Renewable energy policy in Germany: pioneering and exemplary regulations

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The development of renewable energy in Germany has been a great success: 9 % share of green electricity in 2002, world leader in terms of installed wind capacity amounting to 13,512 MW in October 2003 (nearly 40 % of the global capacity), second largest installed photovoltaic capacity in the world (nearly 350 MW at the end of September 2003), European leader in the sale of biodiesel (550,000 tonnes per year at the end of 2002) and insolar heating systems, with 4.75 million m^2 of installed systems at the end of 2002. To understand the success it is necessary to know that it results from – besides suitable background conditions – a comprehensive promotion approach which was launched at the beginning of the 1990s and has been given a further boost, since the coming into office of the Social Democratic-Green government in autumn 1998, through a series of promotion measures.

Since 1991, with the coming into force of the first German feed-in law, the Act on Supplying Electricity from Renewables (Stromeinspeisegesetz, StrEG), fixed remuneration has been paid to electricity based on renewable energy sources (RES), leading to the market breakthrough in wind energy. Its successor, the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) in April 2000, improved the regulations of the StrEG in many respects and made market entry possible for other renewables such as solar photovoltaics and biomass energy. The positive RES development in Germany can be explained by, besides this key promotion measure which served as a subsidy for the operational costs, several promotion programmes, which supported RES through investment subsidies (in the form of grants or soft loans), tax exemptions (within the scope of the Environmental Tax Reform) or in a more indirect way, through the decision to phase out nuclear energy, by means of information dissemination (i.e., the RES export initiative of the federal government) and corporate financing schemes in the case of wind energy.

1. Introduction

The aim of this article is to describe and analyse the policies that have been deployed during the last 10-20 years in Germany to support the use of RES. First, we shall give an overview of the energy situation in Germany (fossil fuel reserves, RES potential, current structure of energy economy). In addition, we shall examine the German renewable energy policy starting with initial measures dating back to the mid-1970s, until the most recent measures to promote renewables. We also discuss important RES promotion programmes like the 100,000 Roofs Photovoltaic Programme (100.000-Dächer-Programm, HTDP) and the Market Incentive Programme for an increased use of renewable energy (Marktanreizprogramm, MAP).

We shall end the article by presenting the most important obstacles to and conditions for the success of RES development in Germany. Concerning obstacles, we focus upon the strong influence of the coal lobby as well as the impact of long-term gas supply contracts. With regard to the successful diffusion of RES, we discuss instrumental (i.e., technology-specific remuneration for RES electricity), political (i.e., the decision to phase out nuclear energy), structural (i.e., high energy import dependence) and cognitive conditions (i.e., strong participation of local population in wind park projects) for success.

2. The energy situation in Germany

In fossil fuel reserves, Germany has above all hard and brown coal resources. The proven reserves at the end of 2002 amounted to 66 billion tonnes (Gt), corresponding to 6.7 % of the global reserves and an estimated reserves/production (R/P) ratio for Germany of 317 years [BP, 2003, p. 30]. In the EU-15, Germany is the biggest coal producer[1] and consumer with extensive subsidies for the German hard coal-mining industry (23 billion euro between 1998 and 2005; see [Reiche, 2004]). However, the exploitation of these resources has been declining for years.

Germany also has small reserves of oil (2001: 35 Mt) and natural gas (2002: 320 Gm^3) with a R/P ratio for Germany of 14 years in the case of oil [WEG, 2001] and 18 years in the case of natural gas [BP, 2003, p. 20].

In contrast to the latter, Germany has a big RES potential as shown by many studies, although these studies differ in their conclusions, depending on assumptions about the availability of suitable sites, technical charac-

Table 1. Technically available potential of RES in electricity and heat generation for Germany

RES technology	RES potential assessment by Enquete-Commission (PJ/yr)		RES potential assessment by UBA (PJ/yr)[1]	
	Electricity	Thermal	Electricity	Thermal
Biomass	140-205	428-695	212	598
Photovoltaics	751	-	302	-
Solar thermal	-	2,112	-	1,541
Hydro power	119	-	90	-
Wind power (onshore)	299-457	-	299	-
Wind power (offshore)	468-853	-	306	-
Geothermal energy	1,620-15,950 (PJ_e + PJ_{th})		237	2520
Total (PJ_e + PJ_{th})	5,937-21,142		6,105	

Sources: Deutscher Bundestag, 2002; Staiß, 2003, p. I-227

Note

1. The original data in the UBA potential assessment is given in TWh/yr. For easier comparability, we have converted it to PJ/yr.

Table 2. The German primary energy consumption[1] and net electricity production[2] in 2002

Energy carrier	Primary energy consumption		Net electricity production	
	PJ	%	TWh	%
Mineral oils	5,370	37.5	20[4]	2
Natural gas	3,107.5	21.7	36	7
Hard coal	1,890.2	13.2	114	22
Brown coal	1,661.1	11.6	143	29
Nuclear energy	1,804.3	12.6	156	31
Renewable energy sources	415.3	2.9	45	9
Others	71.6	0.5[3]	-	-
Total	14,320	100	504	100

Sources: BMU, 2003, p. 14; VDEW, 2003, p. 28

Notes

1. Preliminary data for primary energy consumption
2. Net electricity production = gross electricity production - own use of power plants
3. Balance of foreign trade account
4. Fuel oil and others

teristics of the RES technologies and other factors. The figures presented in Table 1 come from the *Yearbook of RES 2002/2003* [Staiß, 2003], and originate from one of the most recent and extensive RES potential assessments in Germany executed by the Federal Environmental Agency (UBA). Table 1 also presents figures from the final report of the Enquete-Commission of the German Bundestag [Deutscher Bundestag, 2002]. Based on these studies, the technical potential of RES in Germany can be estimated between about 6,000 and 21,000 PJ/yr. Compared with the German primary energy consumption in 2002 of 14,320 PJ [BMU, 2003a, p. 12], this shows that more than 40 % of the German energy demand could be covered by RES. With a higher utilisation of geothermal energy[2] and/or greater efforts in energy saving and energy efficiency, even the whole energy supply could in principle be met by RES.

