



Assessment of environmental and social impacts of the “KfW Renewable Energies Programme – Standard” for the year 2014

Evaluation commissioned by KfW Group

Summary Results

February 2016



Zentrum für Sonnenenergie- und Wasserstoff-Forschung
Baden-Württemberg (ZSW)
Industriestraße 6, D-70565 Stuttgart

Dr Peter Bickel

Email: Peter.Bickel@zsw-bw.de

Phone: +49 711 7870 244

Tobias Kelm

Email: Tobias.Kelm@zsw-bw.de

Phone: +49 711 7870 250

Stuttgart, 17 February 2016

Contents

List of Tables	IV
Abbreviations and explanations.....	V
1 Background.....	1
2 Loan volume, resulting investment volume and power installed.....	2
3 Estimated impacts	5
3.1 Savings in fossil fuel consumption and avoided energy costs for imported fossil fuels in Germany	5
3.2 Savings in greenhouse gas emissions	6
3.3 Savings in external costs through supported plants in Germany	6
3.4 Employment effects in Germany	8
4 Summary of effects.....	9

List of Tables

Table 1: Number and volume of loans as well as supported investment volume in the programme RE Standard for the year 2014.	2
Table 2: Volume of investment supported in the year 2014 by plant type.	3
Table 3: Installed electrical power supported in the year 2014 by plant type.....	3
Table 4: Investment volume and installed electrical power supported outside Germany in the year 2014 by plant type and country.	4
Table 5: Installed thermal power supported in the year 2014 by plant type.....	4
Table 6: Annual fossil fuel savings (primary energy) in Germany resulting from the use of renewables in plants supported by RE Standard in the year 2014.....	5
Table 7: Annual savings in energy costs for imported fossil fuels in Germany resulting from the use of renewables in plants supported by RE Standard in the year 2014.	6
Table 8: Annual savings in greenhouse gas emissions resulting from the use of renewables in plants supported by RE Standard in the year 2014 by location of plant.....	6
Table 9: Annual savings in air pollutant emissions resulting from the use of renewables in plants in Germany supported by RE Standard in the year 2014.	7
Table 10: Annual savings in external costs resulting from the use of renewables in plants in Germany supported by RE Standard in the year 2014.....	7
Table 11: Gross employment effects resulting from the use of renewables in plants in Germany supported by RE Standard in the year 2014.....	8
Table 12: Overview of evaluation results 2014 for the KfW programme RE Standard.....	9

Abbreviations and explanations

a	Year
CO ₂	Carbon dioxide
CO ₂ -equivalent	Unit used for measuring the global warming potential (i.e. the potential contribution to the warming of near-surface layers of the atmosphere) of a greenhouse gas in relation to the effect of CO ₂ . It states the quantity of CO ₂ that would have the same greenhouse effect as the gas in question over a period of 100 years. For instance, one kg of methane (CH ₄) has the same effect as 21 kg of CO ₂ .
GWh	Gigawatt hour; 1 GWh = 1 million kWh
KfW	KfW Group
kW	Kilowatts
kW _{el} / MW _{el}	Kilowatts/megawatts electrical power
kW _{th} / MW _{th}	Kilowatts/megawatts thermal power
kWh	Kilowatt hour
mill.	Million
MW	Megawatts; 1 MW = 1,000 kW
NMVOG	Non-methane volatile organic compounds
NO _x	Nitrous oxide
n.q.	Not quantified
RE	Renewable Energy
RE Standard	KfW Renewable Energies Programme – Standard
SO ₂	Sulphur dioxide
SO ₂ -equivalent	Unit used for measuring the acidification potential of an air pollutant in relation to the acidification potential of SO ₂ .
UBA	German Federal Environment Agency (Umweltbundesamt)
TWh	Terawatt hour; 1 TWh = 1,000 million kWh
VAT	Value added tax

1 Background

The targets set for reaching the German Energiewende are based on the German Federal Government's long-term strategy for future energy supply, according to which at least 60 % of final energy consumption and 80 % of electricity consumption ought to be covered with renewable energies by the year 2050. In combination with challenging energy efficiency targets, greenhouse gas emissions are to be cut by 80 to 95 % in relation to the base year 1990. By the year 2020, 18 % of final energy consumption and at least 35 % of electricity consumption are to be covered with renewable energy sources. Greenhouse gas emissions ought to be cut by 40 % compared to the year 1990.

The renewable energy promotional activities of KfW Group represent an important component for reaching the targets of the German Federal Government with respect to cutting greenhouse gas emissions by expanding the use of renewable energy sources. In the year 2014, the KfW promotional programmes supported a total investment in the construction of plants for using renewable energies of € 6.4 billion (of which € 1.9 billion in plants outside Germany). This means that in 2014, 33.5 % of the total investment in such plants in Germany was co-financed by KfW programmes (not considering offshore wind energy plants).

