Assessment of environmental and social impacts of the KfW loan programme “Renewable Energies – Standard” for the years 2017 and 2018

Summary Results

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Abbreviations and explanations

a	Year
CH_4	Methane
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 25 kg of CO_2.
GW	Gigawatt(s); 1 GW = 1 million kW
GWh	Gigawatt hour(s); 1 GWh = 1 million kWh
KfW	KfW Group
kW	Kilowatt(s)
kW_{el} / MW_{el}	Kilowatts/megawatt(s) electrical power
kWh	Kilowatt hour(s)
kW_{th} / MW_{th}	Kilowatts/megawatt(s) thermal power
mill.	Million
MW	Megawatt(s); 1 MW = 1,000 kW
N_2O	Nitrous oxide; “laughing gas”
NMVOC	Non-methane volatile organic compounds
NO_x	Generic term for the nitrogen oxides that are most relevant for air pollution, namely nitric oxide (NO) and nitrogen dioxide (NO_2)
n.q.	Not quantified
RE	Renewable energy
RES	Renewable energy sources
RE Standard	KfW loan programme “Renewable Energies – 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.
TWh	Terawatt hour(s); 1 TWh = 1,000 million kWh

UBA	German Federal Environment Agency (Umweltbundesamt)
VAT	Value added tax

Abstract for Political Decision Makers

The renewable energy promotional activities of KfW Group (KfW) represent an important element for reaching the targets for renewable energy (RE) use set in the German Federal Government's long-term strategy for future energy supply. These activities comprise low-interest loans, partly in combination with repayment bonuses financed by the federal government. In order to review their effectiveness and significance within the years 2017 and 2018, the resulting reductions in emissions of greenhouse gases and air pollutants, external costs, fossil fuel consumption and associated fossil fuel imports, as well as employment effects, were assessed for supported installations built in Germany. In addition, plants built outside Germany with support of the KfW RE programmes were considered, covering investment volume, capacity installed and CO_2 emissions avoided.

This report summarises the impacts of the KfW loan programme "Renewable Energies – Standard" (RE Standard). The most important results at a glance:

- In the years 2017 and 2018 the KfW programme RE Standard supported a total investment in the construction of plants for using renewable energies of € 5.0 billion and € 2.3 billion respectively (of which €1.6 billion and €1.4 billion in plants outside Germany). This represents shares of 26.5 % and 10.0 % respectively of the total investment in plants for power and heat production from renewable energy sources in Germany in 2017 and 2018 (not including offshore wind energy plants).
- In the field of electricity production, the renewable energy installations co-financed through the RE Standard programme reached shares of 30 % and 12 % of total RE electrical power installed in Germany in the years 2017 and 2018 (excluding offshore wind energy plants). With 35 % and 24 % respectively the highest shares could be found for onshore wind turbines.
- Plants supported in the years 2017 and 2018 reduce German energy imports by approximately € 260 million per annum (total for both years). This cumulates to € 5.2 billion over the plants' lifetime of 20 years.
- The installations built in Germany and financed by KfW RE Standard in the years 2017 and 2018 lead to a reduction of approximately 4.1 million tonnes of CO_2 equivalent (of which 3.8 million tonnes CO_2) per annum. The plants built outside Germany with KfW support reduce another 0.4 million tonnes of CO_2 annually.
- Avoiding greenhouse gas and air pollutant emissions in Germany reduces external costs by approximately € 812 million a year (for both years considered), 92 % of which refer to climate change effects.

- Manufacturing and construction of the installations built in 2017 and 2018 correspond to approximately 40,800 jobs created or preserved in Germany for one year (total for both years). A further 1,029 jobs per annum result from the operation and maintenance of the plants for the assumed 20 years of operation.
- Small and medium-sized enterprises with less than 500 employees account for approximately 53 % of the jobs generated by the construction and operation of plants built in the years 2017 and 2018.

1 Background

In the years 2017 and 2018, renewable energy sources (RES) continued to increase their share in Germany's energy provision[1]: In 2017 the share of RES in electricity consumption saw a sharp rise from 31.6 % (2016) to 36.0 %. In 2018 this share further increased to 37.8 %. Thus, more than every third kilowatt hour of electric energy consumed in Germany originates from renewable sources.