To cover its energy demand, Germany strongly relies on energy imports. In 2002 the share of energy imports in the primary energy consumption amounted to over 60 %, which is above the already high EUaverage of 48 % [DGET, 1999]. The most important energy supplier for Germany is the Russian Federation. Natural gas, oil and hard coal from Russia amounted to approximately 18 % of the whole German energy supply in 2001. Further important suppliers of energy raw materials for Germany are Norway, Great Britain, and the Netherlands [WEC, 2002, p. 17].

With regard to the break-up of the German primary energy consumption in 2002, Table 2 reveals that mineral oil was without doubt the most important source of energy, followed by coal and natural gas (with already nearly the same percentages) and somewhat further behind by nuclear energy. Renewable energy sources only contributed 2.9 % [AG Energiebilanzen; BMWi, 2002, p. 12]. In the case of electricity generation (see also Table 2), the most striking result is the high share of coal, which amounted to more than half the whole production (51 %).

With a share of more than 30 % of nuclear energy, Germany is in fifth place in the EU after France, Sweden, Belgium and Finland [NEA, 2003].

As shown in Table 2, the contribution of RES to Germany's net electricity generation in 2002 already amounted to 9 %. The share of RES in the heat supply was only 3.6 % and in fuel consumption only 0.8 %. Regarding the share of RES in German primary energy consumption (2.9 %), this figure is composed of 1.3 % electricity, 1.4 % heat and 0.14 % fuels. With these RES levels, Germany does not reach the European average of 5.6 % in 2002 [IEA, 2003, p. 74]. Table 3 shows that more than half of the RES energy production is based on biomass. Regarding heat production by RES, the share of biomass amounts to 92 %, whereas in the electricity production hydro power still dominates with 52 %, followed by wind energy with 38 % [BMU, 2003a, p. 12]. Compared with the technically available potential of RES in Germany presented in Table 1, the current use of RES represents a share of 1.8 %, in relation to the most optimistic RES technical potential assessment and 6.5 % in relation to the most conservative one.

Table 3. Energy supply by RES in Germany in 2002

Energy carrier	Quantity (GWh)	%
Biomass (heat)	52,500	49.2
Hydro	24,000	22.5
Wind energy	17,200	16.1
Biofuels	5,688	5.3
Biomass (electricity)	4,200	3.9
Solar thermal energy	1,955	1.8
Geothermal energy (heat)	1,050	1.0
Photovoltaic	176	0.2
Total	106,769	100

Source: BMU, 2003, p. 12.

3. German renewable energy policies and measures since 1989

From an international point of view, Germany can be seen as one of the pioneering countries in the development and application of RES [BMU, 2003a, p. 13; BSi, 2003a; Neue Energie, 2003a, p. 122; Staiß, 2003, p. I-200].

- Germany is the world leader in installed wind capacity amounting to 13,512 MW in October 2003 (nearly 40 % of the global capacity).
- In installed photovoltaic capacity (nearly 350 MW at the end of September 2003), only Japan has up to now realised more.
- Germany is leading in the sale of biodiesel (550,000 t/yr at the end of 2002).
- The German market for solar heating systems (solar collectors) is by far the biggest in Europe, with 4.75 million m^2 of installed systems at the end of 2002.

It is clear that these successes would not have been achieved without adequate political support. Therefore, we will discuss what policies and measures to promote the development and use of RES have been taken in Germany.

3.1. The German approach to stimulating RES

The promotion of RES in Germany took its first steps with measures in the field of research and development. The Federal Ministry of Education and Research (BMBF) started promoting in 1974 the use of wind energy with the aim of increasing its economic efficiency. One impressive result of this kind of support was the so-called *large-scale wind plant project* (GROWIAN) with a multi-megawatt turbine, matching the needs of a power supply system based on big power plants. But the attempts failed, because it was not yet possible either to fabricate large-scale wind plants, or to integrate smaller ones in a centralised electricity supply structure. The GROWIAN project was abandoned in 1987 and the plant pulled down a year later. The development of a second generation of (smaller) wind plants was supported by the BMBF since the mid-1980s [Hemmelskamp, 1999, p. 77]. Between 1980 and 1998, the BMBF made available some DM 4 billion (~2.05 billion euro) for research into RES [Fischedick et al., 2000, p. 22]. Between 1999 and 2001 the annual expenditures of the federal government in this area stayed nearly constant and ranged between euro 89 million (1999) and euro 103 million (2001) [Staiß, 2003, p. 27].

In general, since its start, the German approach to promoting RES has been based on four main instruments:

- (direct) investment subsidies;
- soft loans;
- tax allowances; and
- subsidies for the operational costs/feed-in tariffs.

These instruments are partly applied in combination.

Regarding subsidies for the operational costs/feed-in tariffs, the so-called *100 MW Mass Testing Programme* of BMBF for wind energy from 1989 should be mentioned. In 1991 the programme was enlarged to 250 MW. It was in force until 1995. The aim of the programme was to test and gather experience with the operation of wind plants at economic scales as well as the creation of incentives for the installation of a higher number of wind plants by different operators. Approved wind projects first got a subsidy to the running costs of the plant of 8 Pf/kWh (~ 4.1 euro ct/kWh). When the *Act on Supplying Electricity from Renewables* (Stromeinspeisegesetz, StrEG) came into force (1991), this subsidy was reduced to 6 Pf/kWh (~ 3.1 euro ct/kWh).

3.2. The Act on Supplying Electricity from Renewables (StrEG)

Especially for wind energy, the StrEG was the most important promotion instrument in Germany during the 1990s. It obliged the public energy utilities to purchase and pay for electricity from solar and wind energy, hydro power, biomass, sewage and landfill gas on a yearly fixed basis. The remuneration was coupled to the value of the average revenues of the public utilities for each kWh sold to the end-users. The remuneration for wind and solar power amounted to 90 % of this value. For all the other sources of energy the remuneration was set at 80 % for

plants with a power output under 500 kW and at 65 % for plants from 500 kW to 5 MW for the part of power output above 500 kW. Together with the 250 MW wind programme of BMBF, the StrEG helped the wind power sector to reach a market breakthrough. The installed wind power capacity nearly centupled from 48 MW in 1990 to 4,443 MW in 1999. The wind power development was further stimulated by the provision of soft loans by the state-owned *Deutsche Ausgleichsbank* (DtA). These loans amounted to nearly DM 6 billion (~ 3.1 billion euro) in total between 1990 and 1998 [Staiß, 2003, p. 201].

