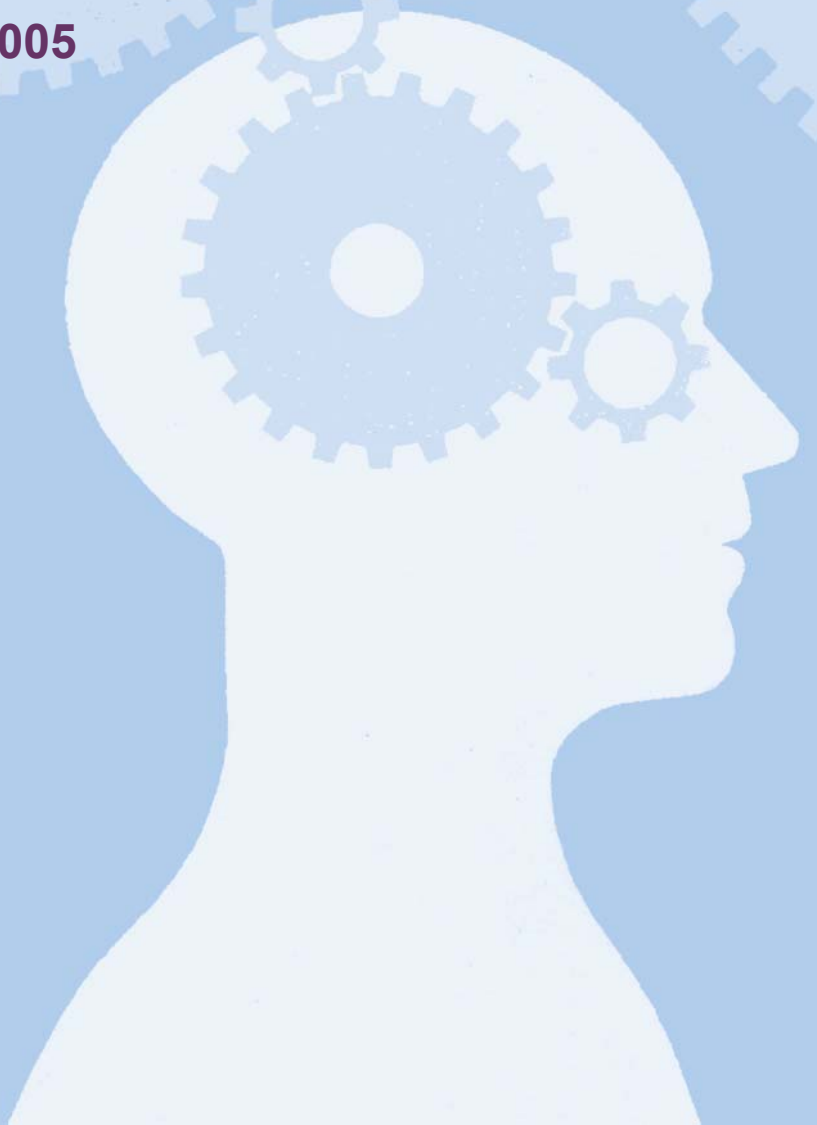
Oxera

Renewables support policies in selected countries

Report prepared for National Audit Office

January 2005



Executive summary

The UK is one among many countries that have chosen to provide financial support for the generation of electricity from renewable sources.

To assist the review by the National Audit Office (NAO) of the UK government's renewables policy, Oxera has examined seven countries that together account for almost half of the world's capacity for renewable electricity generation. The seven countries are Australia, Denmark, Finland, Germany, Italy, Spain, the UK, and the USA. The results of the desk-based research study are presented in this report, describing the support mechanism in each country, the value and term of the support, the type of technologies supported, and any targets for contributions to electricity supply from renewable sources.

Australia has the most similar support mechanism to the UK—a tradeable obligation on electricity suppliers with a target of 12.7% in 2010. In Australia, any buy-out charges paid are returned to consolidated revenue, not suppliers. Renewable electricity has been trading at less of a premium than in the UK because the supplier obligation has been satisfied easily. Biomass and energy-from waste plant are both expected to be large contributors.

Denmark has achieved substantial growth of wind capacity and biomass combined heat and power through a system of feed-in tariffs that has evolved into a guaranteed premium on the wholesale price of electricity. Wind power now contributes over 20% of electricity generation. Germany also used feed-in tariffs, whose rising costs have resulted in reductions in the value of the tariff in recent years. Most of the growth in capacity has been in wind power. Italy has a legacy of feed-in tariffs and an increasing role for tradeable certificates, but so far only modest aims to increase renewable generation capacity. In contrast, Spain has stimulated rapid growth in wind power through feed-in tariffs that are revised annually in line with changing technology costs. In Finland, renewables are supported through rebates of tax paid on electricity and capital grants. Hydropower is the largest renewable contributor, but biomass offers considerable growth potential.

The USA has a large capacity of renewables generation, and a mixture of policies in place at federal and state level, including tax credits and accelerated depreciation.

All the countries examined have concluded that financial support is necessary to make renewable electricity generation viable. Many have introduced fixed tariffs, but there is a trend towards tradeable certificates aligned to national targets for renewable electricity generation. When comparing the value of the policies between countries, the UK's decision to offer support that raises the internal rate of return of onshore wind projects to 15% and above is consistent with other countries that have had ambitions for rapid growth in capacity. The UK's support for biomass is more generous than most, but given the low level of take-up, appears to reflect the more difficult market conditions for biomass in the UK than in some other countries.

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1 Introduction

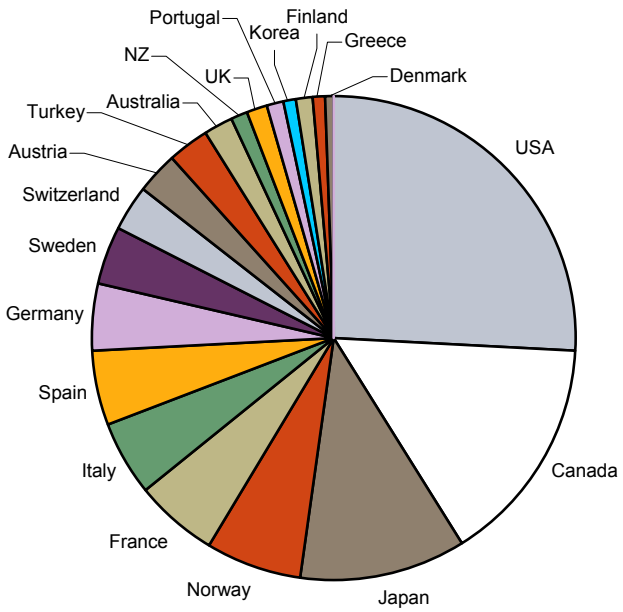
This report examines renewables policy in seven countries, in order to inform the review by the National Audit Office of the DTI's renewables energy programme. The report is structured as follows:

– section 2 provides a brief description of renewables policy in Australia, Denmark, Finland, Germany, Italy, Spain, the UK, and the USA, with particular focus on the support given to onshore wind and biomass;

– section 3 describes the model used by Oxera to estimate the value of policy support in each country.

The countries selected for this report include some of those with the greatest growth in renewables capacity in recent years.

