Germany

IRENA
International Renewable Energy Agency

COUNTRY INDICATORS AND SDGS

GDP per capita — 8.1.1 Real GDP growth rate

7.3.1 Energy intensity

7.1.1 Access to electricity (% population) / 7.1.2 Access to clean cooking (% population) / 7.2.1 Renewable energy (% TFEC)

7.a.1 Public flows to renewables

7.b.1 Per capita renewable capacity

### 11.6.2 Air particulate matter (PM2.5)
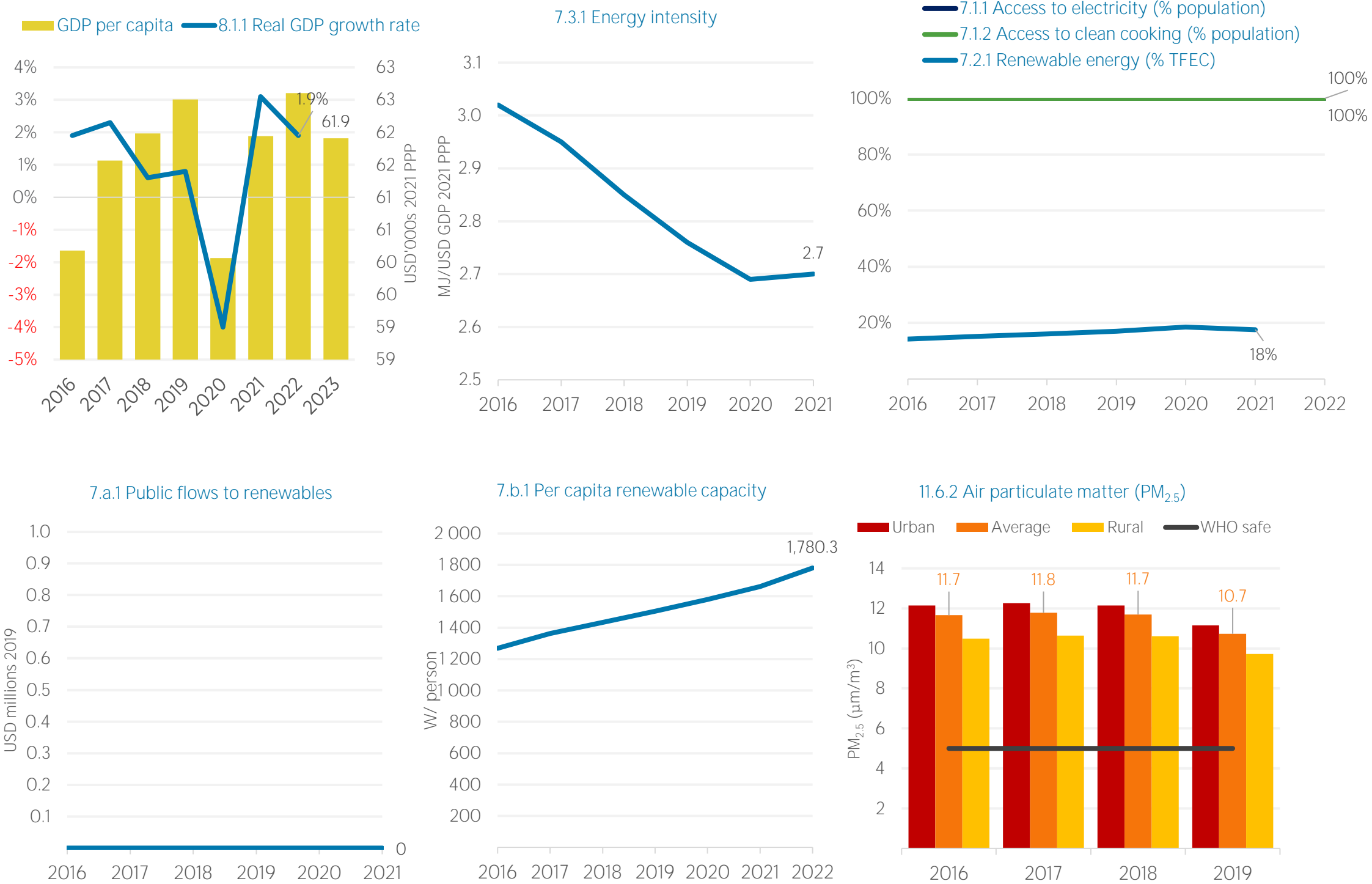
TOTAL ENERGY SUPPLY (TES)

Total Energy Supply (TES)	2016	2021
Non-renewable (TJ)	11 394 974	10 198 032
Renewable (TJ)	1 668 783	1 916 559
Total (TJ)	13 063 757	12 114 591
Renewable share (%)	13	16

