

Renewable Energy – Predictions and Reality

Comparison of forecasts and scenarios with the
actual development of renewable energy sources
Germany – Europe – the world

Report
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“Germany has endless energy”
Prof. Dr. Klaus Töpfer

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Bundesministerium für Ernährung,
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1. Introduction and methodology

Energy forecasts provide important information for political decision-making processes. They are of great importance for the development of renewable energy sources because appropriate framework conditions for fully exploiting renewable energy potential need to be created. Forecasts that are too low can hamper the development dynamic of renewable energy sources. This is especially the case if important decisions are not taken, such as extending energy networks or making timely adaptations to power plant facilities. Energy forecasts, therefore, play a central role in the sustainable development of the energy supply. They need to be updated constantly in order to appropriately map out current and future growth rates of renewable energy sources.

This report evaluates 50 forecasts from recent decades and compares the predicted progression of renewable energy sources with actual developments in Germany, Europe and the world. Almost all the forecasts examined underestimated the percentage of energy consumption actually covered by renewable energy sources. In many cases, renewable energy sources reached the predicted values several years earlier than planned, and surpassed these by several hundred percent.

Our analysis is based on the following selection criteria:

- The study examines development forecasts which map out the extended economic potential of renewable energy sources¹.
- Studies which only refer to theoretical or technical potential are not taken into account.
- In addition to trend scenarios, alternative scenarios are also included which are subject to certain assumptions and objectives, such as increased promotion of renewable energy sources.
- The most important forecasts from scientific and political institutions as well as associations in the energy sector are analysed.

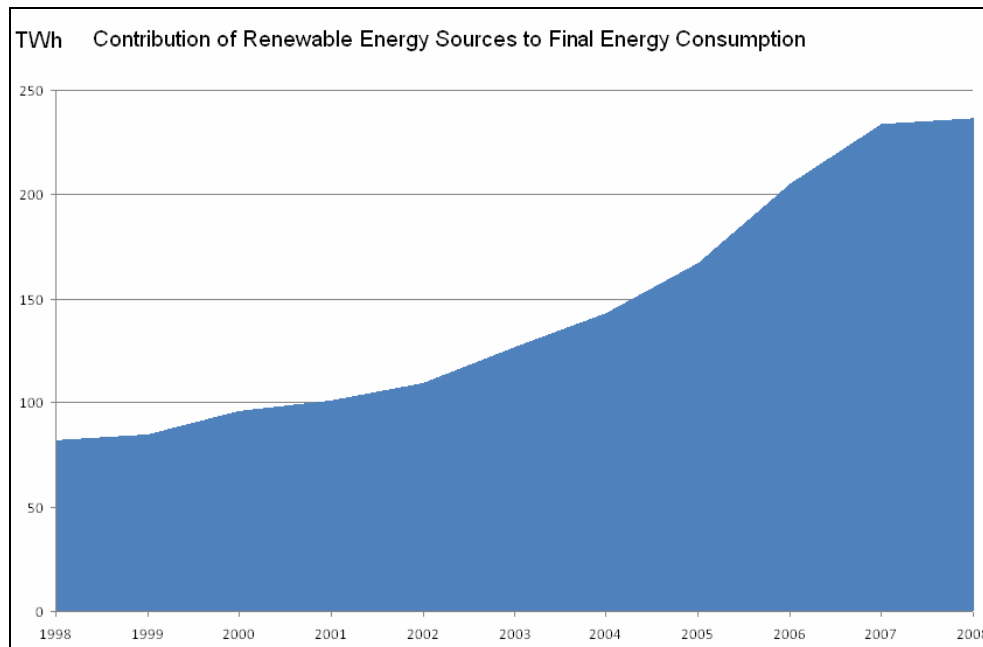
¹ The extended economic potential is the portion of technical potential which one arrives at if total costs (investment, operations and waste removal) for converting energy from a renewable energy source are calculated - taking into account potential promotion instruments - and if these costs lie within the same spectrum as the total costs for competing systems. Cf. Piot 2007.

In addition to the evaluation of scientific studies, this report also contains statements from the world of politics and associations in Germany on the development potential of renewable energy sources.

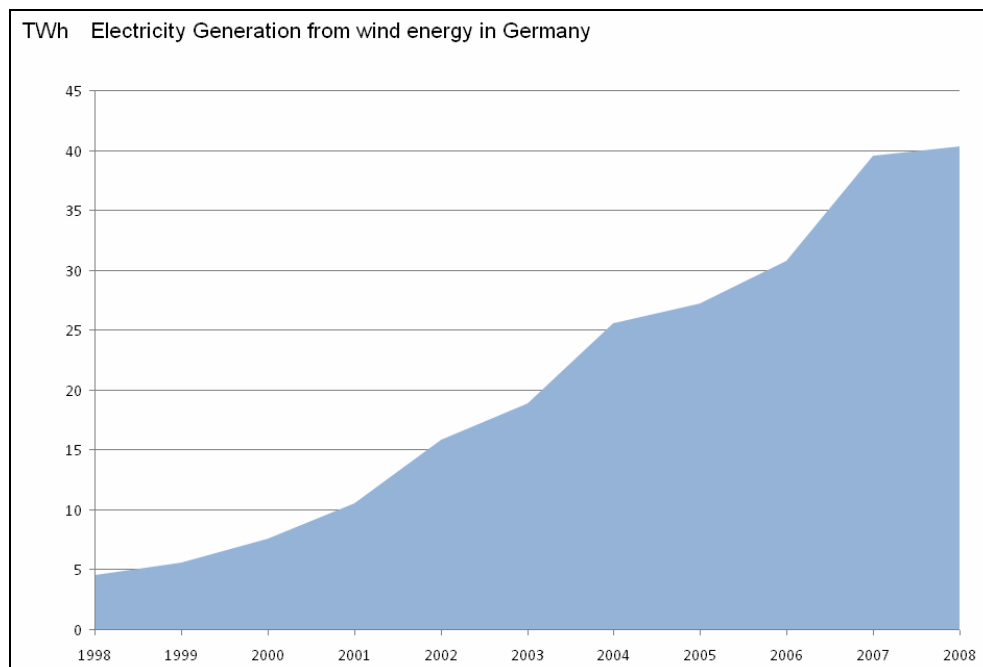
2. The reality – the actual development of renewable energy sources in Germany, Europe and the world

The following graphs demonstrate the high-paced development of renewable energy sources in Germany, Europe and the world within the last ten years:

- The contribution of renewable energy sources to final energy consumption in Germany has tripled.
- The electricity generation from wind energy in Germany has increased by a factor of ten.
- The electricity generation from photovoltaics in Germany has increased more than a hundredfold.
- The supply of electricity, heat and fuels from bioenergy in Germany has tripled.
- The installed capacity of wind energy across the globe has increased by a factor of twelve in the last decade.



