Federal Ministry for the Environment,
Nature Conservation and Nuclear Safety

Report from the Federal Republic of Germany for 2011

Progress towards achieving the indicative target for the consumption of electricity produced from renewable energy sources in the period to 2010

Report from the Federal Republic of Germany under Article 3(3) of Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market

Berlin, October 2011

Table of contents

1 Introduction 3
2 National indicative target for Germany substantially exceeded 4
3 Development of renewable energy sources in Germany 5
4 Development of electricity production from renewables 5
5 Development of electricity production from renewables by sector 6
5.1. Wind energy 6
5.2. Biomass 7
5.3. Solar energy 8
5.4. Hydropower 9
5.5. Geothermal energy 10
6 Changes in emissions avoidance resulting from the use of renewables in the context of national climate change commitments 10
Table of figures 12

1 Introduction

Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market sets the goal of raising the share of renewable energy sources (RES) in the European Community's (EU 27) electricity supply to 21% in 2010.

Article 3(3) of the Directive requires Member States to draw up a report on progress towards achieving the target and on national climate change commitments:

'Member States shall publish, for the first time not later than 27 October 2003 and thereafter every two years, a report which includes an analysis of success in meeting the national indicative targets taking account, in particular, of climatic factors likely to affect the achievement of those targets and which indicates to what extent the measures taken are consistent with the national climate change commitment.'

This report fulfils Germany's obligation under the Directive.

In 2007, with RES accounting for 14.3% of total gross electricity consumption, Germany had already exceeded its national indicative target of increasing the RES share of gross electricity consumption to at least 12.5% by 2010, as set by Directive 2001/77/EC. In target year 2010 the share was already around 17.0%, so the target set by the Directive had been very substantially exceeded.

Germany will continue to develop RES in general and particularly for electricity production, and has set itself ambitious new targets with the Energy Concept of September 2010:

- the RES share of gross final energy consumption is to be increased to 18% by 2020, 30% by 2030 and 60% by 2050;
- the proportion of gross electricity consumption contributed by RES will increase to at least 35% by 2020, at least 50% by 2030 and at least 80% by 2050;
- their share in meeting demand for heat energy is to rise to 14% by 2020 and their share of final energy consumption in the transport sector will go up to 10%.

Germany's targets for developing renewables are closely tied in with the current EU objectives, which will see the RES share of total final energy consumption raised to 20% by 2020.

Ensuring energy supply security in the future whilst limiting the climate change that has already set in are two of the key challenges facing us in the 21st century. Ambitious action is therefore called for in all energy- and climate-related fields. In addition to its key strategy of using energy resources economically and achieving high levels of energy efficiency, Germany is aiming to increase the use of renewables, focusing on substantially raising the RES share of electricity supply.

National legislation on the feeding-in of, and compensatory payments for, RES electricity has been in place in Germany since 1991. In Germany, the development of renewables for electricity production was to a large extent begun by the Electricity Feed-In Act (StromEinspG). Rapid technological developments in this field, with an increasing share of RES in electricity supply, led to the adoption of the Renewable Energy Sources Act (EEG) in April 2000, with fundamental new provisions giving priority to electricity produced from renewables, feed-in and compensatory payments. From 2000 onwards the EEG made possible a huge expansion in the use of renewables in the electricity market.

Amended versions of the EEG entered into force in 2004 and 2009; it was extensively amended and adapted to technological progress and changes in the economic climate. These amendments were introduced on the basis of reports on the EEG that had been submitted to the Bundestag.

The next amendment to the EEG, already adopted by the Bundestag, will enter into force on 1 January 2012. It will help Germany meet its targets for 2020 and beyond and provide longer-term prospects and investment security for all those operating in the renewables sector.
The new EEG will therefore also be key to achieving the targets set under Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources, in the context of which Germany will increase the RES share of its total final consumption of energy to 18%.