In order to review the effectiveness and significance of these activities in the year 2014, the resulting reductions in emissions of greenhouse gases and air pollutants, external costs, fossil fuel consumption and associated fossil fuel imports were assessed for plants built in Germany. Furthermore, impacts on employment in Germany were quantified. In addition, for plants built outside Germany greenhouse gas emissions avoided were estimated. The impacts of the "KfW Renewable Energies Programme – Standard" are summarised on the following pages. A detailed description (in German) of calculation approaches and results of all national renewable energy promotional activities of KfW Group can be found in the evaluation report¹.

¹ Bickel, P., Kelm, T., Edler, D.: Evaluierung der inländischen KfW-Programme zur Förderung Erneuerbarer Energien in den Jahren 2013 und 2014. Gutachten im Auftrag der KfW Bankengruppe, Stuttgart, Dezember 2015. <https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-alle-Evaluationen/Evaluierung-EE-2013-und-2014.pdf> (only available in German)

2 Loan volume, resulting investment volume and power installed

The KfW promotional programme “Renewable Energies – Standard” (RE Standard) was introduced on 1 January 2009 and supports the construction, extension or purchase of plants using renewable energy for producing electricity or combined electricity and heat production by granting low-interest loans. For the year 2014 the maximum loan per project amounted to €25 million.

In the year 2014, the volume of loan commitments totaled almost € 3.8 billion and triggered investments of € 5.9 billion. Thereof, € 1.0 billion and approx. € 1.9 billion respectively are attributable to renewable energy plants built outside Germany (see Table 1). The average investment per commitment amounted to € 1.2 million.

Table 1: Number and volume of loans as well as supported investment volume in the programme RE Standard for the year 2014.

Number of loan commitments	4,805
Volume of loan commitments (€million)	3,785.9
of which plants outside Germany (€million)	1,001.3
Investments financed (€million)¹⁾	5,909.1
of which plants outside Germany (€million)¹⁾	1,885.8
Average loan volume per commitment (€)	787,910
Average investment financed per commitment (€)¹⁾	1,229,780
Average share of financing	64 %

Totals may differ due to rounding.

¹⁾ excl. VAT.

Table 2 presents the supported investment volume split by plant type. Wind energy on-shore dominates the supported investment both in Germany (92 %) and outside Germany (77 %), followed by photovoltaic energy (7 % and 22 % respectively). Other plant types play only a marginal role.

Table 2: Volume of investment supported in the year 2014 by plant type.

		€million (excl. VAT)	%
Germany	Biogas ¹⁾	12.2	0.3
	Solid biomass	3.6	0.1
	Photovoltaic energy	280.1	7.0
	Solar thermal energy	0.02	0.0
	Hydropower	10.1	0.3
	Wind energy onshore	3,717.2	92.4
	Total Germany	4,023.3	100.0
Outside Germany	Photovoltaic energy	411.7	21.8
	Hydropower	21.9	1.2
	Wind energy onshore	1,452.2	77.0
	Total Outside Germany	1,885.8	100.0

Totals may differ due to rounding.

¹⁾ Electricity generation.

In the year 2014, the RE Standard programme cofinanced renewable energy plants with a total electrical power of around 3.7 GW_{el}, of which 67 % belong to plants built in Germany and 33 % to plants built outside Germany (see Table 3). Table 4 gives a detailed picture of the installed electrical power supported outside Germany (by country and plant type).

Table 3: Installed electrical power supported in the year 2014 by plant type.

		MW _{el}
Germany	Biogas ¹⁾	5.5
	Solid biomass	0.1
	Photovoltaic energy	233.7
	Hydropower	5.4
	Wind energy onshore	2,222.0
	Total Germany	2,466.7
Outside Germany	Photovoltaic energy	336.6
	Hydropower	5.6
	Wind energy onshore	860.5
	Total Outside Germany	1,202.7

¹⁾ Electricity generation.

Table 4: Investment volume and installed electrical power supported outside Germany in the year 2014 by plant type and country.

	Photovoltaic energy		Hydropower		Wind energy onshore		Total	
	€mill. ¹⁾	MW _{el}	€mill. ¹⁾	MW _{el}	€mill. ¹⁾	MW _{el}	€mill. ¹⁾	MW _{el}
Austria	0.1	0.07	20.7	5.4	-	-	20.7	5.5
Canada	-	-	-	-	80.0	38.2	80.0	38.2
Czech Republic	-	-	1.3	0.2	-	-	1.3	0.2
Finland	-	-	-	-	64.6	39.6	64.6	39.6
France	411.7	336.5	-	-	500.0	341.1	911.6	677.6
Italy	-	-	-	-	54.9	46.3	54.9	46.3
Netherlands	-	-	-	-	398.0	195.0	398.0	195.0
Sweden	-	-	-	-	240.0	144.0	240.0	144.0
United Kingdom	-	-	-	-	114.7	56.3	114.7	56.3
Total	411.7	336.6	21.9	5.6	1,452.2	860.5	1,885.8	1,202.7

Totals may differ due to rounding.