Growth in TES	2016-21	2020-21
Non-renewable (%)	-10.5	+4.3
Renewable (%)	+14.8	+5.2
Total (%)	-7.3	+4.5

Primary energy trade	2016	2021
Imports (TJ)	10 812 542	9 424 048
Exports (TJ)	2 193 475	1 516 352
Net trade (TJ)	-8 619 067	-7 907 696
Imports (% of supply)	83	78
Exports (% of production)	45	35
Energy self-sufficiency (%)	38	36

Total energy supply in 2021

- Oil — 32%
- Gas — 27%
- Nuclear — 6%
- Coal + others — 20%
- Renewables — 16%
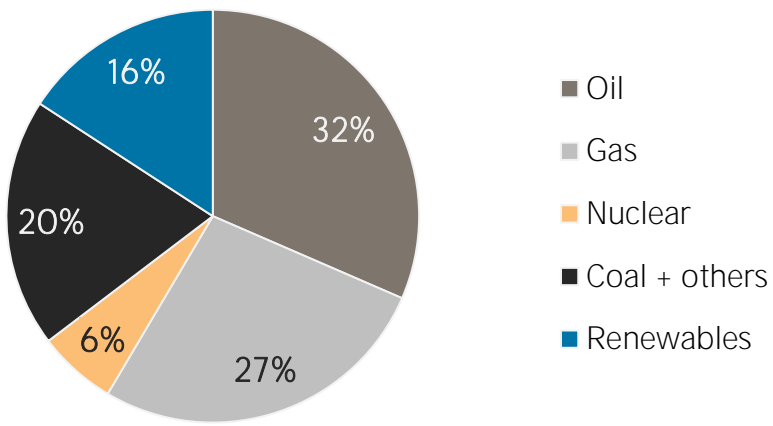
Renewable energy supply in 2021

- Hydro/marine — 3%
- Wind — 23%
- Solar — 13%
- Bioenergy — 60%
- Geothermal — 1%
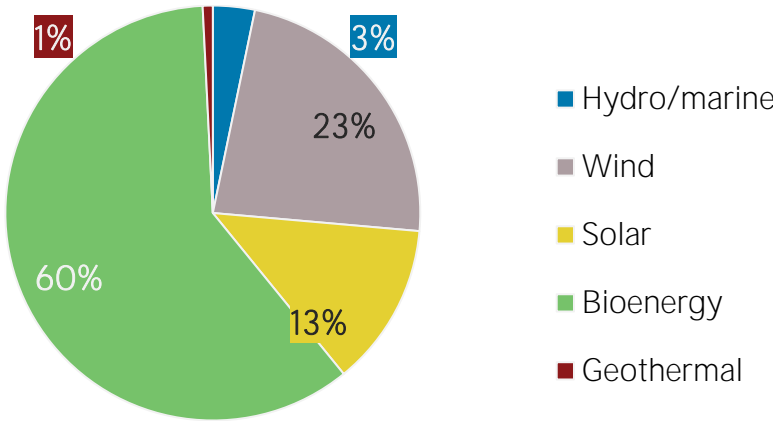
RENEWABLE ENERGY CONSUMPTION (TFEC)

Renewable TFEC trend

Legend: Electricity, Commercial heat, Bioenergy

Values: 2 468 (2016), 2 599 (2017), 2 717 (2018), 2 831 (2019), 2 822 (2020), 2 855 (2021)