The sustainability requirements of Directive 2009/28/EC were already transposed by two ordinances: the Biomass Electricity Sustainability Ordinance (BioSt-NachV) for liquid biomass and the Biofuel Sustainability Ordinance, both of which entered into force in 2009. The Biomass Electricity Sustainability Ordinance specifies in detail how the liquid biomass used to generate electricity under the EEG is to be produced. In order to safeguard the environment, the climate and wildlife, the cultivation of the biomass covered by the Ordinance must not result in the destruction of areas of high nature conservation value (e.g. rain forests) or areas with a high carbon content (e.g. wetlands, peat bogs, etc.). Moreover, the energy use of liquid biomass must lead to a reduction of at least 35% in greenhouse gas emissions compared with fossil fuels. Biomass grown on European farms must also meet the cross-compliance requirements of EU agricultural policy.

In addition, the Ordinance on the further development of the nationwide equalisation scheme under the Renewable Energy Sources Act (AusglMechV) entered into force on 1 January 2010. This Ordinance is aimed at ensuring greater financial and technical efficiency and more transparency in getting RES electricity subject to compensatory payments under the EEG to consumers.

Given the compensatory payments it provides, guaranteed as a rule for 20 years, the EEG has brought about a considerable increase in the use of renewables to generate electricity in the last ten years. In the first phase this was true in particular of the use of wind energy, and also of biomass to a greater extent since 2004, as well as particularly photovoltaics in the past few years.

2 National indicative target for Germany substantially exceeded

The key aim of the Directive on the promotion of electricity produced from renewable energy sources in the internal electricity market (Directive 2001/77/EC), which entered into force in 2001, is to increase the share of renewable sources in electricity production, from 14% in 1997 to 21% (EU 27) by 2010. The target for Germany is to achieve an RES share in its national electricity market of at least 12.5% by 2010.

The RES share of total gross electricity consumption in Germany had been raised to 17.0% by 2010. The indicative target was therefore substantially exceeded.

The successful development of renewables in Germany to date has made them a key pillar of the German energy sector. They therefore also make an important contribution to climate protection and have become a significant economic factor.

3 Development of renewable energy sources in Germany

In 2010, a total of at least 275 terawatt hours (TWh) of final energy was produced from renewables in Germany. This included 103.5 TWh in the electricity sector, 136.1 TWh in the heating sector and 35.7 TWh in the motor fuels sector. Electricity production thus accounted for about 38% of final energy supplied by renewables.

Renewables are making an important contribution to climate protection: according to Federal Environment Agency estimates, the reduction in greenhouse gases by the use of renewables in 2010 totalled 118 million tonnes of CO_2 equivalent. 74.9 million tonnes of these savings were attributable to the electricity sector alone.

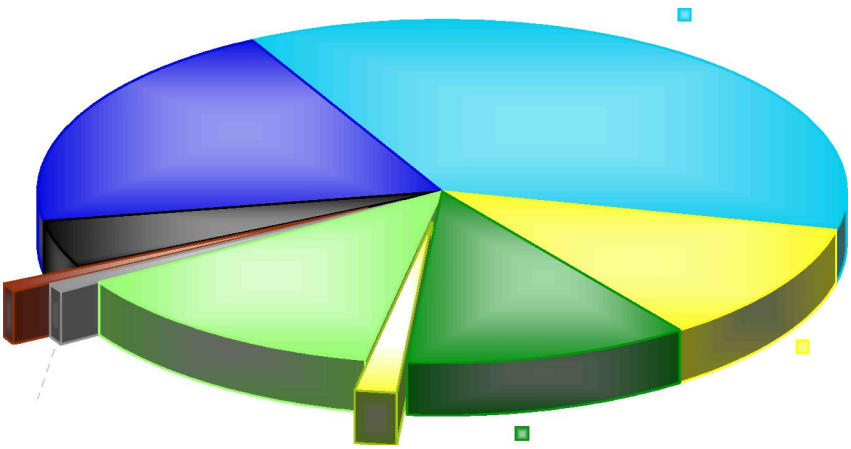
A diverse range of instruments at the federal level – including federal support schemes (in particular the Market Incentives Programme) and other schemes at *Land* and local authority level in addition to the EEG and the Renewable Energies Heat Act (EEWärmeG) – all fostered growth in the renewables sector.

A detailed overview of the development of renewables in Germany, including their environmental impact, is presented in the Federal Environment Ministry's publication "Renewable energy sources in figures - national and international developments", July 2011 (annex).