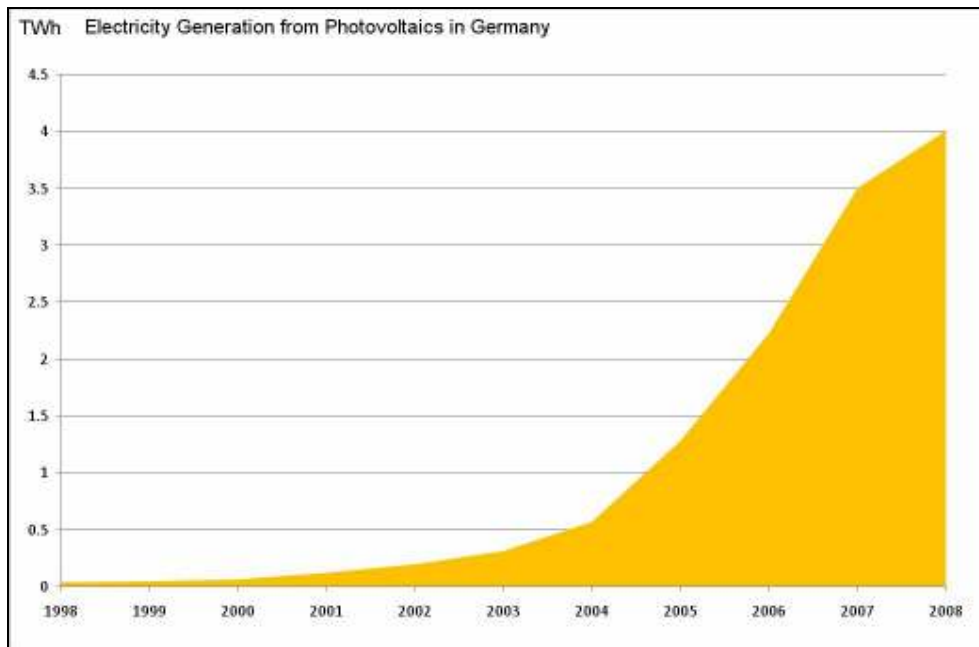
Graph 1: The contribution of renewable energy sources to final energy consumption has tripled in Germany within the last 10 years from 82 to 238 terawatt hours (TWh)².



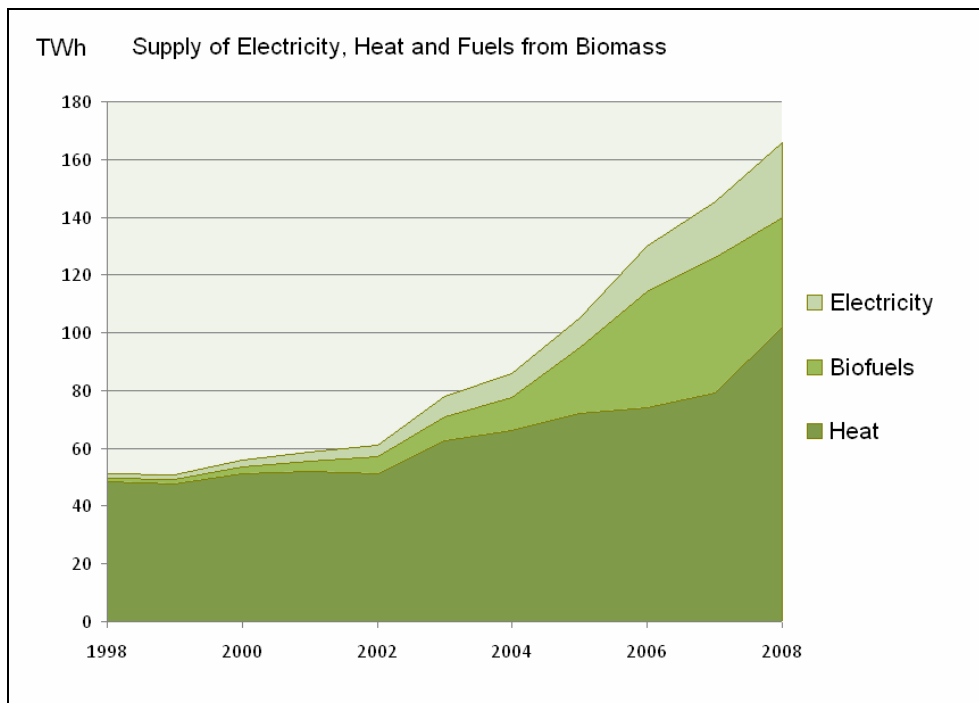
Graph 2: The electricity generation from wind energy has increased by a factor of 10 over the last 10 years from 4 to 40 TWh³.

² Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) 2008. German Renewable Energy Federation (BEE) 2008.

³ *ibid.*



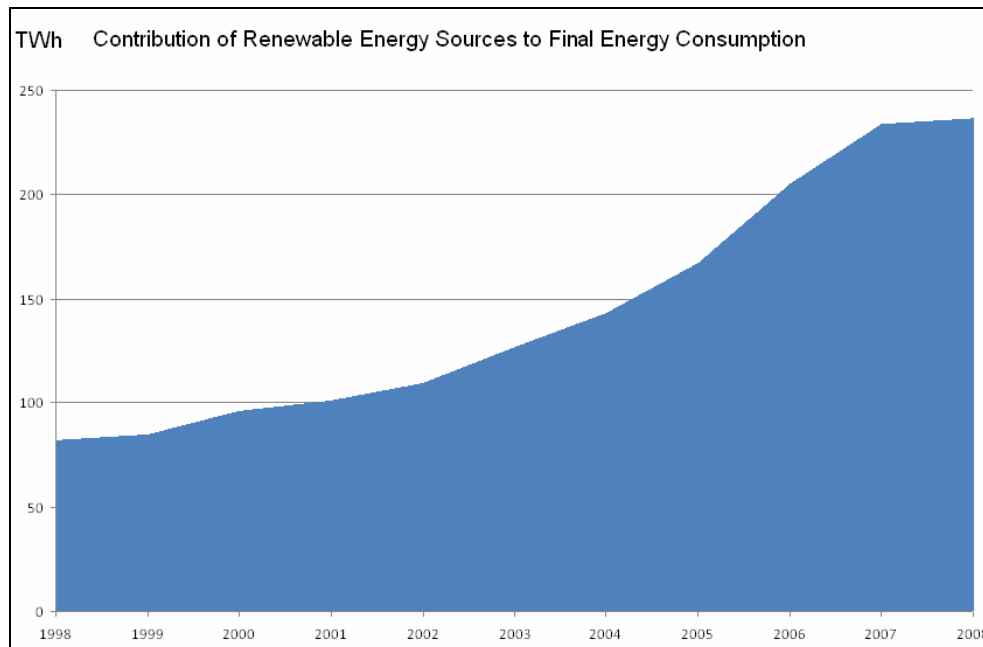
Graph 3: The electricity generation from photovoltaic systems has increased by a factor of 100 in the last 10 years (from 0.03 to 4 TWh⁴).