Figure 1.1 Renewables capacity by country, 2001 (MW)



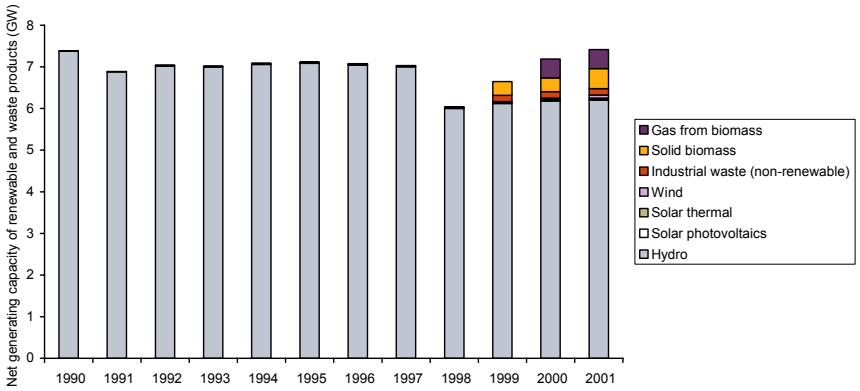
Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

2 Description of policy

Sub-sections 2.1 to 2.8 describe the policy arrangements in each country. A table at the end of each sub-section sets out the policy support assumptions used in Oxera's valuation model (described in section 3.1). In some cases, judgement was required in defining these assumptions—for example, to define a figure for the percentage of capital costs funded by grants in situations where government programmes might contribute varying proportions to different projects. Furthermore, the levels of feed-in tariffs and market premiums have been converted to sterling using a spot exchange rate,[1] and may be affected by future exchange-rate movements. Hence, the figures are indicative only and should not be quoted as the precise level of support available in each country.

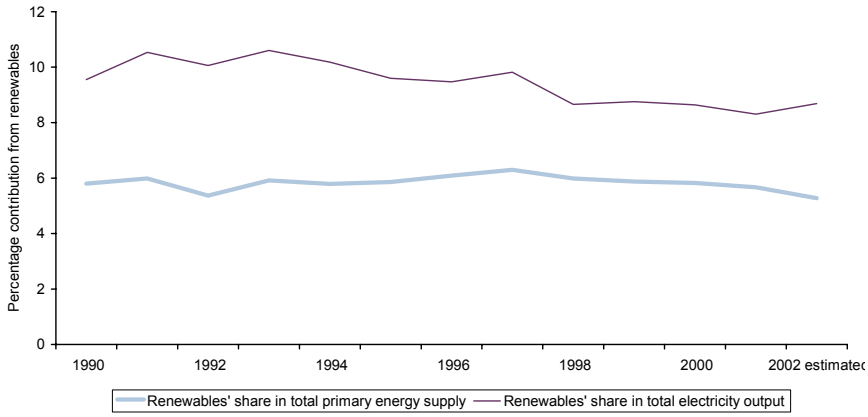
2.1 Australia

Figure 2.1 Renewable and waste generating capacity in Australia, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.2 Renewables' share of primary energy supply and electricity output in Australia, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

[1] Oxera used an exchange rate of £0.67:€1 reported for March 26th 2004 (at the time this report was first delivered to the NAO); £0.55:US$1; £0.39:A$1 and £0.12:1Dkr.

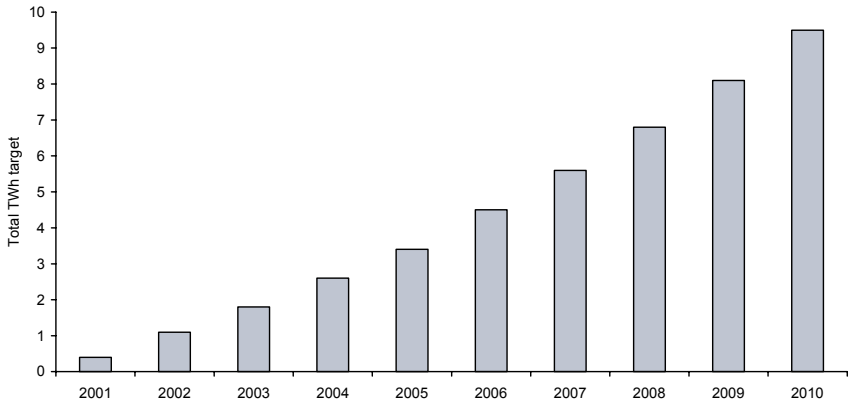
The bulk of renewable energy in electricity generation comes from large-scale hydro schemes located in the Snowy Mountains in southern New South Wales and in Tasmania.

The federal government has set a target of increasing the contribution of renewables to 12.7% of electricity generation by 2010, to be achieved through the Mandatory Renewable Energy Target (MRET). This is a requirement on wholesale purchasers of electricity to contribute proportionately towards the generation of an additional 9.5TWh of renewable energy by 2010. The measure was implemented in April 2001 through the Renewable Energy (Electricity) Act 2000. Retailers are required to surrender renewable energy certificates (RECs) every year to the renewable energy regulator, ramping up from 0.4TWh in 2001 to 9.5TWh in 2010 (as shown in Figure 2.3). Parties with obligations under the measure can either acquire RECs by developing their own contracts with renewable energy generators, or by purchasing RECs from other market participants. The penalty for non-compliance is A$40/MWh (£15.40/MWh).

According to the Office of the Renewable Energy Regulator's 2003 annual report,[2] the interim targets for the first two years have been exceeded by 7%, and the industry is well on the way to meeting targets for the third and fourth years. This level of overshooting of the target is compatible with an explanation that obligated companies took a slightly long contracting position to mitigate the risk of undercompliance. Most RECs appear to be bought and sold under forward agreements, but spot prices of A$32–A$36.50/MWh (£12.30–£14.10/MWh) were reported for 2001.

The stimulus created by the MRET legislation is expected to result in around A$3 billion (£1.24 billion) of investment in new renewable generators. Biomass projects (including energy-from-waste) may account for around half of the new generation capacity, with wind providing around 20%; efficiency gains in large-scale hydro and mini-hydro systems 10–20%; and solar photovoltaics and solar thermal the rest.

Figure 2.3 Annual targets for additional TWh of renewable generation



Source: Australian Government, Office of the Renewable Energy Regulator (2004), 'Annual Report 2003', April.

In the UK, liable parties can buy out their obligation, similar to the Australian system of paying a shortfall charge. The UK buy-out price, which is indexed to the retail price index, is set at £31.39/MWh.[3] This revenue is then recycled to those liable parties that have chosen to

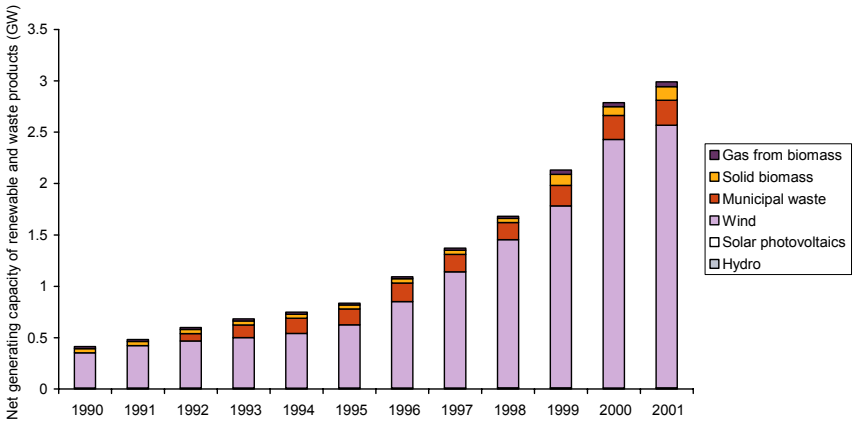
[2] Australian Government, Office of the Renewable Energy Regulator (2004), 'Annual Report 2003', April.