Y-axis: Petajoules (PJ)
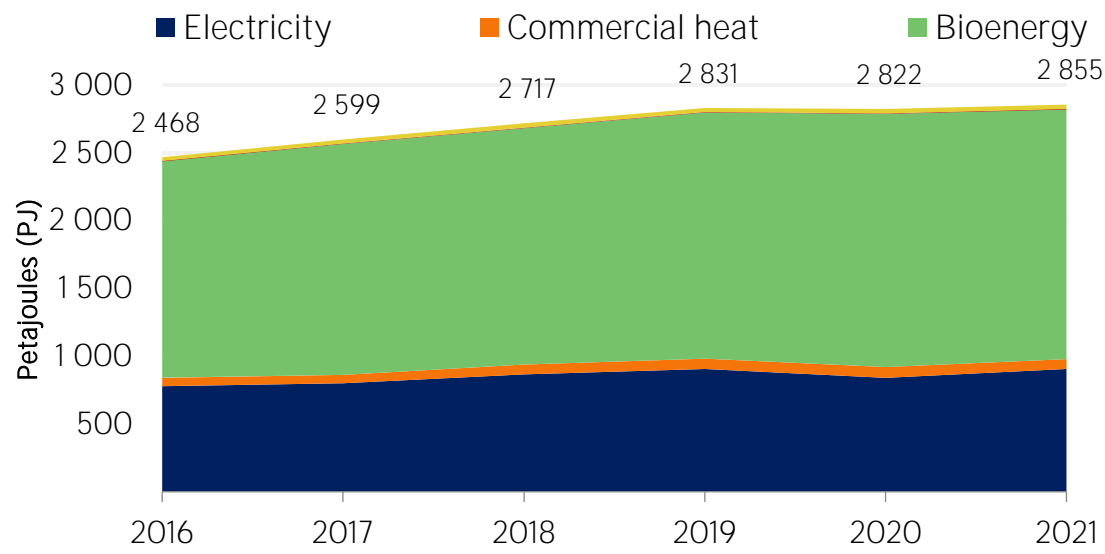
Consumption by sector	2016	2021
Industry (TJ)	489 132	549 624
Transport (TJ)	124 283	141 958
Households (TJ)	493 325	611 916
Other (TJ)	1 360 899	1 551 718

Renewable energy consumption in 2021

Legend: Geothermal, Solar direct

Pie chart: Geothermal 0%, Solar direct 1%, Electricity 32%, Commercial heat 3%, Bioenergy 64%

Pie chart: Industry 19%, Transport 5%, Households 21%, Other 54%
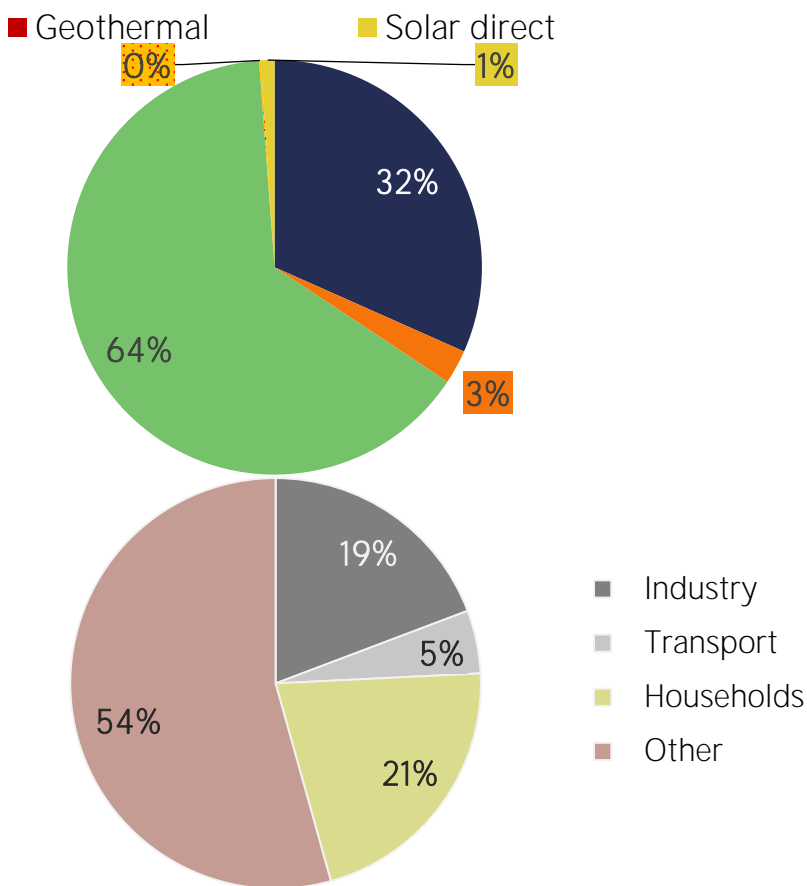
ELECTRICITY CAPACITY