For all other RES this financial support was not sufficient to achieve market entry. For example, the remuneration for photovoltaic power in 1999 amounted to 16.52 Pf/kWh (~ 8.5 euro ct/kWh), whereas the cost of 1 kWh generated by photovoltaics was DM 1.50 (~ 76.7 euro ct/kWh). This situation could not be changed by the so-called *1000 Roofs Photovoltaic Programme* of the federal and state governments – in force between 1991 and 1995 – although this programme was very successful and achieved the installation of more than 2,000 photovoltaic plants with an overall capacity of 4 MW_p. However, after its expiry there was no further promotion programme for photovoltaic systems, which – in the view of many experts – led to the migration of the biggest German solar collector manufacturers into countries with better conditions for solar PV development [Bechberger, 2002, p. 95; Fischedick et al., 2000, p. 21; Hemmelskamp, 1999, p. 80].

3.3. Energy tasks formulated by the new Federal Government in 1998

When the Social Democratic-Green federal government took office in autumn 1998, after four liberal-conservative legislative terms (16 years), a more sustainable energy policy and especially a clear emphasis on RES was expected. The coalition agreement focussed on the following tasks, among others:

- redesign of the energy law to create and secure fair market opportunities for RES;
- removal of obstacles which hamper increased use of RES;
- increased support for the production and launch of primary materials for renewables;
- realisation of a 100,000 Roofs Programme for photovoltaic systems (100.000-Dächer-Programm, HTDP); and
- consensus with the energy industry concerning the phase-out of nuclear energy.

3.4. The 100,000 Roofs Programme (HDTP)

The first RES promotion measure to be introduced after the change of government in 1998 was the HTDP. It came into force in January 1999. Its ambitious goal was to realise the installation of 100,000 new photovoltaic plants with a capacity of 3 kW_p each. Consequently, the installed photovoltaic (PV) capacity would be raised from 50 MW_p at the end of 1998 to 350 MW_p in 2003. The programme would be funded with a grant of 510 million euro and simultaneously would be expected to produce investments of about 1.3 billion euro. With this financial support, the HTDP was one of the biggest promotion programmes in this area worldwide. The HTDP also had a high industry-political importance: besides its contribution to a sustainable energy supply, the aim of the HTDP also was to stimulate the domestic market and to bring German solar manufacturers into a strong position in the fast-growing global market. The HTDP promoted the installation and the extension of PV plants with a power output of more than 1 kW_p. Targets of the programme were private persons, associations, foundations, housing associations, freelancers, and small and medium-sized enterprises (SMEs). The encouragement to RES projects was given in the form of long-term soft loans (maximum amount: 500,000 euro per system) with very low and fixed interest rates (2003: 1.91 % per year effectively) for a term of 20 years. It was also possible to combine the HTDP with other public promotion programmes. After a low demand for PV in the beginning, application increased abruptly with the coming into force of the EEG (Erneuerbare-Energien-Gesetz) in April 2000, because the new feed-in law (see below) increased the remuneration for PV electricity from 8.2 to 50.62 euro ct/kWh. Until May 2000, 15,000 applications with a total capacity of 70 MW_p were made. The programme was such a success that the target of 300 MW_p newly installed PV capacity was reached much earlier than expected. Consequently, at the end of June 2003 the *Credit Bank for Reconstruction* (Kreditanstalt für Wiederaufbau, KfW) announced that it had stopped granting applications because the 300 MW_p target had been attained. It is expected that in 2003 130 MW_p of PV capacity had been installed which would mean a doubling compared with 2002 [Neue Energie, 2003c, p. 105][3].

3.5. The Ecological Tax Reform (ETR)

Another important step of the red-green federal government towards achieving a more sustainable energy system was the introduction of an *Ecological Tax Reform* (ETR) which came into force on April 1, 1999[4]. The central steps of this first phase of the ETR were the increase in the taxes on motor fuels (3.07 euro ct/l), fuel oil (2.05 euro ct/l) and natural gas (0.164 euro ct/kWh) as well as the introduction of an electricity tax (1.02 euro ct/kWh), although the energy-intensive industry and public transport only had to pay a reduced tax of 20 % and 50 % respectively of the normal ETR tax level [Reiche and Krebs, 1999]. With the *Law on the Continuation of the ETR* of December 16, 1999, the tax on motor fuels was further increased by 3.07 euro ct/l and the electricity tax by 0.26 euro ct/kWh every 1st January of the years 2000 to 2003. Regarding fuels, the tax increases in the beginning only concerned those motor fuels with a sulphur content of more than 10 parts per million (ppm), but from January 1, 2003 they applied to all motor fuels. Since November 1, 2001 and in a further step on January 1, 2003, petrol and diesel with a sulphur content higher than 50 ppm were additionally taxed with the so-called sulphur tax, each by 1.53 euro ct/l. On January 1, 2000, the tax for heavy fuel oil was also raised by 0.26 euro ct/kg. With the *Law on the Further Development of the ETR* of December 23, 2002, the taxes on fuels for heating purposes were also increased: the tax on natural gas was raised by

0.2 euro ct/kWh, the tax on liquid gas by 2.226 euro ct/kg and the tax on heavy fuel oil by another 0.7111 euro ct/kg. The reduced tax rate for night storage heaters was also increased from 1.02 euro ct/kWh to 1.23 euro ct/kWh. At the same time the tax allowance for natural gas as fuel was extended until 2020 and the ETR tax rate for energy-intensive industries was raised from 20 to 60 % of the normal ETR tax level. If and how the ETR will be further developed beyond the regulations in force will be discussed by the government parties in 2004.

There are different ecological effects of the ETR for RES. On the one hand, biofuels profit from the ETR, because they are exempted from taxation. In total they reached a competitive advantage of 14.2 euro ct/l, which already led to a strong increase in the production of biodiesel. On the other hand, RES power is not exempted from the electricity tax, with the exception of customer generation by RES. This non-exemption is justified by the federal government by the problem of tracing back the exact production process of the electricity (and the danger of a false labelling and tax fraud as a consequence). In compensation, the federal government has earmarked parts of the ETR revenues for another main RES promotion measure: the Market Incentive Programme for an increased use of RES (Marktanreizprogramm, MAP) [Grotz, 2002, p. 115; Staiß, 2003, p. 203].