Graph 4: The supply of electricity, heat and biofuels from bioenergy has tripled in the last 10 years from 51 to 166 TWh⁵.

⁴ ibid.

⁵ ibid.



Graph 5: The installed wind energy output has increased by a factor of 12 in the last 10 years (from 9,700 to 122,000 MW)⁶.

3. The forecasts – development of renewable energy sources in Germany

3.1 Evaluation of scientific forecasts

The oil crisis in 1973 led to the world's first research and support programmes for renewable energy sources. Together with these research activities, the first forecasts on the development of renewable energy sources were also made at this time. With the exception of just a few studies, almost all forecasts in recent decades hugely underestimated the development of renewable energy sources (see Table 1; Graph 4).

Of the 50 forecasts evaluated by this report, almost all predicted too small a contribution of renewable energy sources to the overall energy supply. The few studies that overestimated the future share of energy from renewable sources assumed an unrealistic rise in energy related prices until the year 2000 and stronger support by promotion

⁶ World Wind Energy Association (WWEA) 2008. EurObserv'ER 2008: Wind Energy Barometer.



instruments. Since these assumptions did not materialise by the year 2000, the early optimistic scenarios from the 1980s did not come about.

The greatest differences between the forecasts and the reality of renewable energy development in Germany are from the studies by Prognos AG, carried out on behalf of the Federal Ministry of Economics and Technology. For example, the actual use of renewable energy sources in the year 2000 was nearly three times as high as the forecast made in 1998. Furthermore, the expected electricity supply from renewable energy sources in 2020 was already surpassed in 2007. But even the forecasts carried out on behalf of the Federal Ministry for the Environment and the German Federal Environment Agency in recent decades fell short of the mark concerning the actual development of renewable energy sources.

These forecasts not only underestimated the development potential of renewable energy sources, but also completely failed to take certain technologies into account. The Prognos study from 1985, for example, only saw development potential for hydro power, firewood, sewage sludge and waste and did not take into account the potential of “new” renewable energy technologies. Therefore, according to this forecast, wind energy, photovoltaic technology, biogas, geothermal energy, solar thermal energy and biofuels could not make any contribution to the energy supply.

The studies that followed only gradually started to take into account the breadth of the technology options available in terms of renewable energy sources. The differences between forecasts and the reality of “new” renewable energy sources are particularly striking. The Prognos study from 1998, for example, estimated that electricity generation from photovoltaic systems would be 0.44 TWh by 2020 - whereas photovoltaics were already generating ten times as much electricity in Germany by 2008.

The Prognos study from 2005 is also far removed from reality. The predicted values for 2030 regarding the generation of electricity from bioenergy and photovoltaics and for heat generation from renewable energies were already reached in 2007, just two years after the study was published. The predicted production of biofuels for 2020 was also already surpassed in 2007.



Renewable energy forecasts for Germany

Year of the forecast	Author/ Commissioning body	Energy type / reference parameters	Forecast target year ⁷	Predicted terawatt hours	Actual energy supply in TWh for the forecast year	Deviation between reality and the forecast
1980	Öko Institut: Energy Revolution: "Sun and coal" scenario	RE overall (PEC ⁸)	2010	516	377 (2008)	2010 forecast will not be met
1982	Kernforschungsanstalt Jülich (KFA ⁹)	RE overall (FEC ¹⁰)	2000	201	96	-52%
1984	Prognos (upper variant) ¹¹ ; Commissioned by the Federal Ministry of Economics	RE overall (FEC)	2000	35	96	+174%
1984	Fraunhofer-Institut für Systemtechnik und Innovations- forschung (Fraunhofer ISI) / Deutsches Institut für Wirtschaftsforschung (DIW); Commissioned by the Federal Ministry of Economics ¹²	RE overall (FEC)	2000	118	96	-18%
1990	Öko Institut: The green energy revolution scenario 2010 ¹³ ; Commissioned by Bündnis 90/die Grünen, Böll-Stiftung	RE - electricity	2010	77	91 (2008)	2010 forecast already surpassed in 2007
1993	Deutsches Institut für Luft- und Raumfahrt (DLR): Geo-Studie	EE overall (FEC)	2005	106	168	+58%
1995	Verband der Elektrizitäts- wirtschaft (VDEW ¹⁴)	RE - electricity (percentage of total electricity generation)	2005	Max. 6%	10.40%	+73%
1995	Inquiry Commission "Schutz der Erdatmosphäre" ('Protecting the Earth's Atmosphere'); Reference scenario	RE overall (PEC, substitution method)	2020	175	377 (2008)	2020 forecast already surpassed in 2003
1995	Inquiry Commission	RE overall (PEC,	2020	196	377 (2008)	2020 forecast

⁷ For long-term forecasts with several time periods, the prediction year is given which has already been exceeded by actual developments.

⁸ Electricity, heat and fuels from renewable energy sources ('RE overall') measured in primary energy consumption (PEC).

⁹ Kernforschungsanstalt Jülich – Atomic Research Center Jülich, 1982. Quoted in Fischer / Häckel 1987.

¹⁰ Electricity, heat and fuels from renewable energy sources ('RE overall') measured in final energy consumption (FEC).

¹¹ The forecast from Prognos AG only takes into account the use of hydro power, fire wood, sewage sludge and waste.

¹² The "positive variant" scenario assumes a significant increase in energy prices (real increase of 2% until 1990, 4% per annum from 1990 onwards). However, real oil prices between 1980 and 2000 actually decreased significantly. Study: Fraunhofer Institute for Systems and Innovation Research / German Institute for Economic Research, 1984: Estimating the potential of renewable energy sources. Quoted in: Hauf 1986.

¹³ The predicted electricity generation from renewable energy sources for 2010 was already surpassed by more than 10 TWh in 2007. Fritsche / Kohler 1990.

¹⁴ Quoted in: *Die Welt*: "Sanfte Energie gewünscht", 23 August 1995.