[3] At the time of writing this report, in April 2004.

meet their obligations using Renewables Obligation Certificates (ROCs). In Australia, the shortfall charge is not indexed, and shortfall charges are returned to consolidated revenue.[4]

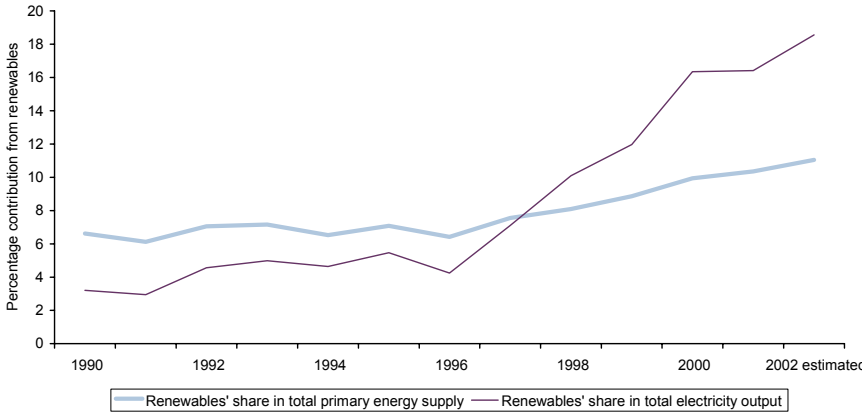
2.2 Denmark

Figure 2.4 Renewable and waste generating capacity in Denmark, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.5 Renewables' share of primary energy supply and electricity output in Denmark, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

As shown in Figures 2.4 and 2.5, there has been substantial growth in renewable energy in Denmark. The government has provided a strong stimulus to combined heat and power (CHP) production, and since the 1980s new heating plant have been fuelled by biomass. Figure 2.4 shows that wind generation has also grown rapidly, with the country having reached its target of sourcing 20% of electricity generation from wind power.[5]

In the past, the main instrument used to promote renewable electricity generation in Denmark was fixed feed-in tariffs. As shown in Table 2.1 below, new tariff levels were

[4] Australian Greenhouse Office (2003), 'Renewable Opportunities: A Review of the Operation of the Renewable Energy (Electricity) Act 2000', September, http://www.mretreview.gov.au

[5] In 2003, 16% of electricity output came from wind turbines. However, this figure would have been 20% if 2003 had experienced average wind speeds.

adopted in 2001, with lower levels of support provided for wind turbines commissioned in 2000, 2001 or 2002 relative to turbines commissioned before January 1st 2000. When these adjustments were made, it was anticipated that a green certificate trading scheme would be operational by 2003. However, this scheme has not been implemented, partly because the target of sourcing 20% of electricity from wind power had already been achieved. Instead, as set out in Table 2.1, there has been a transition from feed-in tariffs to the provision of a premium on the market price of electricity. In addition, the government has provided incentives for the repowering of wind turbines and has tendered for the construction of offshore wind farms.

Table 2.1 Financial support for wind turbines

Wind turbines bought before Dec 31st 1999	£53.3/MWh until end of assigned full load hours, then £38.2/MWh until age 10 years with purchase obligation. From age 10 to 20 years, market price plus financial support of £8.9/MWh. Cap of total support plus market price will be £32/MWh. No purchase obligation
Wind turbines bought after Jan 1st 2000	£38.2/MWh for 22,000 full load hours with purchase obligation. From then on, market price plus financial support of £8.9/MWh. Cap of total support plus market price will be £32/MWh. No purchase obligation
New turbines from 2003	Market price plus financial support of £8.9/MWh. Cap of total support plus market price will be £32/MWh. No purchase obligation

Source: IEA (2004), 'IEA Wind Energy Annual Report 2003', April.

In March 2004, the Danish government reached an agreement with opposition parties on wind energy and decentralised heat and power. The agreement includes plans to construct two new 200MW offshore wind farms, to be connected to the grid in 2007/08. Financial incentives will be provided to remove around 900 older windmills in unfavourable locations (eg, with low wind speeds) and to replace them with larger turbines in new locations.

Favourable taxation schemes were used to stimulate the building of private wind turbine installations. Today, however, income from wind turbines is, by and large, taxed depending on ownership, as is the case for any other source of income.

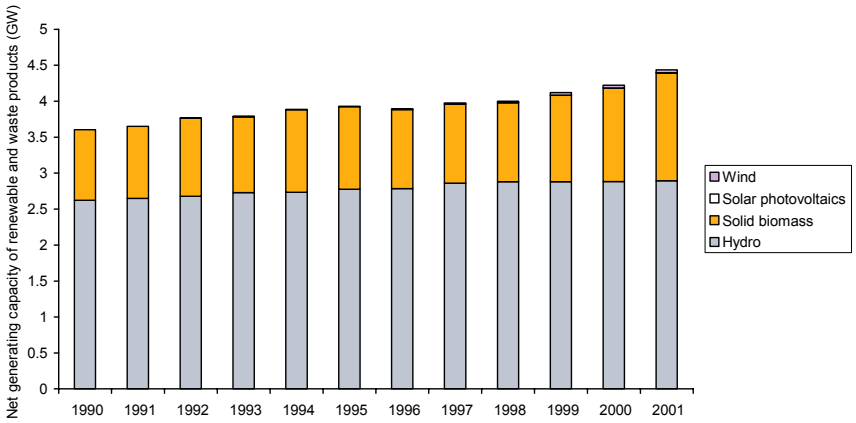
Table 2.2 Modelling inputs for renewables support in Denmark

	Onshore wind		Biomass	
	Historic (pre-2000)	Intermediate (2000–02)	Historic (pre-2000)	Intermediate (2000–02)
Feed-in tariff	£54/MWh for five years, then £39/MWh for up to ten years of operation	£39/MWh for eight years, then £9/MWh	£54/MWh	£54/MWh
Percentage capital grants	22.5	15	22.5	15

Source: IEA (2004), 'IEA Wind Energy Annual Report 2003', April.

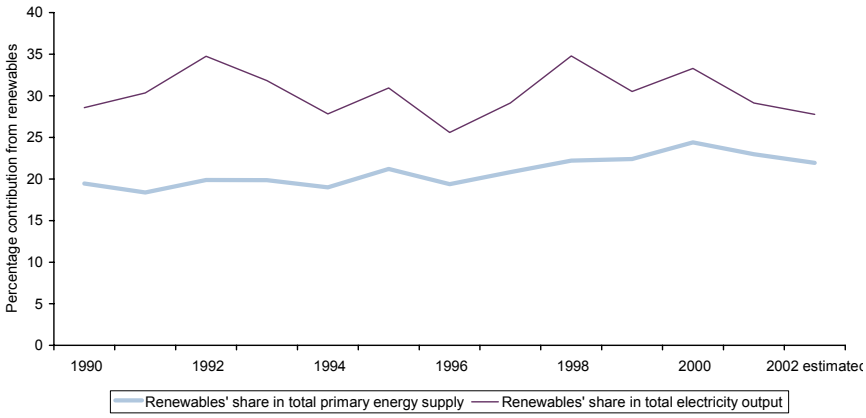
2.3 Finland

Figure 2.6 Renewable and waste generating capacity in Finland, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.7 Renewables' share of primary energy supply and electricity output in Finland, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Hydropower constitutes the largest proportion of renewable generation in Finland, followed by solid biomass. Wind energy is relatively undeveloped, and there has been slow growth in renewable generation capacity over time.