Approximately 0.65 billion euro of the overall ETR revenues of some 57.7 billion euro in the years 1999-2003 were earmarked for the MAP.

3.6. The Market Incentive Programme (MAP)

The MAP started on September 1, 1999 and represents the continuation of the so-called "100 Million DM Promotion Programme for RES", started in 1994, with a yearly volume of DM 20 million (~ 10 million euro). With the MAP, this volume was increased to 102 million euro in the year 2000, to 153 million euro in the year 2001 and to 200 million euro in the year 2002. For 2003, the federal budget was increased again to 230 million euro, but with an earmarked part of 30 million euro for the German RES export initiative (see below), 7.5 million euro for energy consultation measures and 2.5 million euro for the promotion of the rational use of energy. In general, the MAP is currently one of the most important RES support programmes, especially for heat-producing renewable energy technologies[5], particularly because combination with other promotion programmes is partly possible.

With the MAP, financial support is made available for solar thermal systems, installations for the combustion of solid biomass, biogas, small hydro power and geothermal plants as well as for photovoltaic installations at schools. Those entitled to apply for the MAP are similar to those in the case of HTDP: private persons, associations, foundations, housing associations, freelancers, SMEs as well as farmers and foresters. Support is available through direct investment subsidies and soft loans, the latter up to 100 % of the investment costs (maximum 5 million euro). Whereas the former is essentially given for the realisation of small plants, the latter is the normal form of support for projects with high investment costs.

Since its beginning the MAP has been so successful[6] that it has been subject to several amendments and changes, which mostly involved worsening of the support conditions, especially in July 2001. These financial cuts were justified on the ground that otherwise the earmarked budgetary means for 2001 would not have been sufficient. Nevertheless, critics warned against negative consequences for the just commenced successful diffusion process of RES in Germany [Bechberger, 2002, p. 97; Staiß, 2003, p. 143]. Partly for that reason, in March 2002 and February 2003 there have been again some financial improvements in the support conditions. But they are still less generous than the original conditions.

In March 2002, support for solar thermal plants was raised to 92 euro/m^2 with a maximum of 25,000 euro per plant. In February 2003 this support increased to 125 euro/m^2. It would have been reduced in January 2004 to 110 euro/m^2 for installations up to 200 m^2 and to 60 euro/m^2 for collector area exceeding 200 m^2. Automatically operated plants for the combustion of solid biomass to produce heat with a heat output up to 100 kW are supported by 60 euro/kW (at least euro 1,700) if the boiler efficiency amounts to at least 90 % and by 50 euro/kW (at least 1,500 euro) if the plant is operated manually (with a maximum of 250,000 euro per plant). Photovoltaic systems on schools get 3,000 euro if the power output is higher than 1 kW_p. For thermal biomass plants bigger than 100 kW, biomass plants for cogeneration, small hydro power (up to 500 kW) and biogas systems, as well as installations using deep geothermal energy (drill depth minimum 400 m) the support is given via soft loans. These have a term of 20 years with a repayment moratorium for the first three years. Moreover, some RES get partial forgiveness of debt of the soft loans. In the case of biogas this applies for installations up to 70 kW (with a maximum of 15,000 euro). For biomass plants bigger than 100 kW, a sum of 60 euro/kW (with a maximum of euro 275,000) is deducted from the total amount of the original soft loan. In the case of biomass plants for cogeneration, the partial forgiveness of debt amounts to 250 euro/kW_e up to an installed capacity of 250 kW_e. For geothermal plants a repayment deduction of 103 euro/kW is granted (with a maximum of 1 million euro).

Expiry of the MAP was originally planned for the end of 2003, but on September 18, 2003 the BMU announced an extension of the MAP until the end of 2006 with new promotion provisions starting in 2004. The aim is, among other things, to contribute to a doubling of the installed solar collector area in Germany to 10 million m^2 by 2006. Therefore the budget of the MAP will be raised to 200 million euro (from 190 euro million in 2003) in 2004 and will reach 230 million euro in 2006. Besides, the circle of entitled applicants will also be extended. Apart from private users, from 2004 on communities, municipal institutions and churches can also make use of the MAP. Whether the MAP will be extended beyond 2006 will be decided after a programme evaluation in autumn 2005 [BAFA, 2003; BMU, 2003f; BMU, 2003g; BSi, 2003b].

3.7. The Environment and Energy Conservation Programme (EECP) and the Environment Programme (EP)

Other important German RES promotion programmes are the Environment and Energy Conservation Programme (EECP) and the Environment Programme (EP) by the KfW[7]. Those targeted are above all SMEs, freelancers, local/municipal companies and public-private partnerships. Normally, financial support is given in form of soft loans up to 50 % of investment costs. If the two programmes are combined, 75 % can be covered and in the case of SMEs even the full investment sum. The maximum support amounts to 0.5 million euro (western states) and 1 million euro (eastern states) in the case of the EECP and 5 million euro in the case of the EP. These two programmes and their combination are of crucial importance, especially for the development of wind energy in Germany, because wind power is not supported by the MAP. Between 1990 and 2002, the soft loans granted by the two programmes reached a total of nearly 10 billion euro, of which some 95 % concerned wind projects [BMU, 2003b, p. 24; Staiß, 2003, p. 155].

3.8. The Renewable Energy Sources Act (EEG)

The most important German RES promotion measure in the area of electricity is without any doubt the *Renewable Energy Sources Act* (Erneuerbare-Energien-Gesetz, EEG), which came into force on April 1st, 2000, continuing the approach of its predecessor, the StrEG of 1991, in an extended and in many respects improved manner. The design of the former StrEG included several points that harmed the development of RES and made necessary a determined and quick change (see also above).

The aim of the EEG is to contribute to the goal of the EU and Germany to at least double the share of RES in electricity generation in the year 2010 compared with the 1997 level, which represents a minimum of 12.5 % in the case of Germany.