Year of the forecast	Author/ Commissioning body	Energy type / reference parameters	Forecast target year ⁷	Predicted terawatt hours	Actual energy supply in TWh for the forecast year	Deviation between reality and the forecast
	"Schutz der Erdatmosphäre" ('Protecting the Earth's Atmosphere'); R1 scenario ¹⁵	substitution method)				already surpassed in 2004
1995	Inquiry Commission "Schutz der Erdatmosphäre" ('Protecting the Earth's Atmosphere'); R2 scenario ¹⁶	RE overall (PEC, substitution method)	2020	300	377 (2008)	2020 forecast already surpassed in 2006
1996	Öko Institut: Energy revolution scenario 2020; Commissioned by Bündnis 90 / Die Grünen, Böll-Stiftung	RE overall (PEC, substitution method)	2015	387	377 (2008)	2015 forecast almost already met in 2008
1998	Wuppertal Institut (WI); Contribution of the construction and housing sector to climate protection: KE-0 scenario ¹⁷	RE overall (EEC) without import of electricity from solar installations	2020	195	238 (2008)	2020 forecast already surpassed in 2006
1998	Nitsch / Luther et al: long-term solar scenario ¹⁸	RE overall (PEC, substitution method)	2010	216	377 (2008)	2010 forecast already surpassed in 2004
1998	Prognos: Possibilities for stimulating renewable energy sources; Commissioned by the Federal Ministry of Economics and Technology	Re overall (FEC)	2020	144	238 (2008)	2020 forecast already surpassed in 2005
		RE -electricity	2020	85	91 (2008)	2020 forecast already surpassed in 2007
		RE - heat	2020	59	109 (2008)	2020 forecast already surpassed in 2003
1998	Fraunhofer ISI: Delphi survey; Commissioned by the Federal Ministry of Education, Science, Research and Technology	RE - electricity, without hydro power (share of renewables in electricity generation)	2020	10%	11.5% (2008)	In 2007, 10% of all electricity was generated by renewable sources (excluding hydro power)
1999	Federal Ministry for the Environment (BMU) / Federal Environment Agency (UBA): Climate protection study	RE overall (FEC)	2010	82	238 (2008)	2010 forecast already reached in 2003
2000	Öko Institut: Energy Revolution 2020; scenario	RE - electricity	2015	86	91 (2008)	2015 forecast already reached

¹⁵ Assumption of scenario R1: CO₂ reduction by 45% compared to 1990. Quoted in DLR 2000.

¹⁶ Assumption of scenario R2: Withdrawal from nuclear power by 2005, CO₂ reduction by 45% compared to 1990. Quoted in DLR 2000.

¹⁷ Assumption of scenario KE-0: withdrawal from nuclear power by 2010 and a CO₂ reduction of 50% compared to 1990. Quoted in DLR 2000.

¹⁸ Assumption of the scenario: CO₂ reduction of 80% by 2050.

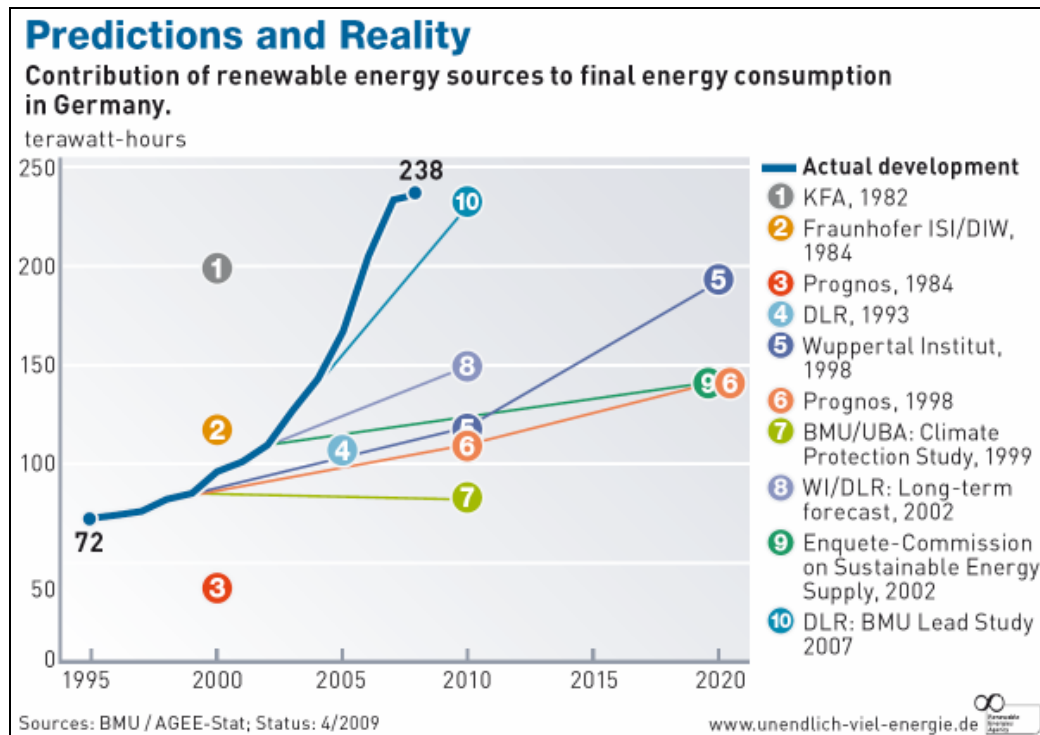


Year of the forecast	Author/ Commissioning body	Energy type / reference parameters	Forecast target year ⁷	Predicted terawatt hours	Actual energy supply in TWh for the forecast year	Deviation between reality and the forecast
	'politics'; Commissioned by the Heinrich-Böll Stiftung					in 2006
2000	Öko Institut: Energy Revolution 2020; scenario 'potential'; Commissioned by the Heinrich-Böll Stiftung	RE - electricity	2015	97	91 (2008)	2015 forecast is expected to be surpassed in 2009
2000	Deutsches Institut für Luft- und Raumfahrt (DLR), Potential and perspectives; Commissioned by the Office of Technology Assessment at the German Parliament	RE - electricity	2015	80	91 (2008)	2015 forecast was already surpassed in 2007
2002	Inquiry Commission "sustainable energy supply" Reference scenario	RE overall (FEC)	2020	143	238 (2008)	2020 forecast was already surpassed in 2005
2002	Inquiry Commission "sustainable energy supply" scenario: REG-/REN offensive	RE overall (FEC)	2010	181	238 (2008)	2010 forecast already surpassed in 2006
		Electricity from photovoltaic systems	2030	1.4	4 (2008)	2030 forecast already surpassed in 2006
2002	WI / DLR: Long-term scenarios; Commissioned by the Federal Environment Agency	RE overall (FEC)	2010	150	238 (2008)	2010 forecast already surpassed in 2005
		RE - electricity	2015	108	91 (2008)	2010 forecast is expected to be reached in 2010
		RE - heat	2010	63	109 (2008)	2010 forecast already surpassed in 2004
2004	DLR, ifeu, WI: Ecologically optimised development of the use of renewable energy in Germany; Commissioned by the Federal Ministry for the Environment	RE overall (PEC)	2010	181	276 (2008)	2010 forecast already surpassed in 2005
2005	Prognos IV; Commissioned by the Federal Ministry of Economics and Technology	RE overall (PEC)	2015	265	276 (2008)	2015 forecast already surpassed in 2007
		Electricity from bioenergy	2030	22	23 (2007)	2030 forecast already surpassed in 2007
		Electricity from photovoltaics	2030	2.6	3.1 (2007)	2030 forecast already surpassed in 2007
		RE - heat	2030	103	100 (2007)	2030 forecast