Finland's 'Action Plan for Renewable Energy Sources' was completed in 1999 and subsequently integrated into the 'National Climate Strategy of 2001', revised in 2002. This proposed that the use of renewable energy be increased by around 30% by the year 2010, compared with the year 2001. Interestingly, the Action Plan encompasses peat, which in Finland has traditionally been considered to be a solid biofuel, but is internationally classified as a non-renewable source of energy. Measures to be taken under the Action Plan are expected to reduce CO_2 emissions by 2 million tonnes per year. Furthermore, the use of waste, which otherwise would have been transported to tips, in energy production is expected to reduce methane emissions by 1 million tonnes per year (CO_2 equivalent).

The Action Plan states that the investment subsidy will remain the primary support mechanism, although new support mechanisms are to be investigated. For wind energy installations, an investment subsidy of up to 40% can be awarded, whereas the maximum subsidy for other types of renewables is 30%. Table 2.3 summarises the investment and research aid granted by the Finnish Ministry of Trade and Industry in 1999–2002 to plant

using renewable energy. The figures include appropriations of the European Regional Development Fund (ERDF).

Table 2.3 Distribution of Ministry of Trade and Industry energy aid to renewable energy sources (£m)

	1999	2000	2001	2002
Plant using wood fuels	10.5	9.5	8.1	12.3
Production of wood fuels (chippers, pellets, brickets)	0.7	1.3	1.1	1.7
Wind plant	1.6	0.9	1.2	4.9
Small-scale hydropower	0.2	0.2		0.07
Exploitation of biogas	0.1	0.5	0.2	–
Solar heat and electricity	–	0.07	0.01	0.01
Heat pumps	–	0.01	0.07	0.01
Production of recycled fuels	0.27	–	0.81	0.47
Studies concerning renewables	0.13	0.07	0.07	0.04
Total	**13.5**	**12.6**	**11.6**	**19.5**

Source: Ministry of Trade and Industry, Energy Department.

The Finnish government also supports renewables through a fiscal incentive involving the refund of an electricity tax paid by consumers as a subsidy to producers of renewable power. As shown in Table 2.4, the highest per-MWh rate is applied to wind and forest chip-fired plant, with lower rates for other biomass and small hydro.

Table 2.4 Tax rebates on energy produced from renewables

Fuel/plant technology	Rebate level (£/MWh)
Wind	4.6
Forest chip-fired plant	4.6
Recovered fuel plant	1.7
Small-scale hydro (<1 MVA, or mega volt amps)	2.8
Wood or wood-based fuels	2.8
Small (<40 MVA) peat-fired district heating plant	2.8
Selected waste gas and waste heat plant	2.8

Source: Finnish Ministry of Trade and Industry.

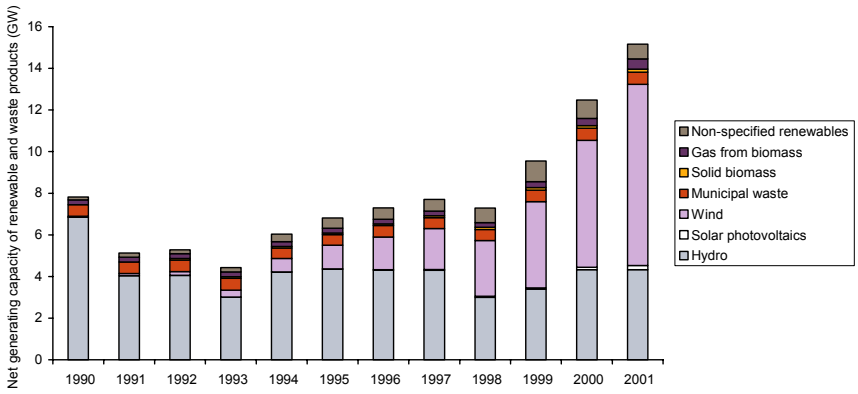
Table 2.5 Modelling inputs for renewables support in Finland

	Onshore wind	Biomass
Market price premium (£/MWh)	4.6	2.8
Percentage capital grants	20	15

Source: Finnish Ministry of Trade and Industry.

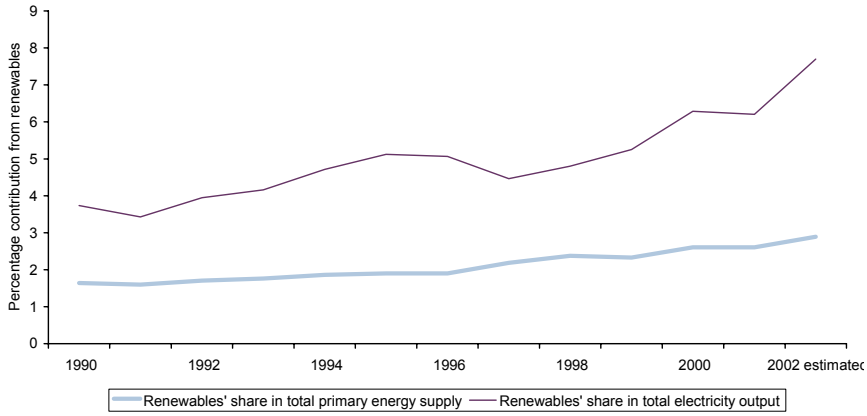
2.4 Germany

Figure 2.8 Renewable and waste generating capacity in Germany, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.9 Renewables' share of primary energy supply and electricity output in Germany, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.8 shows that there has been sharp growth in the volume of wind power in Germany in recent years, increasing the share of electricity generation sourced from renewables.

Feed-in tariffs have been in place for renewables since 1990. Throughout the 1990s, they were defined as a percentage of the average retail electricity rate (eg, 90% for wind, 80% for biomass, and 65% for landfill gas), and were fixed annually by the regulatory authority for a one-year period based on retail tariffs in the previous year. The system changed from April 1st 2000, when the obligation to pay the feed-in tariffs was transferred from retail suppliers to the grid operator whose grid is closest to the location of the renewable installation. Fixed feed-in tariffs were specified for different renewable technologies, with the additional feature that the tariffs decreased from year to year by specified percentages for each technology. In April 2004, Germany's parliament approved amendments to renewables legislation, which will cut the support available for wind generators, while increasing the level of support for biomass.

As shown in Table 2.6, German consumers paid €1.9 billion (£1.28 billion) for the promotion of renewable energy in 2003, more than seven times the figure of €0.26 billion (£0.17 billion) paid in 1999.

Table 2.6 Consumer cost of promoting renewable energy in Germany

	Additional costs to German electricity consumers (£ billion)
1999	0.17
2000	0.60
2001	0.81
2002	1.07
2003	1.28

Source: German Electricity Association.

In the past, the German government has provided investment subsidies to stimulate growth in wind generation and to acquire statistical data on the operation of wind turbines.

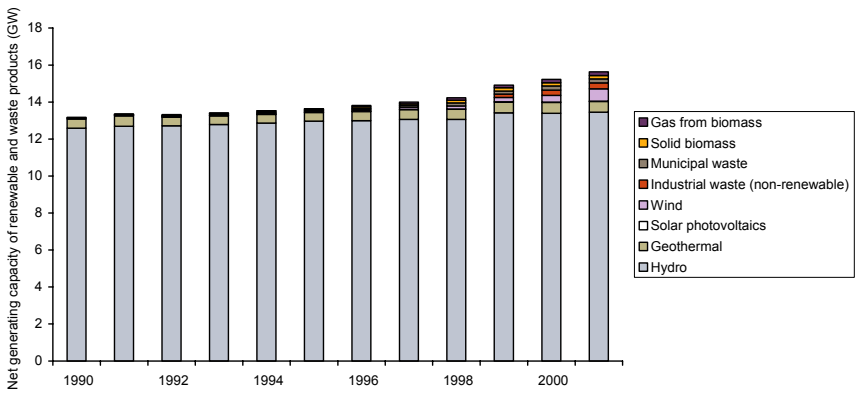
Table 2.7 Modelling inputs for renewables support in Germany

	Onshore wind		Biomass	
	Historic (pre-2000)	Intermediate (2004)	Historic (pre-2000)	Intermediate (2004)
Feed-in tariff (£/MWh)	57	59 for five years, then 41	41	60
Percentage capital grants	25 (max)	0	0	0

Source: German Renewable Energy Association.