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. The Climate Action Programme 2030 adopted by the Federal Cabinet on 9 October 2019 aims to reach a renewable energy share of 65 % in electricity consumption by 2030. In combination with challenging energy efficiency targets, this should make it possible to reduce greenhouse gas emissions by at least 55 % by 2030 compared to the base year 1990.

The renewable energy promotional activities of KfW Group represent an important element for reaching the targets for renewable energy (RE) use described above. These activities comprise low-interest loans, partly in combination with repayment bonuses financed by the federal government.

In the years 2017 and 2018, the KfW promotional programmes supported a total investment in the construction of installations for using renewable energies of € 6.2 billion and € 2.6 billion respectively (of which € 1.6 billion and € 1.4 billion in plants outside Germany). This implies that shares of 29.1 % and 12.5 % respectively of the total investment in plants for power and heat production from RES in Germany in 2017 and 2018 were co-financed by KfW programmes (without considering offshore wind energy installations).

In order to review the effectiveness and significance of these programmes within the years 2017 and 2018, the resulting reductions in emissions of greenhouse gases and air pollutants, external costs, fossil fuel consumption and associated fossil fuel imports, as well as employment effects, were assessed for installations built in Germany. In addition, plants built outside Germany with support of the KfW RE programmes were considered, covering investment volume, capacity installed and CO_2 emissions avoided.

The impacts of the KfW loan programme "Renewable Energies – Standard" (RE Standard) are summarised on the following pages. A detailed description (in German) of the underly-

[1] See Bundesministerium für Wirtschaft und Energie (BMWi) – Hrsg.: Erneuerbare Energien in Zahlen – Nationale und internationale Entwicklung im Jahr 2018. Berlin 2019. www.erneuerbare-energien.de/EE/Redaktion/DE/Downloads/Berichte/erneuerbare-energien-in-zahlen-2018.html

ing calculation approaches and results of all renewable energy promotional activities of KfW Group can be found in the evaluation report[2].

[2] Bickel, P., Kelm, T., Edler, D.: Evaluierung der inländischen KfW-Programme zur Förderung Erneuerbarer Energien in den Jahren 2017 und 2018. Gutachten im Auftrag der KfW Bankengruppe, Stuttgart, Dezember 2019. www.kfw.de/KfW-Konzern/Service/Download-Center/Konzernthemen/Research/Evaluationen/Evaluationen-Erneuerbare-Energien/ / (available in German only).

2 Loan volume and resulting investment

The KfW promotional programme RE Standard was introduced on 1 January 2009 and supports the construction, extension or purchase of plants using renewable energy for producing electricity and/or heat by granting low-interest loans. The maximum loan per project amounts to € 50 million.

In the years 2017 and 2018, the volume of loan commitments totalled approximately € 3.6 billion and € 1.6 billion respectively, of which almost € 1.1 billion and € 0.9 billion are attributable to supported renewable energy plants outside Germany (see Table 1). The loans triggered investments of € 5.0 billion and € 2.3 billion respectively, € 1.6 billion and € 1.4 billion of which in plants outside Germany. The average loan volume per commitment amounted to € 1.3 million in 2017 and € 0.9 million in 2018; the average investment per commitment amounted to € 1.8 million in 2017 and € 1.3 million in 2018. This corresponds to an average share of financing of 72 % and 70 % respectively.

Table 1: Number and volume of loans, as well as supported investment volume in the programme RE Standard for the years 2017 and 2018.

	2017	2018
Number of loan commitments	2,736	1,769
Volume of loan commitments (€ million)	3,575.5	1,632.3
of which plants outside Germany (€ million)	1,051.7	897.8
Investments financed (€ million)[1)]	4,997.5	2,345.6
of which plants outside Germany (€ million)[1)]	1,648.6	1,371.5
Average loan volume per commitment (€)	1,306, 822	922,708
Average investment financed per commitment (€)[1)]	1,826,580	1,325,920
Average share of financing	71.5 %	69.6 %

Totals may differ due to rounding.