The most important structural elements of the EEG can be summarised as follows. Firstly, the remuneration system was uncoupled from the average utility revenue per kWh sold and replaced by fixed, regressive and temporarily limited feed-in tariffs for the whole amount of RES electricity generated. Secondly, a priority purchase obligation for RES power was introduced, to be met by the nearest grid operator. Thirdly, a Germany-wide equalisation scheme was adopted for the costs that grid operators incur as a result of the different amounts of RES each region feeds into the power grid, which leads to an even distribution of the RES power amounts and extends remuneration to all energy supply companies and ultimately to all end-consumers. Fourth, the EEG also contained for the first time provisions concerning the financing of grid connection and grid extension [Bechberger, 2002, p. 100].

The first amendment of the EEG was the extension of its ambit: besides the energy sources already considered in the StrEG, the EEG also included electricity from geothermal energy and pit gas. The power limit for hydro plants and installations using sewage or landfill gas of 5 MW fixed in the StrEG now also applies to installations based on pit gas or solar energy. In contrast, the power limit for biomass[8] plants was raised from 5 to 20 MW.

The most obvious changes in comparison to the StrEG are related to the remuneration scheme. With the coming into force of the EEG, all remuneration rates were raised, although on different scales, depending on the source of energy, capacity or location of the plant. On average they increased by only 10 %, mainly because of the slight increase of the remuneration for wind power from 8.25 to 8.78 euro ct/kWh and the fact that wind energy represents the biggest share of remunerated capacity within the scope of the EEG. By far the biggest increase was made for PV electricity which was raised by more than five times from 8.25 to 50.62 euro ct/kWh. All remuneration rates can be found in Table 4. Except for hydro power, where the amortisation of the power plants normally takes several decades, the EEG fixed the purchase guarantee and the feed-in tariffs for 20 years after commencement of operations of any new plant.

To stimulate innovations and to ensure a better compatibility with the European law on state aid, the remuneration paid under the EEG also includes a regressive element: from 2002 on, new installations of biomass (-1 %), wind (-1.5 %) and PV (-5 %) receive lower tariffs. From 2003 on, new installations of these types receive tariffs lowered by a further 1, 1.5 or 5 %, and so on for the following years.

To comply even more closely with the European law on state aid, the EEG set three further provisions. Firstly, by 30 June, every two years after the entry into force of the law a report shall be submitted on the progress achieved in terms of the market introduction and the cost evolution of RES power generation installations. Where necessary, this report shall propose adjustments of the remuneration amounts and of their reduction rates, in keeping with technological progress and market developments with regard to new installations. Accordingly, the first progress report was presented in June 2002 and served as a basis for a recent amendment of the EEG (see below).

Secondly, relating to the remuneration for wind power, the different quality of plant sites was also taken into account. Pursuing the so-called reference yield model *(''Referenzertragsmodell'')* the compensation to be paid for electricity generated from wind energy shall be at least 9.1 euro ct/kWh for a period of five years starting from the date of commissioning. Hence, the compensation to be paid for installations which, during this period of time, achieve 150 % of the reference yield calculated for the reference installation (the reference site shall be a site with a mean annual wind speed of 5.5 m per second at a height of 30 m) shall be at least 6.19 euro ct/kWh. For other installations, the period of the higher initial remuneration rate of 9.1 euro ct/kWh shall be prolonged by two months for every 0.75 % their yield stays below 150 % of the reference yield. The purpose of these new provisions is to avoid payment of compensation rates that are higher than what is required for a cost-effective operation of such installations, and to create an incentive for installing wind energy converters at inland sites. For offshore wind plants the higher initial remuneration rate will

be paid for nine years if they will be commissioned before the end of 2006. This provision takes into account the higher investment costs of such plants.

Thirdly, the remuneration scheme for PV power also contains a special provision that is connected with compliance with the European law on state aid. The guaranteed remuneration shall not apply to PV systems commissioned after 31 December of the year following the year in which PV systems within the scope of the EEG reach a total installed capacity of 350 MW. This limit was already raised to 1,000 MW in June 2002 because 350 MW seemed about to be surpassed already in 2003 and the successful PV sector needed further planning security[9].

Moreover, the EEG comprises for the first time a clear regulation concerning grid costs. Accordingly, the costs for grid connection have to be paid by the plant operators whereas possible costs for upgrading the grid must be borne by the grid operator. For the settlement of any dispute in relation to grid costs, the Federal Ministry of Economics and Technology (BMWi) also established a clearing centre, with the involvement of the parties concerned.

Finally, the EEG constituted a multi-level and nationwide equalisation scheme for RES electricity purchases and compensation payments. This provision was designed to remedy a shortcoming in the former StrEG, as a result of which the electricity purchases to be made were far above average in some regions. The equalisation provision in the present Act is aimed at the operators of transmission grids because this is a small group with a limited number of players which will easily be able to handle the transactions associated with the equalisation scheme and which will also be able to monitor each other [Bechberger, 2002, p. 100; BGBl, 2000].

The great success of the EEG can be demonstrated with the rapid growth of purchases and remuneration within the scope of the law. Whereas the purchases of RES power under the former StrEG in 1999 reached nearly 8 TWh, under the EEG they reached about 18 TWh in 2001 and 25 TWh in 2002. The latter amounted to a sum of remuneration of 2.213 billion euro (at an average remuneration of 8.87 euro ct/kWh). During 2003, an increase up to about 31 TWh of RES electricity is expected [Bechberger, 2002, p. 102; VDN, 2003].

Taking into account the findings of the first progress report of the EEG of June 2002 as well as the development of the installed RES capacity in Germany since then, on August 13, 2003 the BMU presented the first draft of the EEG amendment. The most important changes in comparison to the current EEG are as follows: reduction of the basic remuneration for wind power by about 7 % and shortening of the higher initial remuneration period to a maximum of 15 years for those wind turbine sites which – after the first five years of operation – have reached less than 60 % of the yield of the reference site. Regarding wind power from offshore sites, the initial higher remuneration will be prolonged from nine to twelve years for all plants which start operating before the end of 2010 (till now: end of 2006). Whereas the former changes seek to adapt the remuneration for very good coastal sites to the current economic development as well as to reduce the incentive to realise wind plants on less windy sites, the latter could be understood as a recognition of the still higher investment costs of offshore wind plants. The draft version also lays down stricter provisions for small hydro power plants, an integration of hydro power plants up to a power output of 150 MW, a more differentiated remuneration scheme for biomass power (mainly with increased incentives for the smallest installations), including an extra bonus for innovative biomass technologies as well as a combustible bonus for those installations which only use plants, parts of plants or liquid manure as combustible, and visibly higher remuneration rates for PV power (divided into five new categories depending on power output and site) as a compensation for the end of the HTDP in mid-2003. Finally, the draft version now also includes all hydro power installations into the 20-year limit for a guaranteed purchase and remuneration of the produced RES power. All planned changes in the remuneration scheme can be found in Table 4.