4 Development of electricity production from renewables

The overall growth in renewables is particularly strongly reflected in the electricity market. In 2010, 103.5 TWh of energy were supplied by renewables, accounting for 17.0% of Germany's total gross electricity consumption (607.8 TWh). This represents about a quadrupling of the figure for the base year of 1997 (4.3%). Wind energy has made the largest contribution since 2003, with 36.5% in 2010. In second place was electricity production from biomass (including landfill and sewage treatment plant gas and the biogenic fraction of waste) at 32.2% followed by hydropower at 19.9% and photovoltaics at 11.3%.

The structure of electricity production from renewables in 2010 is shown in Fig. 1.



Stromerzeugung aus EE/electricity production from renewables: 103.5 TWh
Windenergie/wind energy: 36.5 %
Wasserkraft/hydropower: 19.9%
Biogener Anteil des Abfalls/biogenic fraction of waste: 4.5%
Deponiegas/landfill gas: 0.7%

Photovoltaik/photovoltaics: 11.3%
Biogas: 12.9%
Klärgas/sewage treatment plant gas: 1.1%
biogene flüssige Brennstoffe/biogenic liquid fuels: 1.7%
biogene Festbrennstoffe/biogenic solid fuels: 11.4%
Biomasseanteil/biomass percentage* : ca. 32%

* Solid and liquid biomass, biogas, landfill and sewage treatment plant gas, biogenic fraction of waste; deep geothermal energy is not shown because of the small amounts of electricity produced; 1 TWh = 1 billion kWh; discrepancies in the totals are the result of rounding-off; Source: Federal Environment Ministry KI III 1 based on Working Party on Renewable Energy Statistics (AGEE-Stat); provisional data, October 2011

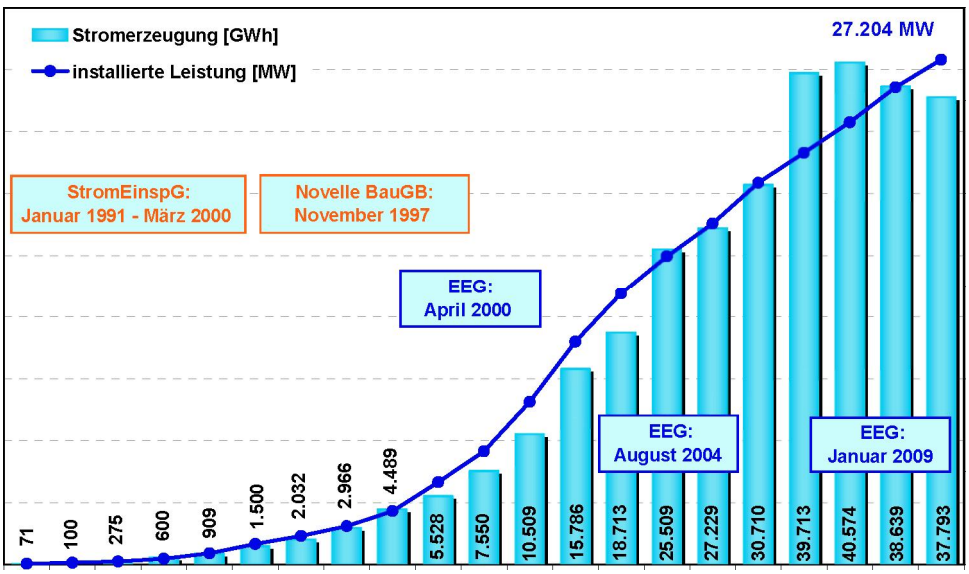
Fig. 1: Structure of electricity production from renewables in 2010 in Germany

5 Development of electricity production from renewables by sector

5.1. Wind energy

In all, 21 585 wind power plants – with a total capacity of 27 204 MW – had been installed in Germany by the end of 2010. In that year they produced just on 37.8 TWh of electricity in all. 2010 was a year of particularly adverse wind conditions and installed wind energy plants ran at much below their production potential. In a year with average wind conditions they would have produced some 5 TWh more. The 37.8 TWh equated to a good 6% of Germany's total gross electricity consumption and resulted in a CO_2 avoidance of about 27.8 million tonnes CO_2 equivalent greenhouse gas emissions.