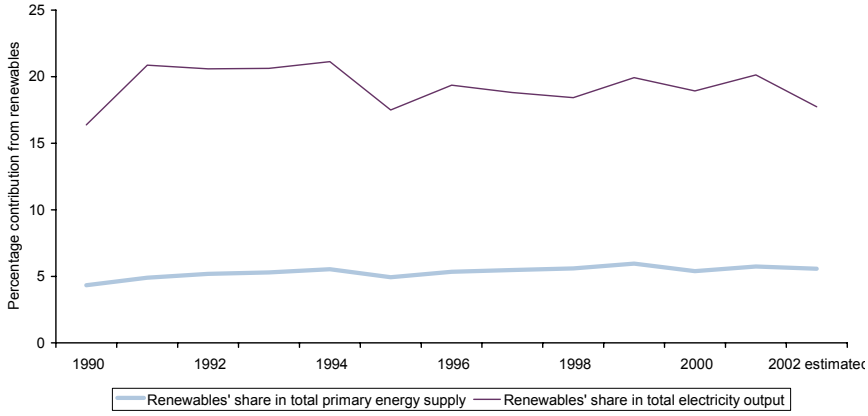
2.5 Italy

Figure 2.10 Renewable and waste generating capacity in Italy, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.11 Renewables' share of primary energy supply and electricity output in Italy, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Italy has a large amount of hydroelectric generating capacity. Among smaller-scale renewable technologies, geothermal energy also plays a significant role.

Provision of Inter-ministerial Committee (CIP) 6/92 of April 29th 1992 allowed renewable energy investors to feed their energy into the national grid at special feed-in tariffs (updated periodically) over the first eight years of the plant's lifetime. In the subsequent years, a lower price is paid, roughly equal to the market price of conventional electricity. The feed-in tariffs are differentiated by technology and producer. The benefit of the CIP was limited to plant included in the lists drawn up by the Italian Ministry of Industry no later than June 30th 1995. Most of these plant have been coming on stream in the last few years and should therefore be receiving CIP 6/92 prices (for the first eight years) until 2008–10. The CIP 6/92 capacity currently in operation is around 3GW, and is expected to peak around 2006, before declining gradually.

In 1999, the Italian government issued new legislation (the Bersani Decree) to improve on CIP 6/92. From 2002, the new mechanism of Decree 79/99 came into force, placing a 2% renewable energy quota obligation (based on the previous year's output figures) on all producers and importers that source more than 100GWh/year of electricity from conventional energy sources. The obligation does not apply to the first 100GWh/year produced by each company, and renewable energy and eligible co-generation are also exempt. At present, there is no formal penalty arrangement for non-compliance, although it is possible under current legislation for the grid operator, Gestore della Rete di Trasmissione Nazionale (GRTN), to ensure that non-compliant operators have limited access to the market.

Producers not generating sufficient renewable output can meet their quota by buying renewable energy or the related rights—'Green Certificates'—from other companies or from GRTN. The obligation can also be met by importing energy produced by foreign renewable power plant put into operation after April 1st 1999, on condition that such plant are located in countries adopting similar schemes of renewable energy promotion that allow the same opportunities as those for renewable energy plant in Italy.

Tradeable Green Certificates are granted to new renewable plant over the first eight years of operation, and are not available to those generators already benefiting from feed-in tariffs. The reference price for 2002 was €84.2/MWh (£56.6/MWh), calculated as the difference between the average cost of CIP 6/92 electricity purchased by GRTN in 2002 and the revenues from the sale of the corresponding energy in the same year. In 2003 the price was €82.4/MWh (£55.4/MWh), set as a ceiling price from which GRTN expects the price to fall towards €50/MWh (£33.6/MWh) in 2010.

The Italian parliament is currently discussing a new piece of legislation, the Marzano Decree, which proposes to increase the obligation annually by 0.35% during 2005–07 and to set a penalty for non-compliance of 1.5 times the price of Green Certificates. The revenues resulting from the payment of these fees will be invested in the development of new renewable energy plant. The Decree also introduces a 'small size' Green Certificate for micro-plant (ie, plant with a maximum capacity of 1MW).

In addition to these measures, the government provides investment subsidies, with grants generally ranging within 30–40% of eligible costs.

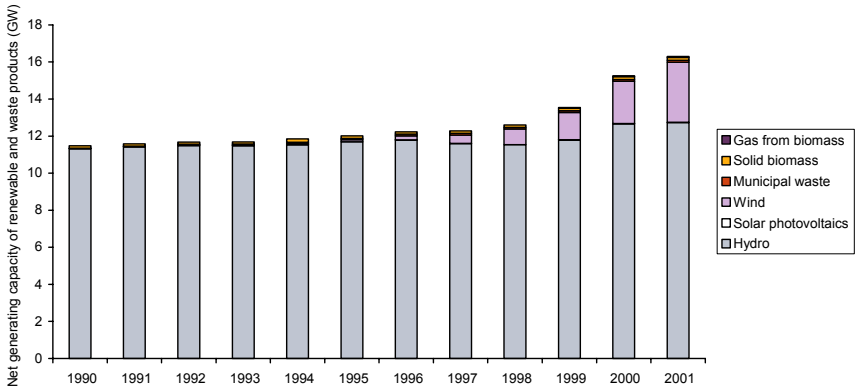
Table 2.8 Modelling inputs for renewables support in Italy

	Onshore wind—historic
Feed-in tariff (£/MWh)	67 for eight years, then 34
Percentage capital grants	35

Sources: CIP 6/92 and IEA (2004), 'IEA Wind Energy Annual Report 2003', April.

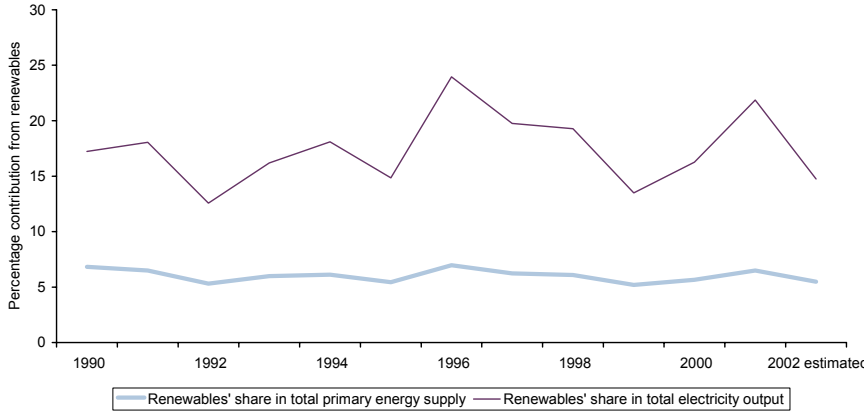
2.6 Spain

Figure 2.12 Renewable and waste generating capacity in Spain, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.13 Renewables' share of primary energy supply and electricity output in Spain, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Spain has over 15GW of hydro generation. Figure 2.12 also shows that wind power has grown rapidly. However, while the overall share of generation from renewables has varied year by year, there is no strong upward trend over the period shown.

