development (Johnson and Jacobsson 2000, Reiche 2002).

Year	Cumulative installed capacity (MWp)
1995	249
1996	299
1997	325
1998	363
1999	411
2000	449
2001	483
2002	**686**
October 2003	**829**

Table 7.4: Total cumulative Wind capacity NL (Source BWE 2003)

Year	Annual installed capacity (MWp)
1995	95
1996	50
1997	26
1998	38
1999	48
2000	38
2001	34
2002	**203**
October 2003	**143**

Table 7.5: Annual installed capacity (Source: BWE 2003)

Year	Growth rate (%)
1996	20.1%
1997	8.7%
1998	11.7%
1999	13.2%
2000	9.2%
2001	7.6%
2002	**42%**

Table 7.6: Growth rates in the Dutch wind market (Source: BWE 2003)

7.4.2. Biomass

It has not been possible to collect detailed information on the historic development of the biomass market in the Netherlands. One commentator pointed out that biomass in Holland enjoys a more favourable investment environment, principally because it was easier to obtain planning permits than in the case of wind and because of the possibility to import biomass fuel from the international market. This last point is also reflected in a statement below from the Dutch Economic ministry on the envisaged future of biomass:

“In addition to residual flows, the Netherlands will also include biomass crops, though these will be primarily grown outside the Dutch Borders. The country is too small to produce enough biomass to meet demand… this is why the Netherlands will look to the international market for its biomass supply…Well developed long-term markets for biomass already exist, with spot markets and markets for financial ‘derivatives’” (Ministerie van Economische Zaken 2003).

7.4.3. Other obstacles to renewables

A major criticism has been the missing long-term security for investors in renewables projects. Frequent changes in the policy framework and a perceived stop-and-go pattern with investment incentives deterred investors. It has been pointed out that the Dutch support schemes have been at times ‘too complex and sometimes confusing’ and there is a real danger that investors might lose confidence in the Dutch government in principle (Reiche 2002). However, following the 4th National Environmental Policy Plan in 2000, a new strategic framework for an ‘Energy Transition’ Programme has been developed. It is too early yet to assess the effectiveness of this Programme in creating a more stable long-term framework for investment. But policy-makers are certainly aware of this issue now.

7.5 Conclusion

The Dutch renewable electricity market has been characterized by frequent changes and a degree of experimentation over the last decade. A host of different policy tools have been employed to promote the market diffusion of renewables technology but in absolute numbers the success has been limited. However, the approach taken in the Netherlands has been successful with respect to low-cost carbon abatement solutions. The opening of the green electricity market coupled with the inclusion of electricity imports and rapid uptake of green tariffs by Dutch customers has led to a marked impact of renewable electricity in the household market sector. Policy instruments used included tax incentives, feed-in tariffs, green certificates and voluntary agreements. With recent adjustments to the incentive structure, favouring the domestic production of renewable electricity, it seems likely that the Dutch domestic renewables industry will finally take off to levels of growth experienced by other European countries in the past. Figures for 2002 and 2003 underpin these expectations of a rapid take off of domestic Dutch renewable capacity.

8 Country study – USA

8.1 Introduction

The USA has yet to come up with a federal approach to supporting renewable energy technologies. There is a tax credit on the federal level but otherwise, renewables are mostly dependent on state- or regional- policies to promote them. Some states have had considerable success in promoting renewables, notably wind and PV, whilst Federal policies have been criticised for their ‘stop start’ nature. Several states have also instituted RPS (certificate trading) schemes – some earlier than most other countries. The diversity of policies, and mixed success, make the US an interesting case study. We mostly focus on the different policies, summarizing the measures in place in key States, with the relative growth of renewables outlined briefly.

The case study is structured as follows:

8.1. Introduction
8.2. Primary energy mix for the USA
8.3. Policies on federal, state and regional level
8.4. Progress with renewable technologies
8.5. Conclusions

8.2 Primary energy mix for the USA

The energy mix in the USA is dominated by oil, nuclear, coal and gas – less than 5% of the energy supply comes from renewable sources. The share in the electricity supply is higher at about 8.4%, largely due to large-scale hydro power plants. The biggest ‘new’ renewables, in terms of total output, are biomass and waste combustion, geothermal power and wind power (IEA 2003d).