The development of wind energy use in Germany up to 2010 is presented in Fig. 2.



Stromerzeugung = electricity production; **installierte Leistung** = installed capacity. StromEinspG: Stromeinspeisungsgesetz/Electricity Feed-In Act; EEG: Erneuerbare-Energien-Gesetz/Renewable Energy Sources Act; BauGB: Baugesetzbuch/Building Code; 1 GWh = 1 million kWh; 1 MW = 1 million watts;
Sources: J.P. Molly: "Status der Windenergienutzung in Deutschland, Stand: 30.06.2011"; Deutsches Windenergie-Institut (DEWI) (Status of wind energy use in Germany; 30.6.2011; German Wind Energy Institute); Federal Environment Ministry KI III 1 based on Working Party on Renewable Energy Statistics (AGEE-Stat); provisional data, October 2011
Left-hand vertical axis, from top: GWh: 45 000 – 40 000 – 35 000 – 30 000 – 25 000 – 20 000 – 15 000 – 10 000 – 5 000 – 0.

Right-hand vertical axis, from top: MW: 30 000 – 25 000 – 20 000 – 15 000 – 10 000 – 5 000 – 0.

Fig. 2: Development of installed capacity and electricity production from wind energy in Germany

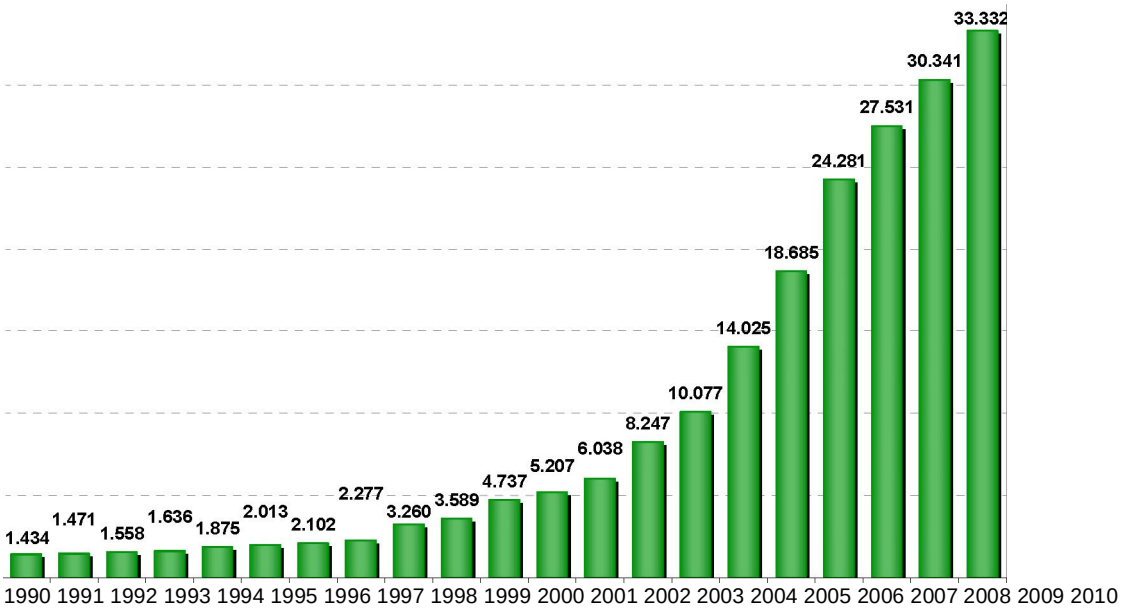
In the past two years offshore wind farms have started to come on stream in Germany. By the end of 2010 two wind farms had been completed in the German EEZ and a further one was under construction; total installed capacity was 168 MW. This trend will continue in future. As part of its sustainability strategy "Prospects for Germany" the Federal Government mandated the Environment Ministry to produce a strategy on the use of offshore wind energy and designate suitable areas for wind farms and conservation areas. 29 offshore wind farms with an output of some 10 000 MW have already been approved. The German offshore development target is up to 25 000 MW installed capacity by 2030. This will mean that about 15% of Germany's electricity demand can be covered by offshore wind energy alone.
The second important strategy for future wind energy development is repowering, the replacement of old installations with new, more efficient ones. 2010 in particular saw a boost to this strategy. 63.5 MW of old installations were replaced with 204.6 MW of new installations under this strategy.