Feed-in tariffs have been applied since 1999, under a system that allows renewable generators to choose between a fixed price and a premium in addition to the market price. The value of the support is updated annually in line with inflation and with changes in the average price of electricity. The tariffs applicable in the years 2002–04 are shown in Table 2.9.

Table 2.9 Feed-in tariffs for renewables in Spain, 2002–04 (£/MWh)

	2002		2003		2004	
	Bonus added to base price	Fixed price	Bonus added to base price	Fixed price	Bonus added to base price	Fixed price
Renewable source						
Small hydro	20.19	42.88	19.78	43.56	19.78	43.56
Wind	19.46	42.19	17.89	41.75	17.89	41.75
Primary biomass[1]	18.73	41.47	22.33	46.03	22.34	46.07
Secondary biomass[2]	17.32	40.05	16.88	40.66	16.89	40.70

Note: [1] Agricultural crops. [2] Agricultural and forest residues.
Source: Spanish Ministry of Energy and Industry.

In 2000, the Renewable Energies and Energy Efficiency Facility was introduced to provide financial backing for projects concerned with energy-saving and renewable energies. Up to 70% of project costs can be eligible for low-interest loans (the proportion is higher for solar power). In 2002, the reduction on interest varied from 2% to 4%.

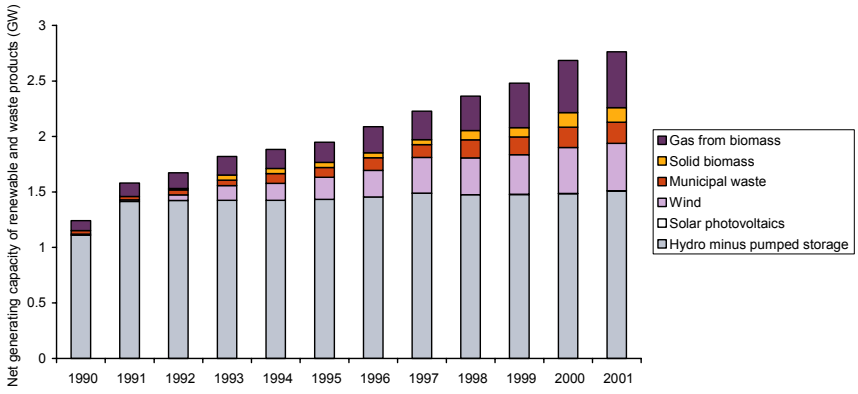
Table 2.10 Modelling inputs for renewables support in Spain

	Onshore wind—historic	Biomass (energy crops)
Feed-in tariff (£/MWh)	42	46

Note: 2003 values. The benefit of reduced-interest loans has not been incorporated into Oxera's valuation model.
Source: Spanish Ministry of Energy and Industry.

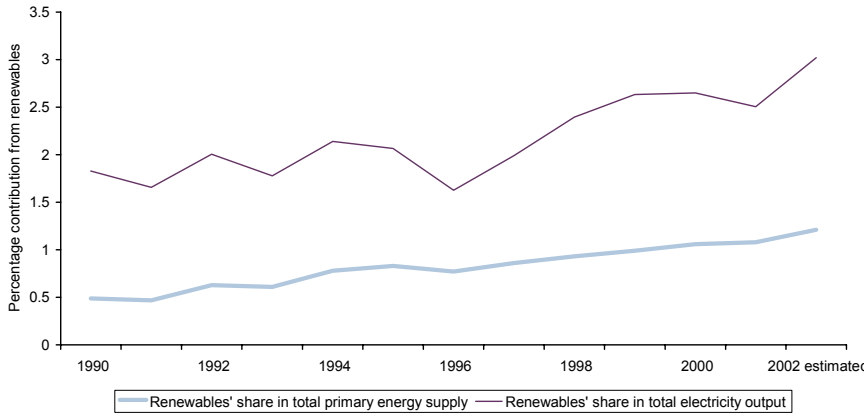
2.7 UK

Figure 2.14 Renewable and waste generating capacity in the UK, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

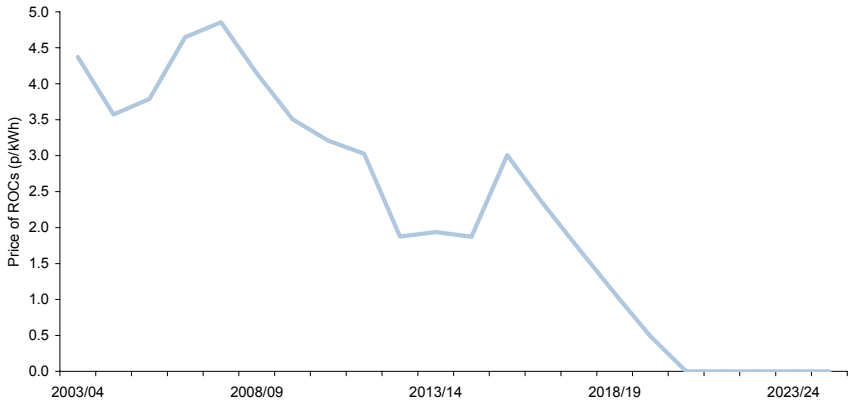
Figure 2.15 Renewables' share of primary energy supply and electricity output in the UK, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

For the purposes of the valuation model, we used the scenario of Renewables Obligation Certificate (ROC) prices shown in Figure 2.16, generated using Oxera's renewables model. We treated the value of the exemption from the Climate Change Levy (CCL) for renewable generation as a premium on the wholesale price of £4.3/MWh. The government does not provide additional grants for onshore wind, but capital grants are available for biomass.

Figure 2.16 Scenario of ROC prices used in the valuation model



Source: Oxera.

Table 2.11 sets out the values used to model renewables support in the UK.

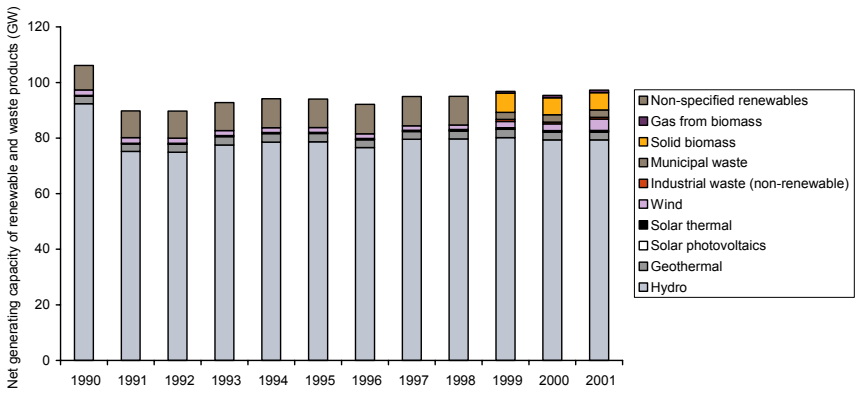
Table 2.11 Modelling inputs for renewables support in the UK

	Onshore wind	Biomass
Value of ROC	As in Figure 2.16	As in Figure 2.16
Market price premium (CCL exemption, £/MWh)	4.3	4.3
Percentage capital grants	0	40

Note: In the current version of the model, CCL exemption is assumed to continue from 2008.
Source: Oxera.