Since late summer 2003 government ministries and lobby organisations have been discussing the proposed changes. The aim of the federal government is to come to a decision of the cabinet by December 2003, so that the German parliament can discuss the proposed changes in the beginning of 2004 and the amended EEG can come into force in spring 2004 [BMU, 2003c; Fell, 2003]. On November 5, 2003 the German Federal Minister of the Environment, Trittin, and the German Federal Minister for Economic Affairs and Labour, Clement, agreed on a Cabinet draft bill of the EEG amendment. In comparison to the draft version of August 13, 2003, the following changes were decided:

- *Wind energy:* Instead of 60 %, the yield limit for wind plants concerning the prolongation of the initial higher remuneration will be 65 %. Also the yearly regression for new plants will rise from 1.5 to 2 %.
- *Photovoltaic:* Instead of the planned 64 euro ct/kWh for PV plants ≤ 30 kW on façades and 59 euro ct/kWh on roofs, the remuneration will be 62.4 euro ct/kWh for the former and 57.4 euro ct/kWh for the latter. Besides, the remuneration scheme for PV systems bigger than 30 kW was again structured in a different way. Now, PV installations between 30 and 100 kW power output will get 54.6 euro ct/kWh and PV systems bigger than 100 kW will be remunerated @ 54 euro ct/kWh. Beyond that, the basic PV feed-in tariff was raised by 2.3 euro ct from 43.4 to 45.7 euro ct/kWh. To compensate the end of the HTDP, the new remuneration for PV power – in contrast to the other amendments – would come into force at the beginning of 2004.
- *Biomass:* Instead of two new tariffs for biomass plants up to a power output of 75 kW and 75-200 kW, there will be only one new category for plants smaller than 150 kW, with a remuneration of 11.5 euro ct/kWh. Apart from that, the remuneration for biomass electric-

Table 4. EEG remuneration rates (in euro ct/kWh) for 2002-2004 and planned rates according to a draft bill of August 13, 2003

	2002	2003	2004	Planned rates
Hydro up to 500 kW	7.67	7.67	7.67	7.67[1]
Hydro 500 kW-5 MW	6.65	6.65	6.65	6.65[2]
Hydro 5-10 MW	-	-	-	6.65[2]
Hydro 10-20 MW	-	-	-	6.10
Hydro 20-50 MW	-	-	-	4.56
Hydro 50-150 MW	-	-	-	3.70
Landfill/sewage/pit gas up to 500 kW	7.67	7.67	7.67	7.67[3]
Landfill/sewage/pit gas 500 kW-5 MW	6.65	6.65	6.65	6.65[3]
Innovation bonus	-	-	-	1.00[4]
Biomass ≤ 75 kW	-	-	-	12.50[5]
Biomass 75 kW - 200 kW	-	-	-	11.50[5]
Biomass 200 kW - 500 kW	-	-	-	9.90[5]
Biomass ≤ 500 kW	10.13	10.03	9.93	9.90[5]
Biomass 500 kW - 5 MW	9.11	9.02	8.93	8.90[5]
Biomass 5 MW - 20 MW	8.60	8.52	8.43	8.40[5]
+ Combustible bonus	-	-	-	2.50[6]
+ Innovation bonus	-	-	-	1.00[7]
Geothermal energy ≤ 5 MW	-	-	-	15.00[8]
Geothermal energy 5 MW - 10 MW	-	-	-	14.00[8]
Geothermal energy ≤ 20 MW	8.95	8.95	8.95	8.95[8]
Geothermal energy ≥ 20 MW	7.16	7.16	7.16	7.16[8]
Wind energy initial/prolongation	8.96	8.83	8.70	8.70[9]
Wind energy final	6.09	6.00	5.91	5.50[9]
Offshore wind 9 years	8.96	8.83	8.70	-
Offshore wind 12 years	-	-	-	9.10[10]
Photovoltaic = 5 MW	48.09	45.68	43.40	-
Photovoltaic (roof) ≤ 30 kW	-	-	-	59.00[11]
Photovoltaic (roof) ≥ 30 kW	-	-	-	55.00[11]
Photovoltaic (façade) ≤ 30 kW	-	-	-	64.00[11]
Photovoltaic (façade) ≥ 30 kW	-	-	-	60.00[11]
Photovoltaic (free space)	-	-	-	43.40[11,12]

Sources: BMU, 2003b; Staiß, 2003, p. II-24

Notes

1. The draft bill establishes a regressive remuneration of 1 % for new plants ≤ 5 MW from 2005 on.
2. The draft version distinguishes between hydro plants ≤ 5 MW and bigger plants. The two size categories have to fulfil different conditions. For example, within the draft version hydro power plants bigger than 5 MW only receive remuneration if the plant will be modernised before the end of 2012.
3. Regressive remuneration of 2 % for new plants from 2005 on.
4. For plants using fuel cells.
5. Regressive remuneration of 1 % for new plants from 2005 on.
6. For installations using only plants, parts of plants or sewage manure as combustible.
7. For installations producing power through thermochemical gasification or by fuel cells, gas turbines, steam engines, organic-Rankine installations, Kalina-cycle plants or Stirling engines.
8. Regressive remuneration of 1 % for new plants from 2010 on.
9. Regressive remuneration of 1.5 % for new plants from 2005 on.
10. Regressive remuneration of 1.5 % for new plants from 2008 on.
11. Regressive remuneration of 5 % for new plants from 2005 on.
12. This kind of PV plants have to fulfil special conditions. For example, their produced power will only be remunerated if the plant will be put into operation before 2015 within the scope of a development plan.

ity will be only guaranteed for 15 and not for 20 years. Additionally, the regression for the remuneration of electricity from new biomass plants was raised from 1 to 2 %.