[1)] excl. VAT.

With shares of 87 % and 92 % in the total loan volume of all KfW promotional programmes for renewable energy in 2017 and 2018, the RE Standard programme was the largest of these programmes. In terms of investment volume supported, the shares of RE Standard amounted to 80 % and 91 %.

Table 2 presents the supported investment volume in RE Standard split by plant type. In the year 2017 (2018), wind energy onshore dominates the supported investment in Germany with 89 % (86 %) followed by photovoltaic energy 11 % (14 %). Other plant types play only a minor role. Outside Germany with 14 % (15 %) photovoltaics has a slightly

higher share with wind energy onshore still dominating (2017: 86 %, 2018: 83 %) and hydropower being practically negligible. Table 3 gives a detailed picture of the investment volume supported outside Germany by country and plant type.

Table 2: Volume of investment supported in the years 2017 and 2018 by plant type.

		2017		2018	
		€ million (excl. VAT)	%	€ million (excl. VAT)	%
Germany	**Biogas**	11.4	0.3	3.6[1)]	0.4
	Solid biomass	4.1	0.1	2.2	0.2
	Photovoltaic energy	353.2	10.5	135.0	13.9
	Large heat pump	0.03	0.001	0.03	0.003
	Solar thermal energy	0.1	0.004	-	-
	Heat grid	0.5	0.01	-	-
	Hydropower	6.1	0.2	0.4	0.04
	Wind energy onshore	2,973.2	88.8	832.7	85.5
	Electricity storage	0.2	0.01	0.1	0.01
	Total Germany	**3,348.9**	**100.0**	**974.1**	**100.0**
Outside Germany	**Photovoltaic energy**	226.5	13.7	211.2	15.4
	Hydropower	-	-	16.5	1.2
	Wind energy onshore	1,422.1	86.3	1,143.8	83.4
	Total Outside Germany	**1,648.6**	**100.0**	**1,371.5**	**100.0**

Totals may differ due to rounding.

[1)] Electricity generation and biogas transportation.

Table 3: Investment volume supported outside Germany in the years 2017 and 2018 by plant type and country.

€ million	2017			2018			
(excl. VAT)	PV	Wind	Total	PV	Hydro	Wind	Total
Denmark	7.2	44.1	**51.2**	39.7	-	109.0	**148.8**
Finland	-	150.8	**150.8**	-	-	108.4	**108.4**
France	58.5	614.4	**672.9**	4.7	-	628.9	**633.5**
Ireland		122.0	**122.0**	-	-	77.4	**77.4**
Italy	-	-	**-**	-	16.5	138.7	**155.2**
Japan	75.5	-	**75.5**	102.5	-	-	**102.5**
Netherlands	32.2	-	**32.2**	64.3	-	-	**64.3**
Norway	-	440.0	**440.0**	-	-	-	**-**
Sweden	-	50.9	**50.9**	-	-	57.2	**57.2**
United Kingdom	53.1	-	**53.1**	-	-	24.3	**24.3**
Total	**226.5**	**1,422.1**	**1,648.6**	**211.2**	**16.5**	**1,143.8**	**1,371.5**

Totals may differ due to rounding.

3 Power installed

In the year 2017, the RE Standard programme co-financed renewable energy plants with a total electrical power of around 3.4 GW_{el}, of which 66 % belong to plants built in Germany and 34 % to plants built outside Germany (see Table 4). In 2018 the total electrical power installed remains at 1.6 GW_{el} with 42 % installed in plants in Germany and 58 % installed outside Germany. Table 5 gives a detailed picture of the installed electrical power supported outside Germany by country and plant type.

Table 4: Installed electrical power supported in the years 2017 and 2018 by plant type.