Year of the forecast	Author/ Commissioning body	Energy type / reference parameters	Forecast target year ⁷	Predicted terawatt hours	Actual energy supply in TWh for the forecast year	Deviation between reality and the forecast
						already nearly reached in 2007
		Solar heat	2030	5.3	5.3 (2008)	2030 forecast already surpassed in 2008
		Biofuels	2020	42	46.4 (2007)	2020 forecast already surpassed in 2007
2005	DLR, WI et al: Development of renewable energy sources in the electricity sector by 2020; Commissioned by the Federal Ministry for the Environment	RE - electricity	2010	85	87 (2007)	2010 forecast already surpassed in 2007
2006	Bundesverband Erneuerbare Energie (BEE) ('Federal Association for Renewable Energy')	RE overall (share in FEC)	2010	9%	9.8% (2007)	2010 forecast already surpassed in 2007
2007	DLR: pilot study 2007; Commissioned by the Federal Ministry for the Environment	RE overall (FEC)	2010	236	238 (2008)	2010 forecast already surpassed in 2008

Table 1: Selected forecasts on the development of renewable energy sources in Germany.



Graph 6: Contribution of renewable energy sources to final energy consumption in Germany.

3.2 Statements on the development potential of renewable energy sources from the world of politics and the energy industry

Scientists are not the only ones who have significantly underestimated the development possibilities of renewable energy sources in recent decades. Politicians and industry associations from the energy sector have also done the same. It was claimed for a long time that renewable energy sources could only cover a small percentage of energy consumption. For example, the *Informationskreis Kernenergie* (Nuclear Power Forum) claimed in an advertisement in 1990 that wind energy could never provide more than one percent of the electricity supply in Germany because of the country's climatic conditions.

It is not only the development potential of renewable energy sources that has been significantly underestimated; the use of certain technologies such as the electricity generation from solar energy was even considered technically impossible. The most recent statements on solar electricity generation in Germany by a board member of *Energie Baden-Württemberg* (EnBW), Hans-Peter Villis, underestimate its development. In an



interview with the *Süddeutsche Zeitung*, he explains that solar electricity will only provide one percent of all electricity in 2020 because of insufficient sunlight. In 2008, however, solar power already provided a share of 0.7% of electricity consumption – and it is estimated that it will surpass the 1% mark in 2010¹⁹.

Recently published forecasts on the development of renewable energy sources show just as well considerable divergences. The Federal Ministry of Economics presented a “vision for electricity supply” for 2030 in its brochure “A secure, affordable and environmentally friendly electricity supply in Germany – can this be done without nuclear power?”. In this scenario, renewable energy sources will provide a share of 33% of electricity consumption until 2030. This view stands in stark contrast to the mid-term forecast of the *Bundesverband der Energie- und Wasser-Wirtschaft BDEW* (‘Federal Association of the Energy and Water Industries’), which expects renewable energy sources to supply more than 28% of electricity consumption as early as 2014²⁰. If increased efficiency causes consumption to decrease by 2030, 33% of electricity consumption being met by renewable energy sources would mean a stagnation in their development after 2014.

Year of the forecast	Author/ Commissioning body	Energy type / reference parameters	Forecast target year	Predicted value	Current situation
2008	Federal Ministry for Economics and Technology (BMWi)	RE - electricity (share of overall electricity generation)	2030	33%	91.4 TWh or 15% (2008)
2008	Bundesverband der Energie- und Wasser- Wirtschaft BDEW (‘Federal Association of the Energy and Water Industries’): Erneuerbare-Energien-Gesetz (‘Renewable Energy Sources Act’) mid-term forecast.	RE - electricity (share of electricity consumption)	2014	156 TWh - only electricity pursuant to the Erneuerbare-Energien-Gesetz (‘Renewable Energy Sources Act’)	91.4 TWh or 15% (2008)
2009	Bundesverband Erneuerbare Energie (‘German Renewable Energy Federation’): Industry forecast: Power supply 2020	RE - electricity (share of electricity consumption)	2020	278 TWh (47%)	91.4 TWh (15%) (2008)

Table 2: Forecasts published in 2008 and 2009 on the development of renewables in Germany

¹⁹ *Süddeutsche Zeitung*: “Solartechnik wird uns nicht weiterhelfen” (‘Solar technology won’t get us any further’). EnBW CEO Hans-Peter Villis on brand strategies, the future of the power grid and renewable energy sources. 15 March 2009

²⁰ By 2014, the BDEW expects 156 TWh of electricity from renewable energy sources to be paid pursuant to the Erneuerbare-Energien-Gesetz (EEG/ ‘Renewable Energy Sources Act’). A further 20 TWh of electricity is expected which does not fall under the Renewable Energy Sources Act (hydro power facilities with an output of more than 5 MW, biomass facilities with more than 10 MW output, proportion of biogenic waste in waste incinerators). With a marginal increase in electricity consumption until 2014 (620 TWh compared to 617 TWh in 2008), the percentage of renewable energy sources will have reached a share of 28%.



Past forecasts from the renewable energy associations have also underestimated their growing contribution to energy supply. For example, the forecast for 2010 from the *Bundesverband Erneuerbare Energie (BEE)* ('Federal Association for Renewable Energy') concerning the share in total final energy consumption provided by renewable energy sources was already surpassed in 2007, one year after publication. In an analysis from 2009, the *Bundesverband Erneuerbare Energie* and the *Agentur für Erneuerbare Energien* ('Renewable Energies Agency') are predicting that 47% of electricity will be supplied by renewable energy sources by 2020.