Furthermore, the provision concerning cases of hardship for energy-intensive companies, which already came into force in July 2003, shall be extended. Up to now only those enterprises get a small reduction of the average remuneration for RES power (-0.05 euro ct/kWh) whose yearly electricity consumption amounts to more than 100 GWh and their electricity costs represent more than 20 % of the gross value added. These thresholds will be reduced to 10 GWh and 15 % respectively. In contrast, the total release must not exceed 10 % of the whole amount of RES remuneration [BMU, 2003h; FAZ, 2003a, p. 15; IWR, 2003]. What kind of amendment of the EEG finally will be decided after the consultations with the RES federations and the different readings in the Parliament remains to be seen.

3.9. Other RES promotion measures

Besides financial measures for promotion of RES, on federal level there have been decisions on RES information dissemination and on improving the general environment for a sustained diffusion of RES in the middle and long term.

Concerning the former, an important step taken by the red-green German government was setting up a German Energy Agency (Deutsche Energie-Agentur, Dena) in September 2000. With Dena, the federal government established a competence centre on rational use of energy in the building sector, as well as in the electricity sector, RES, climate protection and sustainable development and international co-operation. Dena initiates, co-ordinates and moderates projects and programmes in these domains on national and international level. In the area of RES, Dena started an information campaign on solar thermal energy. Also, it will help to prepare the International Conference for Renewable Energies to take place in Bonn in June 2004, as announced by Chancellor Schröder of Germany at the World Summit for Sustainable Development in Johannesburg in September 2002.

The main initiative in the international area is the "RES Export Initiative" ("Exportinitiative Erneuerbare Energien"), founded in summer 2002 to develop a consistent strategy for the international diffusion of German RES technology.

Another initiative in this area was to provide developing countries with 500 million euro during the next five years for the development of RES and with some further 500 million euro for increasing energy efficiency during the same period. This measure was decided within the scope of the special programme "Sustainable Energy for Development" on the occasion of the World Summit for Sustainable Development in Johannesburg in September 2002. It was also laid down in the coalition agreement of the red-green federal government of October 2002 [Bechberger, 2002, p. 112; Mez and Piening, 2002, p. 180; Staiß, 2003, p. I-212].

Relating to new initiatives that influence the further development of RES in Germany in a more indirect manner, the agreement of June 2001 between the federal government and the German electricity suppliers on the phasing-out of nuclear energy should be mentioned. Accordingly, the usual operational life of the 19 German nuclear power plants was limited to 32 years[10]. The corresponding law came into force on April 26, 2002. Although on the one hand this decision secured the undisturbed continuation of operation of the nuclear power plants, on the other hand from 2010 onwards up to 40,000 MW[11] nuclear capacity will have to be replaced by other types of plants. An important part of this will be RES installations.

4. Obstacles to and conditions for success of RES development in Germany

Now that we have looked at the policies and measures that are used to develop and promote RES in Germany, it is useful to know what kind of obstacles to and conditions for success of the applied (and future) RES policy instruments can be identified.

Regarding obstacles to RES development in Germany, the strong influence of the coal sector with a high number of lobbyists in the Social Democratic Party of Germany (SPD) has to be mentioned first. This resulted, for example, in a virulent campaign against wind power in Germany in connection with the 2003 amendment of the EEG and the promise of Chancellor Schröder to further subsidise the German hard coal-mining industry between 2006 and 2012 with 17 billion euro [FAZ, 2003b, p. 13]. Another problem for future RES development in Germany is the procurement policy for natural gas. The (supply) contracts with the most important suppliers will not expire before 2011 and some contracts are even fixed until 2030. Normally, these contracts are so-called "take or pay" contracts, which means that the arranged quantity compulsorily has to be purchased. This could seriously hamper future RES development in Germany; if the energy market will not develop as expected, instead of further expansion of the RES market, the contracted natural gas has to be consumed first [Reiche, 2004].

Taking a look at the most important conditions for the success of RES development in Germany, four categories have to be mentioned: instrumental, political, structural and cognitive conditions.

- *Instrumental conditions:* These concern first of all planning security for investors in RES projects. Although some of the present RES promotion measures such as the HTDP and the MAP are in some way unstable and limited in time, always depending on the provided budgetary means, this does not apply to the core German RES promotion regulation, the EEG. It includes a purchase and remuneration guarantee for RES electricity of 20 years for all considered electricity generation technologies. This endows investors with the security they need to invest in such projects. The HTDP ended in mid-2003, but will be compensated within the scope of the current amendment of the EEG by raising the remuneration rates for PV power. With

this decision, the further development of solar power in Germany will be even more secure. For wind power, if the amended EEG will come into force in its present form, at least the situation for possible investments in plants on less windy sites will be less secure than before. The intention of the legislators has to be judged from two angles. On the one hand, it is possible that a shortened time period for the higher initial remuneration for less productive wind plants will interfere with the need to attain at least a 12.5 % share of RES electricity in 2010. On the other hand it will possibly lead to a faster shift to offshore projects.

Another important instrumental condition for successful RES development is technology-specific remuneration for RES electricity. If the different power production costs of the individual RES technologies are considered in the form of varying remuneration, the possibilities to reach a broad RES supply or technology mix seem without doubt higher than with a uniform remuneration level for RES power. In Germany, the EEG established a broad promotion approach with remuneration rates depending on the technology used, the size of the plant and in the case of wind energy in addition also depending on the age and the generated power output of the installation. The success of these provisions speaks for itself: world champion in installed wind capacity, second place worldwide in installed PV plants.

- *Political conditions:* A measure which led to a closer relationship between the private actors in favour of RES and the governmental institutions which normally have the most positive view with regard to RES was the change of the administrative responsibilities for RES from the BMWA (former BMWi) to the BMU in the context of the re-election of the Social Democratic-Green government in autumn 2002. As the Green Party gained votes, which were decisive for a continuation of the ruling coalition, a concession to them was the abovementioned change of responsibilities for RES. A first result of this administrative reorganisation was the presentation of a draft bill concerning the current amendment of the EEG in August 2003. This is a clear difference in comparison to the legislation process of the first EEG at the end of 1999 and the beginning of 2000, when the BMWi delayed several times the presentation of a draft bill and finally the parliamentary parties of the ruling coalition presented their own, to speed up the legislation process [Bechberger, 2001].