MW_{el}		2017	2018
Germany	**Biogas**	8.3	1.7
	Photovoltaic energy	338.9	132.6
	Hydropower	0.5	0.1
	Wind energy onshore	1,859.9	554.2
	Total Germany	**2,207.5**	**688.5**
Outside Germany	**Photovoltaic energy**	171.4	195.3
	Hydropower	-	10.1
	Wind energy onshore	990.0	730.3
	Total Outside Germany	**1,161.4**	**935.7**

Totals may differ due to rounding.

Table 5: Installed electrical power supported outside Germany in the years 2017 and 2018 by plant type and country.

	2017			2018			
MW_{el}	PV	Wind	Total	PV	Hydro	Wind	Total
Denmark	8.4	24.2	**32.5**	70.0	-	60.3	**130.3**
Finland	-	69.5	**69.5**	-	-	73.4	**73.4**
France	51.8	377.6	**429.4**	4.3	-	400.3	**404.6**
Ireland	-	78.4	**78.4**	-	-	36.5	**36.5**
Italy	-	-	**-**	-	10.1	96.0	**106.1**
Japan	26.7	-	**26.7**	50.8	-	-	**50.8**
Netherlands	40.6	-	**40.6**	70.1	-	-	**70.1**
Norway	-	393.6	**393.6**	-	-	-	**-**
Sweden	-	46.8	**46.8**	-	-	46.8	**46.8**
United Kingdom	43.9	-	**43.9**	-	-	17.0	**17.0**
Total	**171.4**	**990.0**	**1,161.4**	**195.3**	**10.1**	**730.3**	**935.7**

Totals may differ due to rounding.

The estimated electricity production of the installations financed 2017 (2018) built in Germany amounts to 4.7 (1.4) TWh per year over the lifetime of the plants. The plants financed outside Germany produce an estimated 2.4 (1.7) TWh of electricity per year. Over 20 years

of life and operation time of the plants, electricity generation accumulates to an estimated 94 (28) and 48 (34) TWh respectively.

Table 6: Installed thermal power supported in the years 2017 and 2018 by plant type.

MW_{th}		2017	2018
Germany	**Solar thermal energy**	0.1	-
	Solid biomass	3.9	2.9
	Large heat pump	0.02	0.03
	Total Germany	**4.1**	**2.9**
Outside Germa-ny	**Solar thermal energy**	-	-
	Solid biomass	-	-
	Total Outside Germany	**-**	**-**

Totals may differ due to rounding.

In the years 2017 and 2018, the RE Standard programme also supported 4.1 MW_{th} and 2.9 MW_{th} respectively of thermal power (mainly solid biomass), all of which was in plants located in Germany (see Table 6). The heat production of the financed plants can be estimated at 21 and 8 GWh per year. Assuming a 20-year operational lifetime of the plants, this adds up to a total production of an estimated 420 GWh and 160 GWh respectively.

4 Estimated impacts

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

Electricity and heat generated in the plants financed by the RE Standard programme replace energy produced from fossil 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 estimated electricity or heat produced by the newly built installations. Specific substitution factors allow quantifying the amount of fossil energy replaced by each type of renewable energy 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.[3]

Table 7 presents the annual fossil fuel savings of plants financed in Germany in the years 2017 and 2018, which amount to 9.9 and 3.0 TWh per year. The share of hard coal amounts to 68 % in both years, that of natural gas to 29 % (2017) and 30 % (2018) respectively. The shares of lignite and mineral oil are negligible.

Table 7: Annual fossil fuel savings (primary energy) in Germany resulting from the use of renewables in plants supported by RE Standard in the years 2017 and 2018.

GWh/a	2017	2018
Hard coal	6,711	2,028
Natural gas	2,905	883
Lignite	244	74
Mineral oil	11	2
Total	**9,870**	**2,987**

Totals may differ due to rounding.

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 prices[4]. It was assumed that the savings given in Table 7 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 € 199 million and € 62 million for 2017 and 2018 (see Table 8).

[3] A brief description is given in Annex A 1. Details of the calculation approach including substitution and primary energy factors can be found in the evaluation report (in German; see footnote 2).

[4] Details on the import price scenario are given in the evaluation report (see footnote 2).

Table 8: 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 years 2017 and 2018.