Selected quotes

1976: Interview with Hans Matthöfer, then Federal Minister for Research (SPD)

"The generation of electricity from the sun's energy in the Federal Republic of Germany has thus far been described by reputable specialists as 'not yet economically and ecologically possible.'"

Die Zeit, No. 37, 3 September 1976

<http://www.zeit.de/1976/37/lch-glaube-nicht>

1977: Interview with Professor Hans Karl Schneider, then head of the Institute for Energy Economics at the University of Cologne (EWI) and former chairman of the Scientific Advisory Council of the Federal Ministry of Economics as well as the German Council of Economic Experts.

Die Zeit – Question: "In your scenario, what percentage could be reached by alternative energy sources which are not based on fossil fuels or nuclear energy?"

Schneider: "I hope a very high percentage. 'Very high', however, realistically means two to three percent of total energy requirements in the 1980s – perhaps a little bit more by the year 2000. Solar energy, wind energy, geothermal energy and other 'exotic' energy sources simply cannot provide more than five percent."

Die Zeit, No. 25, 10 June 1977



1977: CDU policy document excerpts

“New technologies: they need to be ready on time before fossil fuels become scarce. Solar energy can only be used for heating. Wind energy can make a small contribution to the power supply. Geothermal energy can only cover about one percent of overall energy consumption.”²¹

Die Zeit, No. 42, 7 October 1977

1990: Advert from *Informationskreis Kernenergie* (‘Nuclear Power Forum’)

“‘Electricity from Wind’ – Yes, but...

The Danes are the European front-runners in the use of wind energy: in 1988, nearly one in every hundred kilowatt hours was generated by wind energy – that corresponds to 0.9% of overall electricity consumption. Such an intensive use of wind power is not possible in Germany due to its climatic conditions. In 1989, wind energy only covered 0.03% of overall electricity consumption. We therefore continue to be dependent on other environmentally friendly forms of electricity generation, such as nuclear energy, which currently makes up 40% of electricity generation.

Questions on nuclear energy will be gladly answered by:
Informationskreis Kernenergie, Heussallee 10, 5300 Bonn 1,
0228/507226”

Die Zeit, No. 26, 22 June 1990

²¹ The Office of Technology Assessment (TAB) at the German Parliament identified a technical overall potential for geothermal electricity generation of 300,000 TWh, which corresponds to about 600 times Germany’s annual electricity consumption. The additional potential of thermal energy (heat in cogeneration – combined heat and power) amounts to 600 times Germany’s annual heat requirements if heat pumps are used. TAB 2003.



1993: Advertisement “Your Electricity Providers”

**Wer kritisch fragt,
ist noch längst kein
Kernkraftgegner.**



Viele junge Leute empfinden Kernkraftwerke als bedrohlich. Wir, die deutschen Stromversorger, haben Ihre Kritik nie leichtfertig abgetan. Im Gegenteil: Wir stellen uns denselben Fragen, die Sie bewegen.

Kann Deutschland aus der Kernenergie aussteigen? Ja. Die Folge wäre allerdings eine enorme Steigerung der Kohleverfeuerung, mit allen den Emissionen des Treibhausgases CO₂. Denn **keine erneuerbare Energie wie Sonne, Wasser oder Wind können auch langfristig nicht mehr als 4 % unseres Strombedarfs decken.**

Können wir ein solches Vorgehen verantworten? Nein. Der steigende Energiebedarf der dritten Welt verpflichtet die reichen Staaten, ihre CO₂-Emissionen zu mindern.

Schaffen wir das ohne Kernkraft, alles durch Energie sparen? Nein. Kernkraftwerke liefern 34 % des deutschen Stroms und ersparen der Atmosphäre jährlich 160 Mio. Tonnen CO₂ – bei einem international verbindlichen Sicherheitsstandard. Also: Treibhaus oder Kernkraft? Das ist hier die Frage!

Viele junge Leute stellen kritische Fragen. Wir auch. Denn unsere schärfsten Kritiker sind wir selbst.

Ihre Stromversorger

Niederrhein Karlsruhe - Bayernwerk München - CVS Stuttgart - Inn-Allgemeine München - Netze Bayern Gulligan - PreussenerStrom Hannover - RWE Energie Essen - TWS Gulligan - VEW Dortmund

“Those who ask critical questions are not automatically against nuclear energy.

Many young people feel threatened by nuclear energy. We, the German electricity providers, have never simply dismissed your criticisms. On the contrary: we ask ourselves the same questions that concern you. Can Germany phase out of nuclear energy? Yes. The consequences would, however, be an enormous rise in the burning of coal, along with the emission of the greenhouse gas CO₂. This is because renewable energy sources such as solar power, hydro power or wind energy cannot provide more than 4% of our electricity requirements in the long-term. Can we take responsibility for such a course of action? No. The rising energy requirements of the third world obligate rich countries to reduce their CO₂ emissions. Can we do that without nuclear power, just by reducing energy consumption? No. Nuclear power stations provide 34% of German electricity and prevent 160 million tonnes of CO₂ from being emitted into the atmosphere every year – with internationally exemplary safety standards. So, should we be choosing greenhouse gases or nuclear



power? That is the question! Many young people ask critical questions. We do too, because we are our own fiercest critics. Your electricity providers.

26 June 1993

1995: *Verband der Elektrizitätswirtschaft (VDEW)* ('Association of the Electricity Industry') – forecasts up to the year 2005

“Bonn/Bochum – The percentage of German electricity generation from renewable energy will increase from 4.7% (1994) to a maximum of 6% by 2005.”

Die Welt: Sanfte Energie gewünscht ('Gentle Energy Wanted'), 23 August 1995.

2000: Dr. Rolf Linkohr, Member of the European Parliament

“The conditions vary from country to country. In Sweden, Austria and Finland, renewables have a share of over 20%, whereas in Belgium and Britain they make up less than 3%. Even Germany, with just 2.3%, has an astoundingly low rate. This will increase to 4.4% by 2020 when the measures that the Federal government has now taken come into effect. That is nice, but nothing more.”

Dr. Rolf Linkohr MEP: What consequences does the Kyoto obligation have for the transport sector? Conference “*Erneuerbare Energien 2000*” ('Renewable Energy Sources 2000'), Böblingen, 18 February 2000.

2004: Energy programme of the FDP parliamentary group in the German Parliament

“Renewable energy sources still play a small role today. Nevertheless, their use in regions with suitable climate conditions is particularly sensible.”