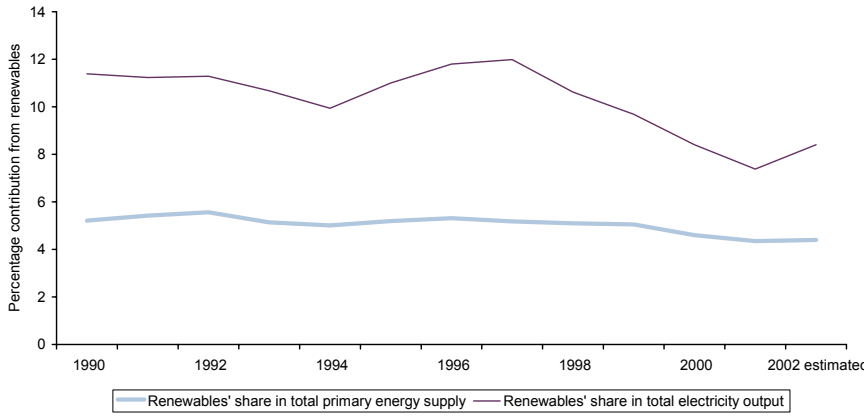
2.8 USA

Figure 2.17 Renewable and waste generating capacity in the USA, 1990–2001 (GW)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Figure 2.18 Renewables' share of primary energy supply and electricity output in the USA, 1990–2002 (%)



Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Federal programmes support the development and installation of renewable energy technologies through financial incentives, regulatory policies, and investment and awareness programmes. Key policy measures include the following.

– *Renewable Electricity Production Credit (REPC)*—this is a tax credit of 1.5¢/kWh (£8.3/MWh) for electricity generated by qualifying energy resources, available during the first ten years of operation and adjusted annually for inflation. Eligible projects had to commence operations between October 1st 1993 and September 30th 2003. Qualifying facilities must use solar, wind, geothermal (with certain restrictions), or biomass (except for municipal solid waste combustion) generation technologies. Fuel cells using hydrogen derived from eligible biomass facilities are also considered an eligible technology.

– *Modified Accelerated Cost Recovery System (MACRS)*—under MACRS, businesses can recover investments in solar, wind and geothermal assets through depreciation deductions. The MACRS establishes a set of asset class lives for various types of asset, ranging from three to 50 years, over which the asset may be depreciated. For solar, wind and geothermal property placed in service after 1986, the current MACRS asset class life is five years.

In addition to the MACRS depreciation, the Job Creation and Worker Assistance Act 2002 included a provision allowing businesses to take an additional 30% depreciation on solar, wind and geothermal assets in the first year. In May 2003, the Job Creation and Tax Relief Reconciliation Act increased the bonus depreciation to 50%.[6]

– *Renewable Energy Systems and Energy Efficiency Improvements Program*—this federal grant programme provides funding to be used to pay up to 25% of the eligible project costs. Eligible projects include those that derive energy from a wind, solar, biomass, or geothermal source, or hydrogen derived from biomass or water using wind, solar or geothermal energy sources.

The Energy Policy Act of 2003, S.14, includes a national renewable electricity standard that requires utilities to generate 1% of electricity from renewable sources by 2005, and 10% by 2020.

At the state level, there is a broad range of programmes and policies among the 50 states to promote renewable energy, as summarised in Table 2.12. Thirteen states have decided to require by law a certain percentage of utilities' sales to be derived from alternative power generation.

Table 2.12 Overview of state programmes

Financial incentives	Rules, regulations and policies	Voluntary programmes
Personal income tax	Construction and design policies	Outreach programmes
Corporate tax incentives	Equipment certification	Utility green pricing
Sales tax incentives	Generation disclosure rules	Voluntary installer certification programmes
Property tax incentives	Green power purchasing	
Rebate programmes	Line extension analysis	
Grant programmes	Required utility green power option	
Loan programmes	Net metering rules	
Leasing/lease purchase	Public benefit funds	
Production incentives	Renewables portfolio	
	Standards	

Source: Interstate Renewable Energy Council, US Department of Energy.

Table 2.13 Modelling inputs for renewables support in the USA (federal programmes only)

	Onshore wind—historic	Biomass—historic
Market price premium (£/MWh)	8	8
Percentage capital grants	25	25

Note: The financial benefit provided by MACRS has not been included in the model.
Sources: REPC, Renewable Energy Systems and Energy Efficiency Improvements Program

[6] Although this has not been adopted by all states.

2.9 Summary

Table 2.14 summarises the policy support mechanisms employed in each country, either currently or historically, to promote renewables. The UK regime is summarised in the last column for the purposes of comparison. The most common support measures are feed-in tariffs and investment subsidies. However, a number of countries other than the UK (eg, Australia, the USA and Italy) have made use of obligations to promote renewable generation.

Table 2.14 Policy support mechanisms

	Australia	Denmark	Finland	Germany	Italy	Spain	USA	UK
Feed-in tariffs	✓	✓	✓	✓	✓	✓	✓	–
Investment subsidies	–	✓	✓	✓	✓	✓	✓	✓
Quota obligations/ green certificates	✓	–	–	–	✓		✓	✓
Fiscal measures	–	✓	–	–	–	–	✓	✓

Source: Oxera.

Table 2.15 Renewable energy trends

	Australia	Denmark	Finland	Germany	Italy	Spain	USA	UK
Total electricity production supplied by renewables in 2001 (%)	8.3	16.4	29.1	6.2	20.1	21.9	7.4	2.5
Average rate of growth of renewable generation over ten years (%)	–1.3	16	0.2	4.7	1.9	2.2	–3.9	2.9
Total renewable capacity at end 2001 (MW)	7,417	2,990	4,437	15,168	15,633	16,301	97,198	2,763

Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

Table 2.16 Capacity of renewable sources in 2001 (GW)

	Australia	Denmark	Finland	Germany	Italy	Spain	USA	UK
Total renewable capacity	**7.42**	**2.99**	**4.44**	**15.17**	**15.63**	**16.30**	**97.19**	**2.76**
Hydro	6.20	0.01	2.90	4.33	20.39	12.73	79.38	1.5
Geothermal	0.00	0.00	0.00	0.00	0.57	0.00	2.79	0.00
Solar photovoltaic	0.03	0.00	0.00	0.20	0.02	0.02	0.21	0.00
Solar thermal	0.01	0.00	0.00	0.00	0.00	0.00	0.38	0.00
Tidal, wave, ocean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind	0.08	2.56	0.04	8.71	0.66	3.24	4.06	0.43
Industrial waste	0.15	0.00	0.00	0.00	0.32	0.00	0.64	0.00
Municipal waste	0.00	0.24	0.00	0.59	0.22	0.09	2.63	0.19
Solid biomass	0.48	0.13	1.50	0.15	0.18	0.17	6.22	0.13
Gas from biomass	0.46	0.05	0.00	0.49	0.20	0.05	0.89	0.50
Unspecified other	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00