Installed capacity trend

Legend: Fossil fuels, Nuclear, Other Non-RE, Hydro/marine, Wind, Solar, Bioenergy, Geothermal, Renewable share

Values: 208 (2016), 215 (2017), 229 (2018), 231 (2019), 234 (2020), 243 (2021), 250 (2022), 264 (2023)

Renewable share: 63%

Y-axis left: Gigawatts (GW); Y-axis right: Renewable share (%)

Net capacity change in 2023 (MW)

Non-renewable **- 4 295**	Hydro and marine **+ 120**
Solar **+ 14 260**	Wind **+ 3 296**
Bioenergy **+ 120**	Geothermal **0**

Renewable capacity in 2023

Legend: Hydro/marine, Solar, Wind, Bioenergy, Geothermal

Pie chart: Geothermal 0%, Hydro/marine 3%, Solar 49%, Wind 42%, Bioenergy 6%

Net capacity change (GW)

Legend: Fossil fuels, Renewable

Year	Fossil fuels	Renewable
2018	7.2	6.4
2019	- 2.9	6.2
2020	- 2.5	6.6
2021	1.4	7.4
2022	1.5	10
2023	- 0.1	18
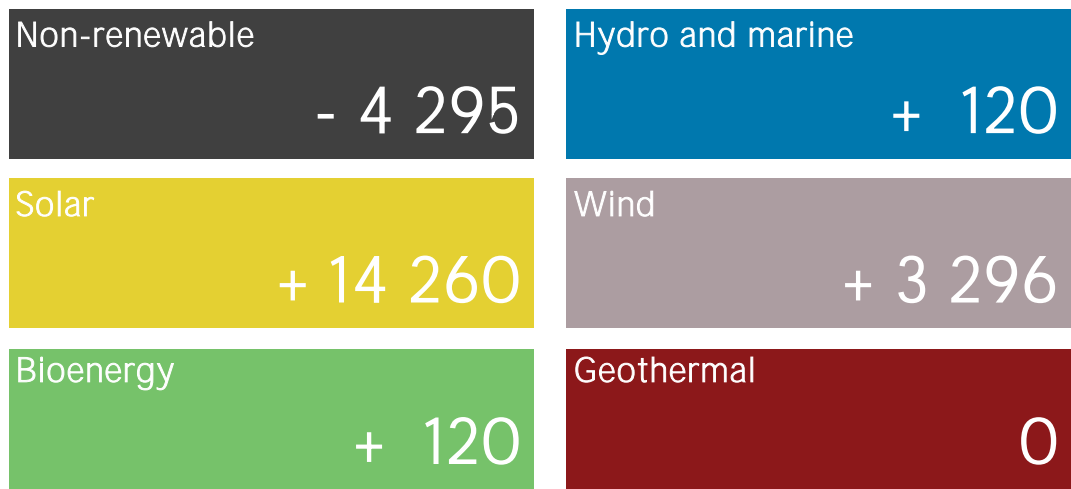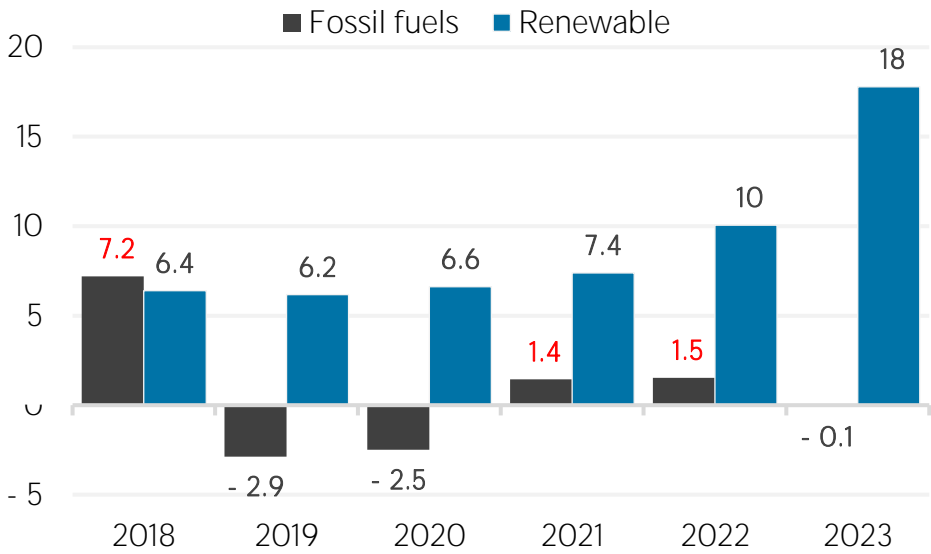
Capacity utilisation in 2022 (%)