8.3 Policies

Overall, there are a host of Federal and State programmes that incentivise investment in renewable energy in some form. Some are aimed at demonstration projects and often they come in the form of tax credits. Below are a selection of policies that are currently at the centre of energy policy debate in the USA. The US led the world in wind energy development in the mid 1980s, due largely to investment subsidies and incentives offered in California. Whilst resulting in a huge boost to the infant wind industry this scheme also result in many 100s of MW of rather inefficient and poorly sited machines. Since then, policies have tended to be rather less ambitious, at both state and federal level, though with some notable successes.

8.3.1 Federal schemes – the stop-go PTC

The most important policy at the federal level is the federal production credit. In 1992 the Energy Policy Act was signed into law and included enactment of a Production Tax Credit (PTC). However, it expired and had to be re-enacted three times. Each time, delays and uncertainties have given rise to a 'stop go' cycle with investments rushed through before the credit expired, followed by market collapse until the scheme won an extension. Most recently it expired at the end of 2001, but was extended in March 2002 to the current deadline of December 31, 2003. Projects that start delivering electricity into the grid before the current deadline will receive a tax credit of 0.018$/kWh for 10 years. An extension of the PTC for another three years has only recently been passed in a Senate version of the new Energy Policy Act (EPA). This would allow a smooth transition from the current deadline. However, the final version of the EPA has now to be negotiated with Congress with the outcome yet uncertain. Due to this uncertainty about the PTC there is a rush for wind projects that can be implemented before the 31 December deadline – 2003 is expected to be a new record year for the American Wind Turbine industry with 1845 MW of newly installed capacity against a total capacity of 4708 MW at the end of 2002. The outlook for 2004 so far is bleak with a flat market expected (Windpower Monthly 2003a,c; American Wind Energy Association – AWEA 2003).

8.3.2 State level RPS

At the State level, a number of states have experimented with a renewable portfolio standard (RPS). Currently, 11 states have some form of RPS requirement as outlined in table 8.1 below:

State	Date effective	Renewables requirement (final target set out in the law)
Arizona	1 May 2001	1% by 2005, 1.1% by 2007
California	12 Sept 2002	20% by 2017
Connecticut	1 Jan 2000	13% by 2009
Iowa	9 Feb 1997	105 MW of renewables annually to be bought, shared by all suppliers
Maine	4 Nov 1999	30% in 2003
Massachusetts	26 April 2002	1% in 2003, rising 0.5% annually until 2009
Nevada	31 May 2002	15% by 2013
New Jersey	1 Sept 2001	6.5% by 2012
New Mexico	1 July 2003	10% by 2011
Pennsylvania	1 Jan 1999	2% in 2001, rising 0.5% annually
Texas	1 Jan 2002	2000 MWp new renewable capacity by 2009

Table 8.1 – US states with RPS schemes in place (Source: REPP 2003)

The exact specification of each RPS varies. Some states specify a technology mix (e.g. New Jersey), while others leave this up to the market. The Senate version of the Energy Policy Act includes a provision of an RPS of 10% renewable electricity by 2020, but again the final version of the EPA has yet to be agreed with Congress.

8.3.3 Regional and additional state level incentives
Besides these federal and state-level policies, there are several regional and local initiatives to promote renewables. For example, in California, besides the RPS, which started in January 2003, a "buy-down" programme offers up to 50% of the total costs of a new PV or small-wind system as a cash subsidy. Similarly the Sacramento Municipal Utility District offers a $3/W subsidy on new PV installations for up to 5MW of installation and the Los Angeles Department of Water and Power up to $5.50/W for new PV installations. The states of Arizona, Illinois, New York, Virginia and North Carolina offer similar programmes. These are far from unsuccessful, even on a global scale, since the US has the third largest installed PV capacity in the world (IEA 2003b).

In Congress, a provision was included in the congress version of the EPA to provide $300m in capital grants for federal and state government buildings to install solar PV and thermal systems. Negotiations between Senate and Congress will decide about the outcome of this measure (AWEA 2003).