Resolution of the Bundestag parliamentary group of 10 February 2004
(http://files.liberale.de/wechsellexikon_liberale-Umwelt-und-Energiepolitik.pdf)

2005: Dr. Angela Merkel, Federal Chancellor, then chairperson of the CDU/CSU parliamentary group in the *Bundestag*

“Increasing the share of electricity consumption covered by renewable energy sources to 20% is unrealistic. I believe it is unrealistic to expect renewable energy sources to be able to fill a gap such as the one that would be made by the early exit from nuclear power.”

Dr. Angela Merkel, Speech on VDEW Congress, Berlin, 8 May 2005



4. Forecasts concerning Europe and the World

Even in Europe and around the world, renewable energy sources have grown considerably faster than predicted. The forecasts of the European Union (EU) and the International Energy Agency (IEA) deviate considerably from actual developments. A particularly clear example of this is the "PRIMES" forecast up to 2020, which was made in 1994. The energy generation by renewable energy sources in 2008 is already significantly higher than the predicted values for 2020. Wind energy is 36% above the predicted value, with bioenergy 26% higher, and solar energy even 15 times higher. In the "PRIMES" forecast there is no mention of solar power or biofuels production in the year 2020. However, the installed output of photovoltaic systems in Europe was 10 Gigawatts in 2008, and biofuel production stood at 7.7 million tonnes in 2007.

Further studies demonstrate similarly large deviations. For example, in 2004 the wind energy use in Europe was already higher than the value predicted for 2020 in the "Advanced Scenario" forecast by the European Union in 1996. But even the European Wind Energy Association (EWEA) considerably underestimated the speed of wind energy development (see Graph 8).

The forecasts have not become more reliable even as the significance of renewable energy sources has increased. The global development of wind energy has been growing by an average of 30% a year for more than ten years. These huge growth rates nevertheless fail to be reflected in the IEA forecasts. In the World Energy Outlook in 2002 the IEA expected an increase in wind energy capacity to 100,000 MW by 2020. Actual installed capacity already surpassed this value by 20% in 2008, just a few years after the forecast was published.



Renewable energy forecasts for Europe

Year of the forecast	Author/ Commissioning body	Geographical scope of the forecast	Energy type	Forecast target year	Forecast	Actual result for the forecast year	Deviation between reality and the forecast
1990	European Wind Energy Association (EWEA)	EU-15	Wind	2000	4,089 MW	12,887 MW	+215%
1996	European Commission: Baseline scenario ²²	EU-15	Wind	2007	6,799 MW	56,535 MW	+732%
1996	European Commission: Advanced scenario	EU-15	Wind / solar (electricity)	2020	30,280 MW	73,504 MW (2008)	2020 forecast already reached at the beginning of 2004
1997	EWEA ²³	EU-15	Wind	2000	8,000 MW	12,887 MW	+61%
		EU-15	Wind	2007	23,709 MW	56,535 MW	+138 %
1997	European Commission White Paper ²⁴	EU-15	Wind	2010	40,000 MW	64, 173 MW (2008)	2010 forecast already reached in 2005
		EU-15	Photovoltaics	2010	3,000 MW	9,331 MW (2008)	2010 forecast already reached by 2007 in Germany alone
		EU-15	Solar heat	2010	100 million m ²	22,33 million m ² (2007)	2010 forecast will not be met
		EU-15	Geothermal (electricity)	2010	1,000 MW	856.8 MW (2007)	2010 forecast will nearly be met ²⁵
		EU-15	Geothermal (heat pumps)	2010	2,500 MWth	7,064 MWth (2006)	2010 forecast already surpassed twice over by 2005
1998	EWEA ²⁶	EU-15	Wind	2007	36,378 MW	56,535 MW	+55%
1998	European Commission: PRIMES ²⁷	EU-15	Wind	2010	22,600 MW	64,173 MW (2008)	2010 forecast already reached in 2002
		EU-15	Wind	2020	47,100 MW	64,173 MW (2008)	2020 forecast already reached in 2007
		EU-15	Solar heat	2020	10,440 MWth	10,110 MWth (2007)	2020 forecast already nearly reached in 2007
		EU-15	Biomass	2010	609 TWh	833 TWh (2006)	2010 forecast already reached in 2001
		EU-15	Biomass	2020	657 TWh	833 TWh	2020 forecast

²² Quoted in: EWEA 2008: Pure Power. Wind Energy Scenarios up to 2030. p. 25

²³ Quoted in EWEA 2003.

²⁴ European Commission: Energy for the Future: Renewable Sources of Energy. White Paper for a Community Strategy and Action Plan. November 1997. p. 41

²⁵ In Italy, the development of installed output is planned to be approx. 100 MW in 2010. EurObserv'ER 2008: The State of Renewable Energies in Europe.

²⁶ Quoted in: EWEA 2003.

²⁷ PRIMES: quoted in EWEA, Response to the European Commission's Green Paper: Towards a European strategy for the security of energy supply. November 2001.



Year of the forecast	Author/Commissioning body	Geographical scope of the forecast	Energy type	Forecast target year	Forecast	Actual result for the forecast year	Deviation between reality and the forecast
						(2006)	already reached in 2003
1999	European Commission ²⁸	EU-15	Wind	2007	17,886 MW	56,535 MW	+216%
2002	Greenpeace / EWEA: Windforce 12	EU-15	Wind	2007	55,703 MW	56,535 MW	+1%
2002	International Energy Agency (IEA): World Energy Outlook	EU-15	Wind	2010	33,000 MW	64,173 MW (2008)	2010 forecast already reached in 2004
		EU-15	Wind	2020	57,000 MW	64,173 MW (2008)	2020 forecast already surpassed in 2008
		EU-15	Wind	2030	71,000 MW	64,173 MW (2008)	2030 forecast almost already reached in 2008
		EU-15	Geothermal (electricity)	2010	1,000 MW	856.8 MW (2007)	2010 forecast will probably be met ²⁹
		EU-15	Geothermal (electricity)	2020	1,000 MW	856.8 MW (2007)	2020 forecast will probably be surpassed ³⁰
		EU-15	Photovoltaics	2010	2,000 MW	9,331 MW (2008)	2010 forecast already reached in 2005
		EU-15	Photovoltaics	2020	4,000 MW	9,331 MW (2008)	2020 forecast already surpassed in 2007
2003	EWEA ³¹	EU-15	Wind	2007	48,286 MW	56,535 MW	+17%
		EU-15	Wind	2010	75,000 MW	64,173 MW (2008)	2010 forecast will probably be surpassed. ³²
2004	IEA: Alternative Policy	EU-25	Biomass	2020	882 TWh	971 TWh (2006)	2020 forecast already surpassed in 2005