€ million per year[1)]	2017	2018
Hard coal	107.8	33.7
Natural gas	90.5	28.5
Mineral oil	0.6	0.1
Total	**198.9**	**62.3**

Totals may differ due to rounding.

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

4.2 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.[5]

The plants built in Germany und financed by KfW in 2017 lead to a reduction of 3.19 million tonnes of CO_2-equivalent (of which 2.92 million tonnes CO_2) per year. The installations with KfW support built outside Germany reduce another 0.18 million tonnes of CO_2 annually. Plants supported in 2018 avoid annual emissions in the amount of 0.96 million tonnes of CO_2-equivalent (of which 0.88 million tonnes CO_2) in Germany and 0.23 million tonnes of CO_2 outside Germany (see Table 9).

Table 9: Annual savings in greenhouse gas emissions resulting from the use of renewables in plants supported by RE Standard in the years 2017 and 2018 by location of plant.

	2017		2018	
Million tonnes per year	Germany	Outside Germany	Germany	Outside Germany
CO_2	2.92[1)]	0.18[1)]	0.88[1)]	0.23[1)]
CO_2-equivalent	3.19	n.q.	0.96	n.q.

1) Figures based on different sets of emission factors.

In many countries abroad in which installations are financed, electricity generation already has a low carbon intensity (e.g. in France due to a high share of nuclear energy or in Swe-

5 A brief description is given in Annex A 2. Details of the calculation approach including emission factors can be found in the evaluation report (in German; see footnote 2).

den due to a high share of renewable and nuclear energy). Therefore, the total savings in greenhouse gas emissions from supported plants outside Germany are comparatively low.

4.3 Savings in external costs through supported plants in Germany

Savings in fossil fuel combustion not only result in reduced CO_2 emissions but also in decreasing emissions of air pollutants such as NO_x, SO_2 etc. Based on emission factors provided by UBA, annual reductions of airborne emissions were calculated for the RE installations financed in Germany as presented in Table 10.

Table 10: Annual savings in air pollutant emissions resulting from the use of renewables in plants in Germany supported by RE Standard in the years 2017 and 2018.

Tonnes per year	2017	2018
SO_2	943	287
NO_x	1,915	587
SO_2-equivalent	2,276	696
NMVOC	104	32
Fine particulate matter	20	6

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 include climate change, human health impacts, crop losses, damage to materials and losses in biodiversity.[6]

Table 11: Annual savings in external costs resulting from the use of renewables in plants in Germany supported by RE Standard in the years 2017 and 2018.

€ million per year	2017	2018
Climate change	573.6	173.7
Health impacts	41.3	12.6
Crop losses	1.5	0.5
Material damage	0.8	0.2
Biodiversity losses	5.9	1.8
Total	**623.1**	**188.8**

Totals may differ due to rounding.

[6] A brief description is given in Annexes A 2 and A 3. Details of the calculation approach including damage cost factors can be found in the evaluation report (in German; see footnote 2).

Avoiding greenhouse gas and air pollutant emissions through financed installations in Germany reduces external costs by € 623 million per year for 2017 and € 189 million per year for 2018 (see Table 11). The largest part of saved external costs can be attributed to global climate change impacts which are caused by the emission of greenhouse gases.

4.4 Employment effects in Germany

Construction and operation of 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 so-called gross employment.[7]

Manufacturing and construction of the plants supported in Germany in 2017 and 2018 correspond to 31,800 jobs and 8,970 jobs respectively created or preserved in Germany for one year. A further 795 (235) jobs per annum result from the operation and maintenance of the plants over the assumed 20 years of operation, adding up to 15,890 (4,690) person years. Over a period of 20 years, building and operating the plants supported by the RE Standard programme in the years 2017 and 2018 creates or preserves employment of 47,690 and 13,660 person years (see Table 12).

Table 12: Gross employment effects in Germany resulting from the use of renewables in plants in Germany supported by RE Standard in the years 2017 and 2018.

Person years[1)]	2017	2018
Construction of plants	31,800	8,970
Operation of plants (over a 20-year period)	15,890	4,690
Total	**47,690**	**13,660**

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.)