Fossil fuels	36%
Nuclear	64%
Hydro/Marine	36%
Solar	11%
Wind	22%
Bioenergy	56%
Geothermal	49%
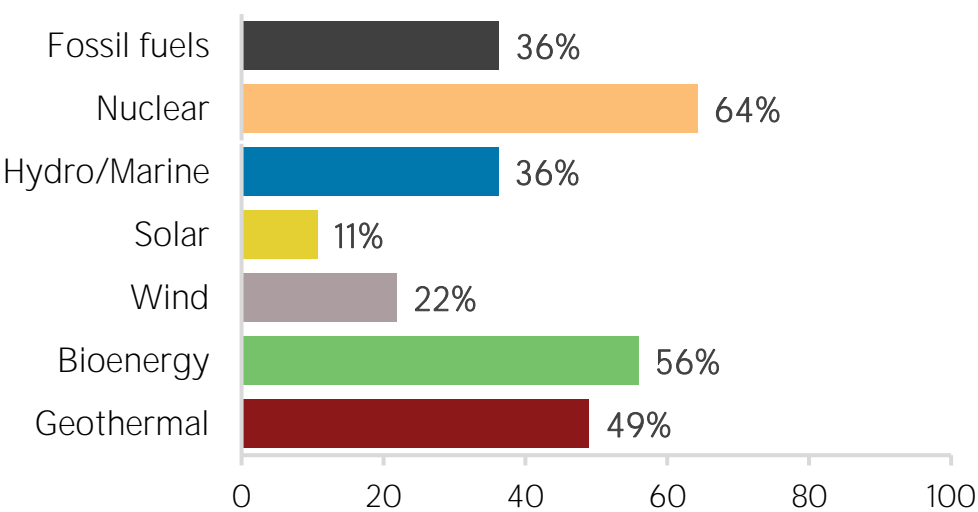
ELECTRICITY GENERATION

Generation in 2022	GWh	%
Non-renewable	329 179	57
Renewable	251 087	43
Hydro and marine	17 625	3
Solar	60 304	10
Wind	124 816	22
Bioenergy	48 136	8
Geothermal	206	0
Total	580 266	100

Per capita electricity generation (kWh)

Total — Renewable
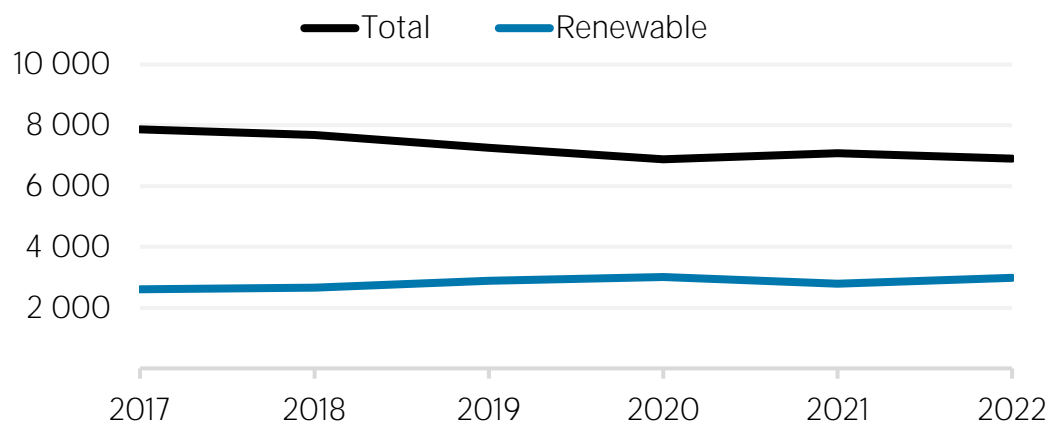
Electricity generation trend