8.4 Progress with key technologies

8.4.1 Wind
Wind has been one of the fastest growing 'new' renewable energy source in the US. The graph below (Figure 8.1) shows the cumulative installed capacity in the past twenty years.

Year	MW
1992	1,584
1993	1,617
1994	1,656
1995	1,697
1996	1,698
1997	1,706
1998	1,848
1999	2,511
2000	2,578
2001	4,275
2002	4,685
2003*	6,336

Figure 8.1 - U.S. Installed Capacity (Megawatts) 1992-2002; Sources: U.S. Department of Energy Wind Energy Program & AWEA 2003; Windpower Monthly 2004

The flat growth in total installed capacity in the 1990s can be attributed mainly to two main factors. On the one hand, there was some repowering, i.e. replacement, of old and inefficient wind installations that were built in the 1980s, and retirement of these old machines has led to a modest net growth rate until recently. Secondly, the stop-and-go nature of the PTC created an environment of uncertainty for the financing of wind power projects.

The high growth rate in 2001 can be attributed to the looming deadline of the then PTC on 31 December 2001. Similarly, the flat growth in 2002 can be explained in this way, with projects being either rushed through in 2001 or delayed considerably because of the financing uncertainty.

The tables below show the twenty windiest States in the USA and the ten States with the highest installed wind power capacity as of 30 September 2003. It is notable, that a number of States that top the list of windiest sites do not figure in the list of installed capacity, most prominently North and South Dakota and Montana. Thus, it could be expected that, if harmonized rules on an RPS on a federal level were agreed, States that so far have not been active in renewable energy promotion could start to exploit the top wind spots (and thus the cheapest wind sites) in the USA.

THE TOP TWENTY STATES for wind energy potential, as measured by annual potential in billions of kWhs, factoring in environmental and land use exclusions for wind class of 3 and higher:

1	North Dakota	1,210	11	Colorado	481
2	Texas	1,190	12	New Mexico	435
3	Kansas	1,070	13	Idaho	73
4	South Dakota	1,030	14	Michigan	65
5	Montana	1,020	15	New York	62
6	Nebraska	868	16	Illinois	61
7	Wyoming	747	17	California	59
8	Oklahoma	725	18	Wisconsin	58
9	Minnesota	657	19	Maine	56
10	Iowa	551	20	Missouri	52

Table 8.2: US wind energy potential by state (AWEA 2003)

Below are the top ten of installed wind power capacity by state as of 30 September 2003

State	Installed capacity in MWp
California	1958
Texas	1105
Iowa	432
Minnesota	360
Washington	228
Oregon	220
New Mexico	205
Wyoming	141
Kansas	114
West Virginia	66

Table 8.3: US Installed wind capacity by state (Windpower Monthly 2003a)

8.4.2 PV

The US was the world leader in PV installations during the 1980s and into the early 1990s. Installations of PV systems in the USA rose steadily over the past decade, however at a much slower pace than in Japan or Germany. As the PTC did not provide a major incentive to build PV systems, installations were mainly dependent on regional and local capital grant and subsidy programmes, such as the one described in California. California had the largest share of new installations in 2002 with 8 MW of the total of 44 MW installed (IEA 2003b).