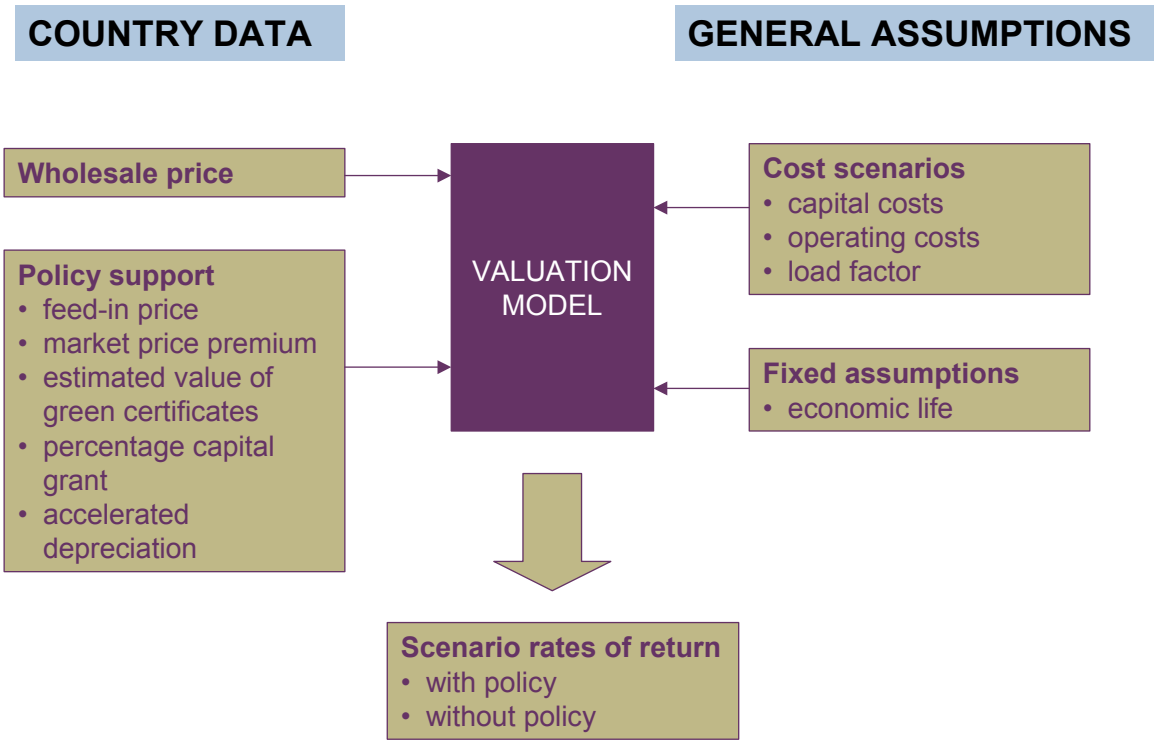
Source: International Energy Agency (2003), 'Renewables Information 2003', Paris.

3 Valuation of policy support

3.1 Description of model

Oxera has used a simple model to value and compare the support provided to onshore wind and biomass in different countries. Figure 3.1 illustrates how the model combines data on the wholesale price and policy support arrangements in each country with scenario assumptions for the cost and operational characteristics of the renewables technology under consideration. The output of the model consists of scenario rates of return for renewables projects in each country with and without policy support, thus allowing the incremental impact of government policy to be identified.

Figure 3.1 Model used to value policy support



Source: Oxera.

While the model can provide an indication of the level of government support for renewables in each country, the results are subject to the following caveats.

– *Cost variations*—the model uses common assumptions for the cost of each technology across all countries. This may be appropriate for turbine costs, where there is potential for international trade, although exchange-rate movements could alter the cost of turbines in local currency. For other costs, including for land rent, labour and network access, substantial variations are likely between countries.

– *Policy support*—in some cases, the level of policy support for renewables is well defined (eg, where generators earn a fixed feed-in tariff). However, this is not always the case. For example, there may be variations in the level of capital grant provided to different projects, and the value of green certificates will depend on market outcomes. In some cases, it has been necessary to employ indicative estimates in the modelling exercise.

– *Wholesale prices*—the model assumes that the current wholesale price in each country will apply over the lifetime of projects. However, wholesale electricity prices are likely to increase in European countries due to the impact of the EU Emissions Trading Scheme and the Large Combustion Plants Directive. In addition, no adjustments have been made to reflect the potential discount on the wholesale price that wind generators might receive as a consequence of the unpredictability of their output.

3.2 Assumptions

Table 3.1 sets out the wholesale price assumptions used in the model. Oxera's cost and load-factor scenarios for onshore wind are presented in Table 3.2. The assumptions used for the financial value (in sterling) of policies in each country were set out in sections 2.2 to 2.8.

Table 3.1 Wholesale price assumptions

Country	Wholesale price (£/MWh)
Denmark	19
Finland	19
Germany	21
Italy	20*
Spain	21
UK	22
USA	20*

Note: Reported prices converted to sterling using exchange rates from the same day.
Source: All Electricity Argus, March 26th 2004 except * Oxera assumption.

Table 3.2 Cost and load factor scenarios for onshore wind and biomass

	High	Low
Onshore wind		
Capital cost (£/kW)	553	387
Operating cost (£/kW/year)	14	8
Load factor (%)	28	35
Biomass (energy crops)		
Capital cost (£/kW)	1,350	1,620
Operating cost (£/kW/year)	40.5	49
Fuel cost (p/kWh)	1.8	3.6
Load factor (%)	80	90

Source: Oxera.

3.3 Results

Tables 3.3 and 3.4 present the results of Oxera's policy valuation model for onshore wind and biomass.

Table 3.3 Results for onshore wind from Oxera's policy valuation model (% internal rate of return)—low scenario

	Without policy	With policy	
		Historic	Current/future
Denmark	1	23	9–30
Finland	1	n/a	7–20
Germany	3	30	20–42
Italy	2	41	–
Spain	3	n/a	15–31
UK	4	(NFFO not examined)	16–33
USA	2	3	–

Note: [1] Historic internal rates of return (IRR) are calculated using the high cost assumptions, given that costs fall through time. The ranges of figures in the current/future column correspond to the high and low cost assumptions set out in Table 3.2. The IRRs are uncorrected for policy risk: they assume that the current policy on renewables support will continue.
Source: Oxera.

Table 3.3 shows that the level of support for wind power offered in the UK is similar to the level available in Spain, at around 15–30%. It also shows that countries that have recently built large volumes of onshore wind capacity have offered rates of return of between 15% and 30%.

Table 3.4 Results for biomass (energy crops) from Oxera's policy valuation model (% IRR)—low scenario

	Without policy	With policy	
		Historic	Current/future
Denmark	1	27	24–33
Finland	1	n/a	5–17
Germany	3	15	23–32
Italy	3	n/a	17–34
Spain	4	(NFFO not examined)	28–56
UK	2	3	–
USA	1	27	24–33

Note: [1] Historic IRRs are calculated using the high cost assumptions, given that costs fall through time.
Source: Oxera.

The results for biomass show the following.

– Oxera's cost assumptions for biomass are based on estimates for energy crops. Under federal policy arrangements in the USA, which provide the same level of support for wind and biomass, the rate of return estimated for biomass is identical to that for onshore wind, as higher costs are offset by a higher load factor.

– The level of support for biomass appears to vary significantly between countries. With policy support, returns vary from 5% to 17% in Finland to 28–56% in the UK. It is difficult to draw conclusions from the small number of results above, but the UK's support for energy crops is clearly high relative to that in Spain and Finland, and may reflect a high level of perceived contractual, operational and policy risk for energy crops in the UK.

3.4 Summary

It has not been possible to collate comparable data on more than a handful of countries, but it is nevertheless clear that:

– without financial support through renewables policies, rates of return on renewables investments would be insufficient to stimulate investment in renewable generation;

– the UK is not alone in introducing support at a level which offers an IRR of between 15% and 30% for onshore wind—these rates of return are consistent with those offered historically in countries where there has been rapid deployment of renewables;

– the UK's support for biomass is more generous than in some other countries, but is delivering little new build relative to the others, suggesting that UK projects might be perceived as more risky and/or may have higher costs than similar projects in other countries.

Oxera
Blue Boar Court
Alfred Street
Oxford OX1 4EH
United Kingdom

Tel: +44 (0) 1865 253 000
Fax: +44 (0) 1865 251 172

www.oxera.co.uk