4.5 Impacts attributable to the KfW financing portion

The impacts presented in the previous sections refer to the total investment in installations for using renewable energy supported by KfW funding. In a further step the share of those impacts is calculated that corresponds to the share of financing of the RE Standard programme in the total amount of investment (pro rata calculation).

7 A brief description is given in Annex A 4. Details of the calculation approach can be found in the evaluation report (in German; see footnote 2).

Table 13 presents the average share of financing (which is calculated as loan volume divided by investment volume) by plant type. It illustrates that the share of financing varies considerably between different plant types and years. For this reason, the calculations are carried out on plant type level and then added up for each year. Table 14 shows the resulting shares of KfW financing in impacts for installations in Germany, Table 15 reports the figures for installations outside Germany. Please note that due to differing compositions of impacts by plant type the sum over all plant types generally differs from the RE Standard total average percentage share of financing.

Table 13: Share of financing of the RE Standard programme in the years 2017 and 2018 by plant type.

		2017	2018
Germany	**Biogas**	95.5%	90.9%
	Solid biomass	97.8%	70.7%
	Photovoltaic energy	80.2%	86.9%
	Large heat pump	100.0%	100.0%
	Solar thermal energy	91.6%	-
	Heat grid	67.3%	-
	Hydropower	77.0%	81.1%
	Wind energy onshore	74.7%	73.5%
	Electricity storage	84.7%	99.7%
	Total Germany	**75.4%**	**75.4%**
Outside Germany	**Photovoltaic energy**	66.8%	59.6%
	Hydropower	-	93.9%
	Wind energy onshore	63.3%	66.1%
	Total Outside Germany	**63.8%**	**65.5%**
RE Standard	**Total**	**71.5%**	**69.6%**

Table 14: Share of KfW financing in impacts resulting from the use of renewables in plants in Germany supported by RE Standard in the years 2017 and 2018.

		2017	2018
Supported installed electrical power	MW_{el}	1,668.9	524.0
Annual electricity production	TWh_{el} per year	3.5	1.1
Supported installed thermal power	MW_{th}	4.0	2.1
Annual heat production	TWh_{th} per year	0.021	0.007
Annual fossil fuel savings (primary energy)	GWh per year	7,430	2,230
Annual savings in energy costs for imported fossil fuels	€ million per year	149,9	46.5
Annual savings in greenhouse gas emissions	Million tonnes of CO_2 per year	2.20	0.66
	Million tonnes of CO_2-equivalents per year	2.40	0.72
Annual savings in external costs	€ million per year	467.9	140.8
due to climate change	€ million per year	431.2	129.6
due to health impacts	€ million per year	30.7	9.3
due to crop losses	€ million per year	1.1	0.3
due to material damage	€ million per year	0.6	0.2
due to biodiversity losses	€ million per year	4.4	1.3
Gross employment effects in Germany	Person years	35,970	10,240
due to plant construction	Person years	23,930	6,730
due to plant operation (over 20-years)	Person years	12,040	3,500

Totals may differ due to rounding.

Table 15: Share of KfW financing in impacts resulting from the use of renewables in plants outside Germany supported by RE Standard in the years 2017 and 2018.

		2017	2018
Supported installed electrical power	MW_{el}	741.3	608.8
Annual electricity production	TWh_{el} per year	1.5	1.1
Annual savings in CO_2 emissions	Million tonnes of CO_2 per year	0.11	0.15

5 Summary of effects

Table 16 and Table 17 summarise the evaluation results of the KfW´s RE Standard programme for the years 2017 and 2018.

Table 16: Overview of evaluation results 2017 for the KfW programme RE Standard.