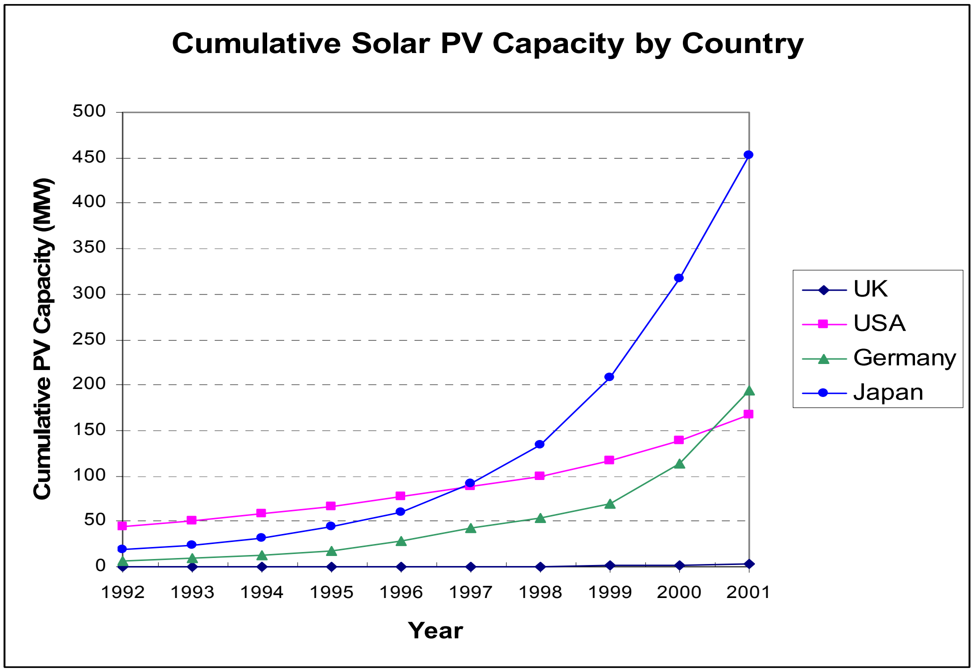


Figure 8.2: PV capacity growth in the US, Germany, Japan and UK (Stenzel et al. 2003)

8.5 Conclusions

The purpose of this section was to outline some of the measures that were used and are discussed in US energy policy to promote renewable energy. As mentioned in the introduction, the USA does not have a coherent federal strategy to support renewables and investors in the USA had to use a mixture of federal tax incentives and State-level capital grant and RPS programmes to secure financing of investments. The development in the wind sector illustrates the stop-and-go nature of these policies with boom and bust years following one another, depending on the introduction and withdrawal of support mechanisms. There are a number of proposals currently under discussion in Senate and Congress that would offer a more coherent approach to renewables policy on the federal level, but their outcome is as yet uncertain.

9 Key Findings from the Case Studies

The previous six chapters presented information from five European countries and the USA on policies to promote renewable energies and evidence on their respective progress in deploying various technologies. In this chapter, some key findings from these country case studies will be presented and subsequently contrasted with the situation in the UK. These will be grouped under the following headings:

9.1. Trends and Impacts of Policies and Technology Deployment
9.2. Cultural and Regional Factors
9.3. Community Involvement
9.4. Conclusion

9.1. Trends and Impacts of Policies and Technology Deployment

9.1.1. General observations

Of the six countries reviewed, four countries have implemented or were in the process of implementing a system of feed-in tariffs. Germany and Spain started these laws in the 1990s while the Netherlands and Austria had an RPS system in place so far, and now have moved towards feed-in tariffs. Interestingly, the policy framework in the Netherlands now allows a co-existence of a certificate trading scheme and feed-in tariffs.

Sweden and the USA were the two countries that were looking at a certificate trading scheme. While Sweden just started an RPS this year, the USA is still debating the introduction of such a policy on a federal level. Both countries have no previous experience at a national level in specific market mechanisms to support the commercial deployment of renewables other than with capital grants.

9.1.2. Feed-in Tariffs

Price differentiation and exit strategy
In all four countries, different tariffs are paid according to the source of renewable electricity. This reflects the different stages of technological development, as, for example, wind is already much closer to a level of full market competitiveness than PV. However, in all countries, it is recognized that feed-in tariffs as a measure of market support cannot be paid indefinitely. There are different exit strategies between countries, which will be outlined below.

Table 9.1 shows the feed-in tariffs (in €cent/kWh) for selected technologies available in different countries in 2003. Exact definitions vary between the countries, but the table still presents a general picture of the feed-in tariffs available in the four countries. Where price bands are given, the payment varies with the size of the installation or the length of operation.