  A further political condition for the success of RES is the decision to phase out nuclear energy in Germany through the corresponding law of April 26, 2002 which will lead to a higher demand for RES in the middle and long run. The first German nuclear power plant that was taken out of operation in the context of the decision of a nuclear phase-out was the plant in Stade on November 14, 2003, after 31 years of operation [BMU, 2003e].
- *Structural conditions:* Because of its marginal oil and gas reserves, Germany strongly relies on energy imports. In 2002, the share of energy imports in primary energy consumption amounted to over 60 %, so that Germany lies above the already high EU average of about 48 %. This fact shows that – together with the decision to phase out nuclear energy – Germany has to emphasise its support for RES because of their domestic availability to reduce the high level of energy import dependence.
- *Cognitive conditions:* In comparison with other EU member states (e.g., Great Britain), local resistance against onshore wind projects in Germany currently visible at a relatively low level only. The reasons for this astonishing fact – if one takes into account that till late summer 2003 already more than 13,000 MW of wind power capacity had been installed in Germany – are two related factors. First, the development of the wind sector in Germany was from its beginning closely connected with associated companies, with a sometimes high involvement of the local population, reducing the so-called NIMBY ("Not in my backyard") effect. Second, German municipalities have to show in their spatial planning where it is feasible to build wind plants, which makes it easy for investors on the one hand, but which can also be seen as a means to reduce local resistance, as municipalities can decide for themselves where to build such installations[12] [Bechberger, 2002, p. 109; Reiche, 2002, p. 19]. The positive cognitive environment for RES in Germany can also be recognised from the fact that in the year 2001 more than 100,000 households decided on a solar thermal installation [Staiß, 2003, p. 89]. The strong alliance for RES was again demonstrated on November 5, 2003 when some 10,000 people of different political convictions assembled in Berlin to show their support for RES because of a feared deterioration of the RES promotion scheme in the current EEG amendment [Spiegel Online, 2003].

Nevertheless, to come to a sustainable energy system, great progress concerning energy-saving measures and the efficient use of energy has also to be made. ■

Notes

1. After the next round of accession in May 2004 this will be Poland [Reiche, 2003, p. 14].
2. On November 12, 2003, the German federal minister of environment, Trittin, inaugurated the first German geothermal power plant in Neustadt-Glewe (Mecklenburg-Western Pomerania) with a power output of 210 kW. The BMU supported the project with 400,000 euro [BMU, 2003d].
3. Nevertheless private investors in PV plants can continue to apply for financial support. The Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) has already announced that with the end of the HTDP, applications for soft loans concerning private PV installations can be made within the KfW Environment Programme and the KfW CO_2 Reductions Programme [BMU, 2003b, p. 21].
4. By increasing the costs of energy consumption, the ETR on the other side lowered the contributions to public pension and social insurance schemes from 20.3 % in 1998 to 19.5 % in 2003. Without the ETR, this would have reached a level of 21.2 %. In 2003 alone, the ETR tax revenues amounted to 18.8 billion euro, of which 17.4 billion euro were used to lower the public pension and social insurance schemes and a further 1 billion euro for the rehabilitation of the state budget. Besides, only a small amount of 200 million euro was earmarked for the MAP and 200 million euro for the so called CO_2 Building Redevelopment Programme [Staiß, 2003, p. 203].
5. Between 1993 and 2002 the BMBF also supported the construction of up to 100 big solar thermal installations (greater than 100 m^2 collector space) in the new *laender* and the eastern part of Berlin with the programme "Solarthermie 2000". The programme had mainly demonstrative purposes and supported projects by investment subsidies for

the costs of planning, installation and measurement [Solarserver, 2003].

6. Between September 1999 and July 31, 2003 there have been 369,490 applications within the MAP of which 224,613 already were granted. This represents a financial support of 292 million euro in the form of 223,370 grants and some 288 million euro via 1,243 soft loans for bigger projects. Whereas the former is equivalent to an investment volume of 2.1 billion euro, the corresponding investment sum for the granted soft loans was not available [BMU, 2003b, p. 20].
7. The Environment Programme was originally managed by the DtA. But the DtA merged with retrospective effect from January 2003 with the KfW, so that the latter is now responsible for the mentioned programme.
8. As the term biomass was specified neither in the StrEG nor directly in the EEG, the BMU – with the aim of reaching legal and planning security to investors -- was authorised through the EEG to lay down what substances shall be considered biomass, what technical processes for generating electricity from biomass fall within the EEG and what environmental standards must be met in the generation of biomass. Therefore, with the so called Biomass Ordinance (Biomasseverordnung) of 21 June 2001, the BMU decided that biomass of vegetable or animal origin (but not animal carcasses) as well as secondary sources of energy like biogas or alcohol (biomethanol or bioethanol) produced from it are registered as such. Besides, biological waste and waste wood, comprising used wood or industrial waste wood (if not strongly contaminated) are seen as biomass. Excluded are peat, mixed municipal solid wastes, paper, cardboard, pasteboard, sewage sludge, textiles, sewage and landfill gas [Bechberger, 2002, p. 86].
9. In the planned amendment of the EEG this capacity limit will be removed completely.
10. Decisive, however, is not the real remaining operational life of the plants, but the arranged remaining power amount of 2,613 TWh (in 2002 the whole net electricity production of all 19 German nuclear power plants amounted to 156 TWh), which also can be transferred from older to newer plants [Staiß, 2003, p. I-212].
11. This figure also includes the fossil power plants to be replaced after 2010. If one only counts the overall German nuclear power capacity, which has to be replaced, this amounts to a power output of 23,500 MW [Mez and Piening, 2002, p. 163].
12. Another measure to reduce local resistance against wind projects is the so-called repowering, which means the replacement of old wind plants through new and more powerful ones at an already existing site. In one of the first German repowering projects, during the months of August to October 2003 the ecojoule project e.K. replaced near Hanover six 150 kW wind plants dating from 1995 by new 600 kW wind plants with a six times higher electricity yield. The old turbines will be reused in Greece and the USA [Neue Energie, 2003b, p. 8].

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