5.2. Biomass

The production of electricity from biomass in Germany has seen rapid growth since 2004. The numerous improvements introduced by the 2004 and 2009 amendments to the EEG fostered further growth in electricity production from biomass, in particular biogas. These include the enhanced compensatory payments that are differentiated according to plant size and the introduction of various bonuses for the use of renewable raw materials or residues, for new technologies or the operation of plants in CHP mode.

In 2010 some 28.7 TWh of electricity were produced by the use of solid, liquid and gaseous biomass (excluding the biogenic fraction of waste). The past few years have seen the upward trend in biogas electricity production maintained; this accounted for around 13.3 TWh in 2010 alone. Trends in electricity production from whole biomass (solid and liquid biomass, biogas, landfill and sewage treatment plant gas, biogenic fraction of waste) are presented in Fig. 3. At a total of 33.3 TWh its percentage of electricity production in 2010 was already 5.5%.

At the end of 2010 biomass (heat and) power plants with an installed capacity of some 2 100 MW_{el} were producing electricity from solid biomass in Germany. In the growing biogas sector, just on 6 000 plants with an installed capacity of about 2 200 MW_{el} were in operation at the end of 2010. Plants with an installed capacity of about 300 MW_{el} were generating electricity from liquid biomass.
At the end of 2010 Germany had a total of around 5 000 MW installed capacity generating electricity from biomass.



y-axis, from top: 35.000 - 30.000 - 25.000 - 20.000 - 15.000 - 10.000 - 5.000 – 0.
Solid and liquid biomass, biogas, landfill and sewage treatment plant gas, biogenic fraction of waste; 1 GWh = 1 million kWh; Source: Federal Environment Ministry KI III 1 based on Working Party on Renewable Energy Statistics (AGEE-Stat); provisional data, October 2011

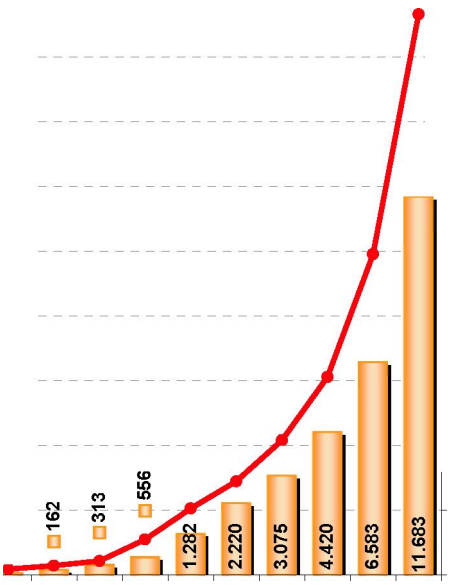
Fig. 3: Electricity production from total biomass in Germany

5.3. Solar energy

Photovoltaic installations have expanded rapidly over the past few years. The addition of some 3 800 MW_{peak} in 2009 was exceeded by a new peak of around 7 400 MW_{peak} in 2010. By the end of 2010 photovoltaic installations had a total installed capacity of 17 320 MW_{peak}.

As a result of the major capacity increase in 2010, solar energy accounted for 1.9% of Germany's gross electricity consumption.

Since the adoption of EEG 2009 the annual reduction of compensatory payment rates for new photovoltaic installations has been adapted to take account of the amount of new installed capacity in each year. The target, therefore, is an annual capacity increase of some 3 500 MW.
The development of installed capacity and electricity production from photovoltaics is presented in Figure 4.