Technology		Austria	Germany	Netherlands[1]	Spain[2]
Wind	Onshore	7.8	6.01 - 8.87	4.9	6.21
	Offshore	n/a	6.01 - 8.87	6.8	6.21
PV		47 – 60	45.7	6.8	21.6 – 39.6
Hydro (small scale)		3.15 – 6.25	6.65 – 7.67	6.8	6.49
Biomass	Pure	10.2 – 16	8.6 – 10.10	4.8	6.05 – 6.85
	Mixed	6.63 – 12	n/a	2.9	n/a

Table 9.1 – Feed-in tariffs in selected countries

As can be seen in Table 9.1, the typical feed-in tariff for most renewables technologies is around 6-8 €cent per kWh. The biggest exception is PV, which receives much higher payments in all countries except the Netherlands, where the government put in place a maximum possible tariff of 7 €cent/kWh. Spain and Germany dominate the European PV market and the Austrian market has seen a remarkable boom since the inception of the new feed-in law.

The administrator and the length of the contracts vary between countries as can be seen in Table 9.2.

	Contract Administrator	Length of contract
Austria	'E-Control', the energy regulation authority	13 years
Germany	Local Grid Operator that will connect renewable installation to grid	20 years
Netherlands	'TenneT', the national grid operator	10 years
Spain	Regional Grid Operator that will connect renewable installation to grid	5 years (with an implicit renewal guarantee)

Table 9.2 – Administrators and Length of contracts

In none of the four countries is the government itself directly involved, either as a contracting party or in administrating or distributing the flow of payments. Contracts are at least ten years long (in Spain, this is not explicitly spelled out but no conflict over contract renewals have so far arisen – see chapter 4 for details), which adds to investor certainty over political involvement in these arrangements and also adds to the high certainty of future revenues. Indeed, from a policy perspective, it seems that formal contracts have the desirable feature of being shielded from day-to-day political meddling.

[1] Total income for renewable electricity producers is determined by the feed-in tariff and the sale of green certificates which are worth 2.9€cent in 2003. Thus, for total income, 2.9€cent have to be added to the figures given in this column (see chapter 7 for details).

[2] Shown are the fixed prices paid rather than the 'premium' on top of the market price for electricity (see chapter 4 for details)

Also, approaches to tariff adjustments and other measures to define an exit strategy are organised differently, as outlined below in table 9.3.

	Exit strategy
Austria	Feed-in tariffs only available for systems installed between 01/03-12/04; 15MW max capacity for PV
Germany	Annual reduction of tariffs by 1.5-5%; 1000MW max capacity for PV
Netherlands	Tariffs determined annually by Economic ministry; Tariff for wind only available for first 18,000 full-load hrs of 10-year contract
Spain	Tariffs determined annually by Economic ministry

Table 9.3. Exit strategies

While contracts lock-in the prevailing feed-in tariff in the year of agreement, governments used various strategies to define an exit strategy for feed-in tariffs. While Germany has an automatic mechanism of lowering tariffs annually by a fixed percentage, Spain and the Netherlands revise tariffs annually, taking into consideration technology progress and the general development of market prices for electricity. Austria has a defined period in which contracts are agreed and will review its future strategy after evaluating progress over this period. Also, various capacity ceilings for certain technologies are in place to limit the overall potential tariff payments in a specified market segment (e.g. PV in Austria and Germany).

Costs of feed-in tariffs

The total costs of the feed-in tariffs are determined by the total amount of electricity produced by each renewable technology multiplied by the feed-in tariff for each technology. As tariffs vary, it is important to determine the relative contribution of each technology to this total, especially if concerns about overall costs become important.

	Total output from renewables technologies eligible for tariffs (in 2001)	Average tariff paid (in 2001)	Total tariff payments (in 2001)	Contribution of wind to total renewables (in 2001)
Germany	17.8 TWh	8.64 €cent/kWh	€1.5 bn	10.45 TWh
Spain	12.2 TWh	6.6 €cent/kWh	€805 m	6.9 TWh

Table 9.4 Costs of feed-in tariffs in Germany and Spain (Sources: BMU 2003a, APPA 2003)

As can be seen above, the average German tariff was about 2 €cent/kWh above the Spanish average tariff. The main factor influencing this is the fact that individual tariffs for the different technologies are lower in Spain than in Germany, thus reducing the per kWh payments. Specifically, wind, which is the technology with the biggest share of electricity production, and PV, which is the technology with the highest available feed-in tariff, make a bigger impact on the average tariff paid. Wind received 6.2 €cent/kWh in Spain, while in Germany the figure was 9.1 €cent/kWh for new wind parks. PV electricity received 21 – 39 €cent/kWh in Spain in 2001, while in Germany PV received 50.62 €cent/kWh in that year.