	Unit	Germany	Outside Germany	Total
Volume of loan commitments	€ million	2,523.7	1,051.7	3,575.5
Investments financed[1)]	€ million	3,348.9	1,648.6	4,997.5
Supported installed electrical power	MW_{el}	2,207.5	1,161.4	3,368.9
share of KfW financing	MW_{el}	1,668.9	741.3	2,410.2
Annual electricity production	TWh_{el} / a	4.7	2.4	7.1
share of KfW financing	TWh_{el} / a	3.5	1.5	5.0
Supported installed thermal power	MW_{th}	4.1	-	4.1
share of KfW financing	MW_{th}	4.0	-	4.0
Annual heat production	TWh_{th} / a	0.021	-	0.021
share of KfW financing	TWh_{th} / a	0.021	-	0.021
Annual savings in greenhouse gas emissions due to plants supported	million tonnes CO_2-equiv. / a	3.19	0.18[2)]	-[3)]
share of KfW financing	million tonnes CO_2-equiv. / a	2.40	0.11[2)]	-[3)]
Annual savings in energy imports	€ million / a	198.9	n.q.	
share of KfW financing	€ million / a	149.9	n.q.	
Gross employment effects	person years	47,690	n.q.	
share of KfW financing	person years	35,970	n.q.	
due to plant construction	person years	31,800	n.q.	
share of KfW financing	person years	23,930	n.q.	
due to plant operation (over a 20-year period)	person years	15,890	n.q.	
share of KfW financing	person years	12,040	n.q.	
Annual savings in external costs	€ million / a	623.1	n.q.	
share of KfW financing	€ million / a	467.9	n.q.	

Totals may differ due to rounding.

[1)] excl. VAT.

[2)] in million tonnes CO_2 / a

[3)] Figures based on different sets of emission factors.

Table 17: Overview of evaluation results 2018 for the KfW programme RE Standard.

	Unit	Germany	Outside Germany	Total
Volume of loan commitments	€ million	734.5	897.8	1,632.3
Investments financed[1)]	€ million	974.1	1,371.5	2,345.6
Supported installed electrical power	MW_{el}	688.5	935.7	1,624.2
share of KfW financing	MW_{el}	524.0	608.8	1,132.8
Annual electricity production	TWh_{el} / a	1.4	1.7	3.1
share of KfW financing	TWh_{el} / a	1.1	1.1	2.2
Supported installed thermal power	MW_{th}	2.9	-	2.9
share of KfW financing	MW_{th}	2.1	-	2.1
Annual heat production	TWh_{th} / a	0.008	-	0.008
share of KfW financing	TWh_{th} / a	0.007	-	0.007
Annual savings in greenhouse gas emissions due to plants supported	million tonnes CO_2-equiv. / a	0.96	0.23[2)]	-[3)]
share of KfW financing	million tonnes CO_2-equiv. / a	0,72	0.15[2]	-[3)]
Annual savings in energy imports	€ million / a	62.3	n.q.	
share of KfW financing	€ million / a	46.5	n.q.	
Gross employment effects	person years	13,660	n.q.	
share of KfW financing	person years	10,240	n.q.	
due to plant construction	person years	8,970	n.q.	
share of KfW financing	person years	6,730	n.q.	
due to plant operation (over a 20-year period)	person years	4,690	n.q.	
share of KfW financing	person years	3,500	n.q.	
Annual savings in external costs	€ million / a	188.8	n.q.	
share of KfW financing	€ million / a	140.8	n.q.	

Totals may differ due to rounding.

[1)] excl. VAT.

[2)] in million tonnes CO_2 / a

[3)] Figures based on different sets of emission factors.

Annex: Overview of the underlying methodology

The following sections give a brief description of the methodology used for evaluating the effects caused by the renewable energy plants supported by the KfW´s RE Standard programme. Detailed information is available in the evaluation report.

A 1 Estimation of savings in fossil fuel consumption and avoided energy costs for imported fossil fuels in Germany

Electricity and heat from renewable energy sources replace fossil fuels. The savings in fuel use are calculated in two steps. In the first step, substitution factors for electricity and heat production provided by the German Umweltbundesamt (UBA – Federal Environment Agency) are applied. These factors give the shares of electricity from lignite, hard coal, natural gas and mineral oil that are replaced in Germany by electricity from renewables. Each technology (wind energy, hydro power, solid biomass, photovoltaics, biogas and geothermal energy) has its specific substitution pattern, determined mainly by the time structure of energy provision. In the second step, the amounts of electricity replaced are combined with primary energy factors for each energy carrier that give the units of fossil primary energy (including up- and downstream processes) necessary to provide one unit of electricity. The fossil energy use associated to the use of renewable energy (in up- and downstream processes) is subtracted from the calculated fossil energy savings, resulting in net savings in fossil energy due to electricity produced in the renewable energy plants supported.