Table 3: Forecasts for renewable energy sources in Europe

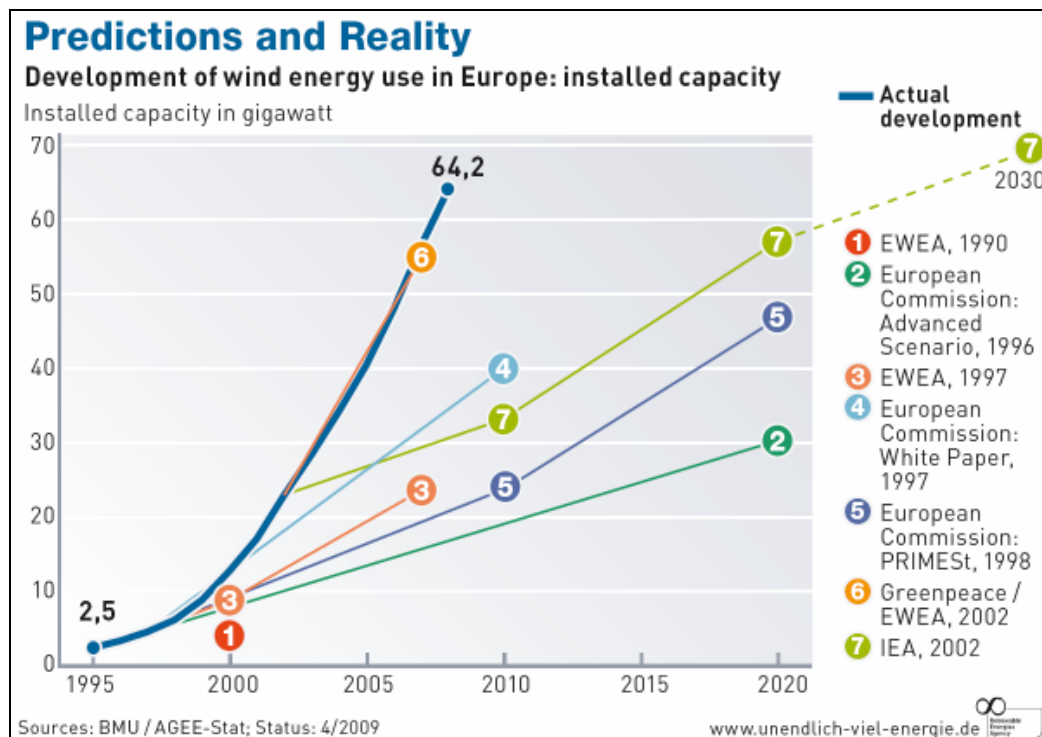
²⁸ Cf. EWEA 2008

²⁹ In Italy the development of installed output is planned to be around 100 MW by 2010. EurObserv'ER 2008: The State of Renewable Energies in Europe.

³⁰ A stagnation in the use of geothermal power in Europe after 2010 is not likely.

³¹ Cf. EWEA 2008

³² It is very likely that the annual growth rates in the development of wind energy in Europe will continue until 2010.



Graph 7: Development of installed wind energy capacity in Europe



Renewable energy forecasts worldwide

Year of the forecast	Author/ Commissioning body	Geographical scope of the forecast	Energy type	Forecast target year	Forecast	Actual result for the forecast year	Deviation between reality and the forecast
1976	Lovins ³³	USA	RE overall	2000	26%	7%	-370%
1995	International Energy Agency: World Energy Outlook, Energy Savings (electricity)	OECD countries	Geothermal	2010	105.4 TWh	38.76 TWh (2007)	2010 forecast will not be met
		OECD countries	Solar	2010	13.9 TWh	10 TWh world (2008)	2010 forecast will probably be surpassed
		OECD countries	Wind/tidal /other	2010	70.4 TWh	260 TWh (2008), only wind power	2010 forecast already reached in 2004
		OECD countries	Biomass	2010	173.7 TWh	171.19 TWh (2006)	2010 forecast already reached in 2007
1996	Department of Energy (DOE) / Energy Information Administration (EIA): Annual Energy Outlook	USA	Wind	2010	5,000 MW	25,170 MW (2008)	2010 forecast already reached in 2003
		USA	Wind	2015	12,000 MW	25,170 MW (2008)	2015 forecast already surpassed in 2007
1998	IEA: World Energy Outlook	OECD countries	Wind	2020	45,000 MW	97,304 MW (2008)	2020 forecast already surpassed in 2005
		OECD countries	Geothermal	2010	15,000 MW	6,157 MW (2007)	2010 forecast will not be reached
		OECD countries	Photovoltaics / tidal / other	2010	2,800 MW	Photovoltaic: 14,184 MW Tidal power: 260 MW (2008)	2010 forecast already reached in 2004
		OECD countries	Photovoltaics / tidal / other	2020	6,300 MW	Photovoltaic: 14,184 MW Tidal power: 260 MW (2008)	2020 forecast already reached in 2007
2000	IEA: World Energy Outlook ³⁴	World	Wind	2007	26,614 MW	93,881 MW (2007)	+253%
2000	DOE /EIA: Annual Energy Outlook	USA	Wind	2010	3,260 MW	25,170 MW (2008)	2010 forecast already surpassed in 2002
2002	IEA: World Energy Outlook ³⁵	World	Wind	2007	41,952 MW	93,881 MW	+124%
		World	Wind	2020	100,000 MW	121,188 MW (2008)	2020 forecast already surpassed in 2008
2004	IEA: World Energy Outlook; Reference ³⁶	World	Wind	2007	66.136 MW	93,881 MW	+42%
2004	IEA: World Energy Outlook;	World	Wind	2007	76,454 MW	93,881 MW	+23%

³³ Lovins A. 1976. The Road Not Taken. Foreign Affairs

³⁴ Quoted in: Rechsteiner 2008: Wind Power in Context. A Clean Revolution in the Energy Sector. p. 85.

³⁵ ibid.

³⁶ ibid.



Year of the forecast	Author/Commissioning body	Geographical scope of the forecast	Energy type	Forecast target year	Forecast	Actual result for the forecast year	Deviation between reality and the forecast
	Alternative						
2004	IEA: World Energy Outlook; Reference ³⁷	World	Wind	2007	73,031 MW	93,881 MW	+29%
2004	IEA: World Energy Outlook; Alternative	World	Wind	2007	73,559 MW	93,881 MW	+28%

Table 4: Forecasts on the development of renewable energy sources worldwide

5. Summary

This report evaluates German, European and global energy forecasts from the last few decades and compares the predicted levels with the actual development of renewable energy sources. The majority of the 50 forecasts examined underestimated the proportion of energy provided by renewable energy sources. Renewable energy sources often reached the predicted values several years in advance and surpassed these values by several hundred percent.

³⁷ ibid.

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