If comparisons of the Spanish and German schemes were to be made with the UK renewable obligation certificate (ROC) market, the difference between the market price of electricity and the average price of the tariffs has to be calculated. Thus, for a full appreciation of feed-in tariffs, the average market price of electricity has to be subtracted from the average feed-in tariff paid in order to find the extra costs of renewable electricity per kWh. In Spain, the extra costs were 2.85 €cents/kWh (1.9 pence/kWh), in Germany they were 3.9 €cents/kWh (2.6 pence/kWh) in 2001 (APPA 2003; BMU 2003a). It is notable that these extra costs are lower than both the current UK market price for ROCs (4.5 p/kWh) and the ROC buy-out price (3 p/kWh), despite the fact that the Spanish and German system even support some PV on their system.

Another aspect, besides total costs and average tariff, is the mode of finance for the feed-in tariffs. In Germany, feed-in tariffs are paid by a levy on all electricity consumption. This levy currently amounts to a third of a eurocent/kWh (about 0.22 pence/kWh) and a typical consumer household pays €12 annually (about £8) to support renewables in this way.

In the Netherlands, the feed-in tariffs are paid not through electricity consumption but through a levy on connections to the electricity grid. With total tariff payments estimated to be €258m (£178m) and 7.53m connections, the levy is about €34 (about £23) per household.

Longevity of institutional arrangements

Two countries, Germany and Spain, have had feed-in tariffs in place for a sufficiently long time period to make some remarks on their impact on technology deployment. The evidence suggests that they were successful in convincing investors about the stability of its institutional arrangement. By offering long-term contracts (20 years in Germany, 5 years plus an implicit renewal guarantee in Spain), it provides long-term certainty of a market and a high certainty of expected revenues.

Furthermore, besides Denmark, which also used feed-in tariffs, Germany and Spain are the two countries with the highest level of wind deployment in Europe, and were leading the EU by an order of magnitude in the PV area. Growth rates in both markets coincide with the enactment of the feed-in tariffs, whereby especially the price differentiation for PV allowed rapid growth in this area. Preliminary data for Austria and the Netherlands suggest that since their adoption of feed-in tariffs, the wind market in the Netherlands and Austria have seen a solid expansion over previously installed capacity. Arguably, feed-in tariffs were one of the most important policy tools underpinning the boom in the wind market over the past decade.

	Annual growth rate of wind market, year before enactment of feed-in tariff	Annual growth rate of wind market, year(s) after enactment of feed-in tariff	Cumulative capacity before feed-in tariff (in MWp)	Cumulative capacity after five years of feed-in law (in MWp)
Germany	1989[1]: 50%	1990: 106%; 1991: 61%	42	505
Spain	1994: 53%	1995: 104%	52	834
Austria	2002: 46%	End 2003: 199%	139	415 (End 03[2])
Netherlands	2002: 42%	End 2003: 27%	686	873 (End 03[2])

Table 9.5: Growth rates in wind market year before and after enactment of feed-in tariffs

([1] The 100/250 MW capital grants programme started 1 January 1990 while the feed-in law was only actually enacted in December of that year, nevertheless, it can be argued that installation in 1990 took advantage of capital subsidies while anticipating the feed-in law; [2] based on data published in BWE 2004)

Table 9.5 above illustrates how growth rates increased rapidly in the years following the enactment of feed-in tariffs in three countries. Germany, Spain and Austria experienced triple-digit growth in annual installed capacity, with Austria having an exceptional 199% growth rate in 2003. The Netherlands are the exception. Here, conditions were different to the other countries in that the year before the enactment of the feed-in law, the market already experienced a boom from market liberalisation and certificate trading. Also, the base of annual installed capacity was much higher than in the comparative years in the other countries. However, the figures of cumulative installed capacity show that there was not only a substantial increase in terms of the growth rate but also in terms of absolute installed capacity. Germany saw its wind capacity increase more than ten-fold, in the case of Spain the increase was more than fifteen-fold in the first five years following the enactment of the feed-in laws. As the separate chapters describe in more detail, there have been other policies in place, complementing the feed-in laws, thus simple cause-effect relationships are hard to establish. Nevertheless, a major part of the growth rates described above are likely to be attributed to the feed-in laws.