The amounts of net fossil energy saved due to heat provision from renewable energy are calculated accordingly, based on substitution and primary energy factors for fuel oil, natural gas, hard coal, lignite, district heating and electricity for heat provided by solar thermal systems, heat pumps, biogas, solid biomass and geothermal plants.

Since a large share of Germany's fossil fuels have to be imported, the savings calculated lead to a reduction in German energy imports. Lignite, as the only major German domestic fossil fuel source, is assumed not to be imported. The associated costs due to savings in fossil fuel imports are calculated using price forecasts for the import prices of crude oil, hard coal and natural gas.

A 2 Estimation of savings in greenhouse gas emissions and air pollutant emissions

Savings in greenhouse gas (CO_2, CH_4, N_2O) and air pollutant (SO_2, NO_x, NMVOC, fine particles) emissions due to supported RE installations in Germany are calculated based on emission reduction factors provided by the German Umweltbundesamt (UBA – Federal Environment Agency). These factors are based on the substitution factors mentioned in the previous section and reflect the specific fossil fuel mix that the renewable energy source replaces. They describe net emission savings, setting off the volume of emissions caused by the use of renewables (final energy supply) against the volume of gross emissions that are no longer being released thanks to fossil sources having been replaced with renewables. All upstream process chains involved in the production and supply of the various energy sources and in installation construction and operation (but not dismantling) are also taken into account.

When calculating the savings in greenhouse gas emissions due to supported plants in countries other than Germany, emission reduction factors are required for each country. No consistent emission factor set of comparable quality is available, therefore emission reductions are estimated based on CO_2 emission factors of the average electricity mix of the countries considered as a second-best approach.

A 3 Valuation of external costs avoided

Air pollutant emissions cause changes in environmental burdens and associated impacts on various receptors, such as human beings (e.g. emissions of air pollutants leading to respiratory diseases), crops (decrease in yields), building materials (mainly degradation and soiling) or ecosystems (mainly due to acidification and eutrophication). This change in impacts leads either directly or indirectly (e.g. through health effects) to a change in the utility of the affected persons. Welfare changes resulting from these impacts can be transferred into monetary values and represent external costs to society as they are not borne by the polluter. The German Umweltbundesamt (UBA – Federal Environment Agency) recommends pollutant-specific damage cost factors that link emissions to damages caused by a certain quantity (e.g. one tonne) of pollutant emitted in Germany. In addition to the damage cost factors for air pollutants (SO_2, NO_x, NMVOC, fine particles), cost factors for greenhouse gas emissions (CO_2, CH_4, N_2O) are provided. The cost categories considered for deriving the external costs avoided comprise climate change, human health impacts, crop losses, damage to materials and losses in biodiversity.

The external costs avoided by supporting RE installations in Germany are then calculated by multiplying the savings in pollutant and greenhouse gas emissions (in tonnes) by the specific cost factor per tonne of pollutant or greenhouse gas emitted.

A 4 Estimation of employment effects

Employment effects arise from the construction and the operation of renewable energy installations. Investments in facilities, operation and maintenance create direct employment for manufacturers, operators and service companies. They in turn demand goods from other economic sectors, thus creating indirect employment for suppliers of intermediate inputs. The sum of direct and indirect employment is the so-called gross employment.

Starting point for the calculation of gross employment effects is the demand for goods in Germany resulting from the investments in renewable energy installations supported by the KfW RE standard programme. Direct and indirect effects resulting from this demand are modelled by means of input-output tables, which map the flow of goods and interdependencies of industries within the German economy and with foreign countries. In the final step, employment effects are calculated using sector-specific labour intensities, which reflect the productivities in the different economic sectors.