1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Source: Federal Environment Ministry KI III 1 based on Working Party on Renewable Energy Statistics (AGEE-Stat); 1 GWh = 1 million kWh; 1 MW = 1 million watts; provisional data, October 2011
Left-hand vertical axis, from top: GWh: 18 000 – 16 000 – 14 000 – 12 000 – 10 000 – 8 000 – 6 000 – 4 000 – 2 000 – 0
Right-hand vertical axis, from top: MW_p: (same scale as above)
Energiebereitstellung/energy supply [GWh]
installierte Leistung/installed capacity [MW]
[Translator's Note: Please see PDF original for full figure (years 1990-2001)]

Fig. 4: Development of installed capacity and energy supply from solar energy use in Germany

5.4. Hydropower

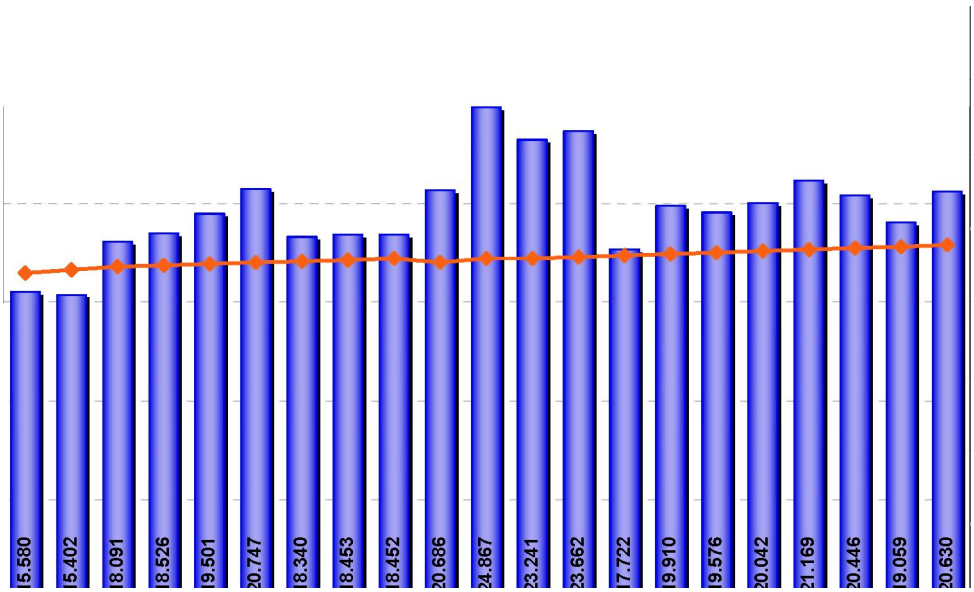
The available potential for hydropower has already been at a high degree of development for decades now. Since the introduction of the Electricity Feed-In Act and the EEG the small hydropower plants sector has undergone a revival, particularly through the modernisation and reactivation of old plants. Since the inclusion of large hydropower plants (> 5 MW) in EEG 2004's subsidy scheme there has been an incentive to develop plants with greater capacities too.

At the end of 2010 hydropower plants with a total installed capacity of some 4 780 MW were on stream in Germany, supplying about 20.6 TWh of electricity that year. Hydropower therefore accounted for about 3.4% of electricity supplies.

Figure 5 presents installed hydropower capacity and energy supply in recent years.

The potential for further expansion in the hydropower sector lies mainly in the replacement or modernisation and expansion of existing plants, but there is some potential in reactivation and the construction of new plants in rivers with existing transverse structures. However, compared to other renewables – in particular wind energy and photovoltaics – expansion potential is low.

Energiebereitstellung/energy supply [GWh] - installierte Leistung/installed capacity [MW]



Source: Federal Environment Ministry KI III 1 based on Working Party on Renewable Energy Statistics (AGEE-Stat); 1 GWh = 1 million kWh; 1 MW = 1 million watts; provisional data, October 2011
Left-hand vertical axis, from top: GWh: 30 000 – 25 000 – 20 000 – 15 000 – 10 000 – 5 000 – 0
Right-hand vertical axis, from top: MW: 8 000 – 7 000 – 6 000 – 5 000 – 4 000 – 3 000 – 2 000 – 1 000 - 0

Fig. 5: Development of installed capacity and energy supply by hydropower use in Germany

5.5. Geothermal energy

Geothermal energy offers interesting prospects not only for heat supply but also for electricity generation. The first plant producing electricity from deep thermal energy went on stream in 2003. By 2010 there were a total of five plants with an installed capacity of 7.5 MW in all, but only two were supplying electricity – 27.7 GWh.