9.1.3. RPS schemes

Meier (2003) observed that the policy trend up until recently pointed towards the wide-spread adoption of RPS schemes in many European countries. This trend, however, could not be confirmed in the case studies presented in this paper. Rather, there is an overall move away from RPS schemes or at least an ebbing of enthusiasm. As mentioned before, Austria and the Netherlands have moved from RPS schemes towards feed-in tariffs and mixed feed-in tariff/certificates scheme respectively. Furthermore, Denmark abandoned its plans to replace feed-in tariffs with an RPS scheme and France opted for feed-in tariffs over an RPS.

From the six case studies, Sweden was the only country that has just started an RPS scheme in 2003. The basic set-up of the market is very similar to the UK RO system, with a fixed renewables target and an associated certificates market, and it remains to be seen what impact this scheme will make in the coming years. With just 36 MW of new wind power capacity installed in the first nine month of 2003, preliminary data suggests only a modest start.

In the USA, the introduction of an RPS scheme is currently subject to intense political discussions. Although the Senate proposal was introduced in a bi-partisan bill, it has to be negotiated with the Congress with an uncertain outcome. Examining those US states that have implemented an RPS, no pattern between policy and growth in installed capacity could be observed. Of the ten states with the most installed wind capacity, only four have an RPS in operation. However, in many states RPS schemes have only been implemented recently so it is too early to make an overall judgement on this matter yet.

9.1.4. Capital Grants and soft loans

Similarly to feed-in tariffs, there is a wide variety to the administration of capital grants between the different countries. Table 9.6 below outlines some of the main programmes in each country.

	Capital Grant	Soft Loan
Austria	Financing of biomass installations in district heating by regional or local authorities	'Kommunalkredit' bank provides low-interest-rate loans for up to 30% of the total investment cost of approved renewable energy projects
Germany	'100,000 roof programme' subsidised up to 50% of total investment costs for PV installations	'KfW' and 'DtA' quasi-governmental banks provide low-interest rate loans on up to 100% of approved renewable energy projects
Netherlands	Energy Premium (EPR) provides grants for between 25% to 50% of total capital investment into approved renewable energy projects; Greenpeace offers, through the project 'Solaris', PV systems for private homes at half the market price	n/a
Spain	Economic ministry provides subsidies for approved small-scale renewable energy projects	'IDEA' energy institute provides low-interest-rate loans for between 70% and 96% of total investment costs of approved renewable energy projects

Table 9.6 – Capital Grant and Soft Loan schemes in selected countries

Capital grant and soft loan programmes have been especially important for the development of PV technologies. Where high feed-in tariffs have not existed in the past, as was the case in Austria and the Netherlands for some time, they were often the only programme that incentivised the installation of PV systems. Where high feed-in tariffs were also in force, they furthermore underpinned the boom in its up-take, as was witnessed in Germany.

9.1.5. Tax incentives

With respect to biomass, the impact of tax incentives deserves special mention. In Sweden and Austria, where biomass plays a central role in the heating sector, the price differential between biomass and other fuel sources played an important role in determining the market diffusion. While there is dedicated biomass technology, such as gasification, this is mostly still at an early stage in its technological development. Thus, biomass is today mostly used with conventional firing technology in the heating sector and is one among many fuels that competes on the market. With rising oil prices in general, and tax advantages such as those given in Austria and Sweden, in particular, a significant share of the biomass market can be attributed to fuel switching in existing infrastructure or the preference of biomass furnaces over others where new developments were planned. Thus, for example in Austria, the largest growth of biomass use could be witnessed in the district heating and CHP sector.