¹⁾ excl. VAT.

The estimated electricity production of the supported plants built in Germany amounts to 4.9 TWh per year over the lifetime of the plants. The plants supported outside Germany produce 2.1 TWh of electricity per year. Over 20 years of life and operation time of the plants, electricity generation accumulates to 98 and 42 TWh respectively.

Table 5: Installed thermal power supported in the year 2014 by plant type.

		MW _{th}
Germa- ny	Solar thermal energy	0.01
	Solid biomass	5.4
	Total Germany	5.4
Outside Germa- ny	Solar thermal energy	-
	Solid biomass	-
	Total Outside Germany	-

Totals may differ due to rounding.

In 2014, the RE Standard programme supported also 5.4 MW of thermal power (mainly solid biomass), all of which was in plants located in Germany (see Table 5). The heat production of the supported plants can be estimated at 0.8 TWh per year. Assuming 20 years of life and operation time for the plants, this adds up to a total production of 16 TWh.

3 Estimated impacts

3.1 Savings in fossil fuel consumption and avoided energy costs for imported fossil fuels in Germany

Electricity and heat produced in the plants supported by the RE Standard programme replaces energy produced from fossil and nuclear fuel. The savings in fossil fuel are determined by the type of power plant substituted (e.g. coal, natural gas, etc.). They are calculated starting with the electricity or heat produced by the newly built plants. Specific substitution factors allow quantifying the amount of fossil energy replaced by each type of renewable energy (RE) plant. The fossil fuel savings (which were calculated for RE plants built in Germany only) finally result by applying primary energy factors to the quantities of substituted electricity/heat.²

Table 6 presents the annual fossil fuel savings of plants supported in Germany, which amount to 11.9 TWh per year. More than three quarters of this falls upon hard coal, the share of mineral oil is negligible.

Table 6: Annual fossil fuel savings (primary energy) in Germany resulting from the use of renewables in plants supported by RE Standard in the year 2014.

	GWh/a
Hard coal	9,080
Natural gas	2,301
Lignite	492
Mineral oil	7
Total	11,880

As Germany has to import most of the fossil energy carriers consumed, the savings in fossil fuel use reduce the country's dependency on energy imports. To measure this effect the corresponding reductions in energy costs were calculated using import prices³. It was assumed that the savings given in Table 6 fully lead to a reduction in energy imports with one exception: None of the lignite, which is the only relevant fossil energy source extracted in Germany, is substituted by the RE plants. Decreased imports of hard coal, natural gas and mineral oil lead to annual savings in energy costs for imported fuel of € 187 million (see Table 7).

² A detailed description (in German) of the calculation approach including substitution and primary energy factors can be found in the evaluation report (see footnote 1).

³ Details on the import price scenario are given in the evaluation report (see footnote 1).

Table 7: Annual savings in energy costs for imported fossil fuels in Germany resulting from the use of renewables in plants supported by RE Standard in the year 2014.

€million per year ¹⁾	
Hard coal	115
Natural gas	72
Mineral oil	0
Total	187

Totals may differ due to rounding.

¹⁾ Assumption: no lignite imported, therefore no resulting cost savings.

3.2 Savings in greenhouse gas emissions

The calculation of reductions in greenhouse gas emissions for plants built in Germany builds upon the approach for quantifying savings in fossil fuel consumption. It applies emission reduction factors that are based on the substitution factors mentioned in the previous section. These are provided by the German Umweltbundesamt (UBA – Federal Environment Agency) and consider net reduction effects: additional emissions from using renewable energy sources (e.g. methane emissions during biogas production) are subtracted from the reduction in emissions from fossil fuels. For plants built outside Germany a simpler approach had to be applied as no emission factors of equivalent quality were available.⁴

Table 8 shows the resulting annual emission reductions of 3.27 million tonnes of CO₂ and 3.54 million tonnes of CO₂-equivalent in German plants and 0.61 million tonnes of CO₂-equivalent in plants outside Germany.

Table 8: Annual savings in greenhouse gas emissions resulting from the use of renewables in plants supported by RE Standard in the year 2014 by location of plant.