Other plants are currently in the planning or construction stage, particularly in southern Germany. However, given the long planning times a rapid expansion of installed capacity is not currently expected.

In May 2009 the Federal Government adopted its Report on a strategy for the promotion, development and marketing of electricity produced from geothermal energy and heat utilisation. It describes the status of geothermal energy use in Germany, analyses the steps taken by the Federal Government to improve the framework conditions, and makes recommendations for further action. It concludes that the measures taken to date by the Federal Government to promote geothermal energy use will greatly stimulate the market. The authorities have so far granted about 180 permits and authorisations to prospect for geothermal resources. EEG 2012 will further improve compensatory payment conditions.

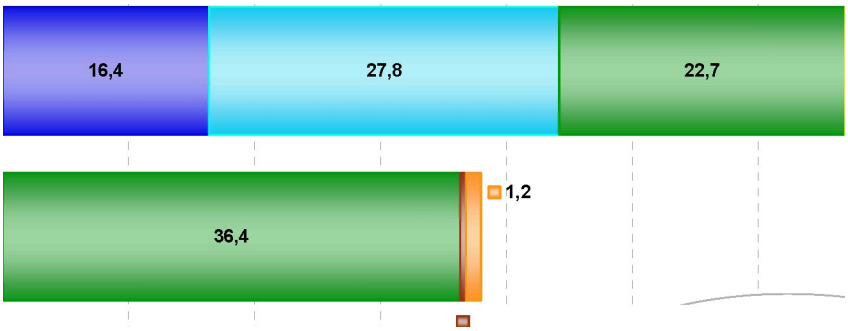
6 Changes in emissions avoidance resulting from the use of renewables in the context of national climate change commitments

The use of renewables in Germany avoids the use of the fossil fuels coal, oil and gas and thereby reduces emissions of CO_2 and other greenhouse gases. This emission reduction is making an important contribution to achieving Germany's climate change goals and is actively assisting efforts to meet the European Union's climate change targets.

In 2010 the use of renewables avoided a total of about 118 million tonnes CO_2 equivalent greenhouse gas emissions of which CO_2 accounted for 115 million tonnes. Electricity

supplies from renewables accounted for the major proportion of the emission reduction, about 75 million tonnes CO_2 equivalent, with 57 million tonnes attributable to the impact of the EEG. This has become one of the most important climate change pillars in Germany.

Figure 6 provides an overview of total greenhouse gas emission avoidance through the use of renewables, broken down into electricity, heat and fuels, for 2010.



Strom/electricity 74.9 Mt
Wärme/heat 38.0 Mt
Kraftstoffe/fuels 5.0 Mt
Gesamt/total: ca. 118 Mt CO_2 eq.,
davon/of which ca. 57 Mt CO_2 eq. avoided through EEC-compensated electricity
0 10 20 30 40 50 60 70 80
THG-Vermeidung/greenhouse gas avoidance [Mt CO_2 eq.]
• **Hydropower Wind Biomass Photovoltaics Geothermal Solar thermal Biofuels**
THG: Greenhouse gases; discrepancies in the totals are the result of rounding-off; deep geothermal energy is not shown because of the small amounts of electricity produced; Source: Federal Environment Ministry based on Working Party on Renewable Energy Statistics (AGEE-Stat); provisional data, October 2011

Fig. 6: Total CO_2 avoidance through the use of renewables in Germany, 2010

Table of figures

Fig. 1: Structure of electricity production from renewables in 2010 in Germany

Fig. 2: Development of installed capacity and electricity production from wind energy in Germany

Fig. 3: Electricity production from total biomass in Germany

Fig. 4: Development of installed capacity and energy supply from solar energy use in Germany

Fig. 5: Development of installed capacity and energy supply by hydropower use in Germany

Fig. 6: Total CO_2 avoidance through the use of renewables in Germany, 2010

Annex:

Advance copy of the Federal Environment Ministry publication “Renewable Energy Sources in Figures – National and International Development”