9.2. Regional and Cultural Factors

In some cases, weak evidence for specific regional and cultural factors in the market development of renewable energy were found. Three countries are especially worth mentioning: The Netherlands, Austria and Sweden. However, overall this factor seems to be of small significance in influencing investment decisions in renewables.

In the Netherlands, strong demand for renewable electricity was manifest in the fast growth of green electricity supply contracts. The IEA, in a country report, highlighted the fact the Dutch people had a higher marginal willingness to pay for environmental quality than its neighbour countries. When green electricity tariffs were offered at the same price as conventional electricity, within 2 years, 32% of all electricity customers valued this factor high enough to switch their electricity supplier. In 2004, the electricity market in Netherlands will be fully opened up, thus conventional electricity will then enter into direct competition with green electricity. Then, it will be possible to test the marginal willingness to pay in full market competition.

Sweden and Austria both had a number of cultural and regional factors that are worth mentioning. For historic reasons, district heating grids had a significant share in both countries. Furthermore, a small percentage of the population used small stoves as their main source of domestic heating. Also, regional government involvement in the housing sector enabled the setting of advanced building standards. These factors were especially important in the market introduction of biomass heating systems. Stoves already used woodchips, a biomass product, as their fuel source. Their common place as a source of heating in these countries aided the further dispersion of stove heating. District heating played an important role in housing projects, and there is evidence from both Austria and Sweden that regional governments used their leverage in new housing projects to mandate the installation of biomass CHP systems, and also solar thermal and electric installations in the case of Austria.

9.3. Community involvement in renewables projects

Generally, some patterns between the level of community involvement and the uptake of renewables could be observed. However, it is difficult to establish cause-effect relationships in this area, especially given the multitude of policy instruments operating simultaneously. Generally, it can be stated that where policy allowed for community involvement and this was used pro-actively, a positive influence could be observed. However, there were also exceptions to this contention.

Positive examples existed in a number of countries. In Germany, where the policy environment was favourable, e.g. small-scale wind parks or limited partnerships between private individuals to operate larger developments, numerous case studies exist of 'citizens' wind parks' (Bürgerwindpark) that successfully circumvented some of the local opposition witnessed in other countries. Similarly, the strong involvement of the autonomous regions in Spain in the development of wind parks increased community involvement in the planning process and reduced local opposition. As mentioned in section 9.2, regional involvement in housing projects in Sweden and Austria led to the inclusion of renewable technologies in numerous developments. In the Netherlands, where local authorities were bypassed when national renewables targets were set, local opposition to wind developments was particularly strong and slowed down significantly the market expansion.

However, the earlier Austrian practice of setting regional feed-in tariffs led to confusion and investment uncertainty in the market and was consequently harmonised at a national level to avoid what was seen as 'regional meddling'. And there are still numerous opposition groups in Spain and Germany that campaign against wind developments. In fact, the building code in Germany grants wind developments a 'preferred' status in order to speed up the passage of development permits.

9.4. Conclusion

This report reviewed evidence from six countries on the implementation and consequences of various support policies for renewable energy. Factors that were found to benefit the market diffusion of renewables included:

- Policies that create a stable investment environment;
- Policies that create high certainty on investment returns;
- Policies that set long-term goals;
- Policies that address local concerns with renewables development;
- A wider policy environment that is supportive of renewables.

nOverall, the evidence suggests that feed-in laws in the countries studied were successful in meeting these criteria. RPS schemes were less successful in creating an investment environment, compared with the stability and certainty created by the contracts offered under feed-in tariffs. Furthermore, feed-in laws were found to be not necessarily more expensive than RPS schemes, with the additional costs per kWh in Spain and Germany around or below the price of a ROC in the UK. It is also notable that certificate schemes and feed-in laws can co-exist and even complement each other, as seen in the Netherlands, described in chapter 7.

Another important factor in the four countries with feed-in tariffs was the setting of long-term goals. All four countries set targets in terms of percentage share of renewables in total electricity/energy supply that gave some long-term guidance to investors. Lastly, ways to overcome local opposition especially to wind developments varied in the countries under study. However, investment schemes that allow for small groups/community participation, and planning schemes that share the benefit of a wind development with the community, both worked well in overcoming some of this resistance.

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