Million tonnes per year	Germany	Outside Germany
CO ₂	3.27	n.q.
CO ₂ -equivalent	3.54 ¹⁾	0.61 ¹⁾

¹⁾ Figures based on different sets of emission factors.

3.3 Savings in external costs through supported plants in Germany

Savings in fossil fuel combustion not only result in reduced CO₂ emissions but in decreasing emissions of classical air pollutants such as NO_x, SO₂ etc. as well. Based on emission factors provided by the German Umweltbundesamt, annual reductions of air-

⁴ A detailed description (in German) of the calculation approach including emission factors can be found in the evaluation report (see footnote 1).

borne emissions were calculated for the RE plants supported in Germany as presented in Table 9.

Table 9: Annual savings in air pollutant emissions resulting from the use of renewables in plants in Germany supported by RE Standard in the year 2014.

	Tonnes per year
SO₂	1,517
NO_x	2,291
SO₂-equivalent	3,112
NM VOC	104
Fine particulate matter	71

Air pollutants and greenhouse gases cause damage to human health as well as the natural and man-made environment which represents costs to the society that are not borne by the polluter. These so-called external costs can be quantified by applying (monetary) damage cost factors that link emissions to damages caused by a certain quantity (e.g. one tonne) of pollutant emitted. Accordingly, the reduction of pollutant emissions leads to a decrease in external costs, which was quantified for the plants supported in Germany. The cost categories considered for deriving the savings in external costs comprise climate change, human health impacts, crop losses, damage to materials and losses in biodiversity.⁵

Avoiding greenhouse gas and air pollutant emissions through supported plants in Germany reduces external costs by approximately € 361 million per year (see Table 10). The largest part of saved external costs can be attributed to global climate change impacts which are caused by the emission of greenhouse gases.

Table 10: Annual savings in external costs resulting from the use of renewables in plants in Germany supported by RE Standard in the year 2014.

	€ million per year
Climate change	299.3
Health impacts	52.8
Crop losses	1.1
Material damage	1.1
Biodiversity losses	6.6
Total	360.9

Totals may differ due to rounding.

⁵ A detailed description (in German) of the calculation approach including damage factors is given in the evaluation report (see footnote 1).

3.4 Employment effects in Germany

The construction and operation of the renewable energy plants leads to a demand in goods and services which creates or preserves employment. Employment effects in Germany caused by the plants supported in Germany were calculated using an approach based on input-output analysis. This approach allows consideration of both direct employment (e.g. building a wind turbine) and indirect employment (e.g. producing steel for a wind turbine). The sum of direct and indirect employment results in the so-called gross employment.⁶

Manufacturing and construction of the plants supported in Germany in 2014 correspond to approx. 42,000 jobs created or preserved in Germany for one year. A further 1,400 jobs per annum result from the operation and maintenance of the plants over the assumed 20 years of operation, adding up to 28,000 jobs. Over a period of 20 years, building and operating the plants supported by the RE Standard programme in the year 2014 creates or preserves employment of more than 70,000 person years (see Table 11).

Table 11: Gross employment effects in Germany resulting from the use of renewables in plants in Germany supported by RE Standard in the year 2014.

	Person years ¹⁾
Construction of plants	42,150
Operation of plants (over a 20-year period)	28,080
Total	70,230

Totals may differ due to rounding.

¹⁾ One person year equals one person employed for the duration of one year (or 2 persons employed for half a year etc.)

⁶ A detailed description (in German) of the calculation approach is given in the evaluation report (see footnote 1).

4 Summary of effects

Table 12 summarises the evaluation results of the “KfW Renewable Energies Programme – Standard” for the year 2014.

Table 12: Overview of evaluation results 2014 for the KfW programme RE Standard.

	Unit	Germany	Outside Germany	Total
Volume of loan commitments	€ million	2,784.6	1,001.3	3,785.9
Investments financed¹⁾	€ million	4,023.3	1,885.8	5,909.1
Supported installed electrical power	MW _{el}	2,466.7	1,202.7	3,669.4
Annual electricity production	TWh _{el} / a	4.9	2.1	7.0
Supported installed thermal power	MW _{th}	5.4	-	5.4
Annual heat production	TWh _{th} / a	0.8	-	0.8
Annual savings in greenhouse gas emissions due to plants supported	million tonnes CO ₂ -equiv. / a	3.54	0.61	- ²⁾
Annual savings in energy imports	€ million / a	187	n.q.	
Employment effects	person years	70,230	n.q.	
due to plant construction	person years	42,150	n.q.	
due to plant operation (over a 20-year period)	person years	28,080	n.q.	
Annual savings in external costs	€ million / a	360.9	n.q.	

Totals may differ due to rounding.

¹⁾ excl. VAT.

²⁾ Figures based on different sets of emission factors.