Legend: Fossil fuels, Nuclear, Other Non-RE, Hydro/marine, Wind, Solar, Bioenergy, Geothermal, Renewable share

Gigawatt-hours (GWh) / Renewable share (%)

654, 640, 607, 575, 593, 580

43%
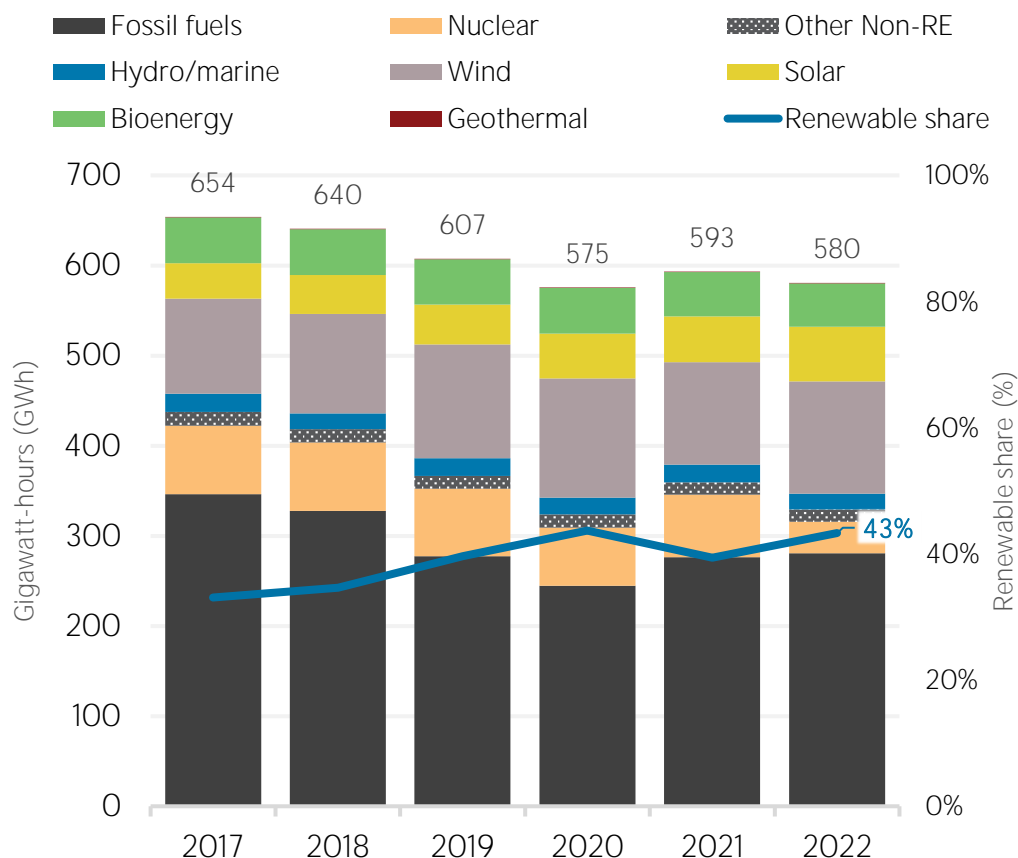
LATEST POLICIES, PROGRAMMES AND LEGISLATION

| 1 | Electricity, gas and heating price brakes | 2023 |
2	France-Germany-Italy Joint Communique on Critical Raw Materials	2023
3	Joint declaration of intent between Australia and Germany on a critical minerals value chain feasibility study	2023
4	National Security Strategy: Integrated Security for Germany	2023
5	Policy paper of the Federal Ministry of Economics and Climate Action: Ways to a sustainable and resilient supply of raw materials	2023

ENERGY AND EMISSIONS

CO_2 emissions by sector

Legend: Elec. & heat, Industrial Combustion, Transport, Processes, Buildings, Fuel Exploitation, Agriculture, Waste

Mt CO2 Emissions

-12%

Elec. & heat generation CO_2 emissions in

245 Mt CO_2

2%, 19%, 80%

Coal + others, Gas, Oil
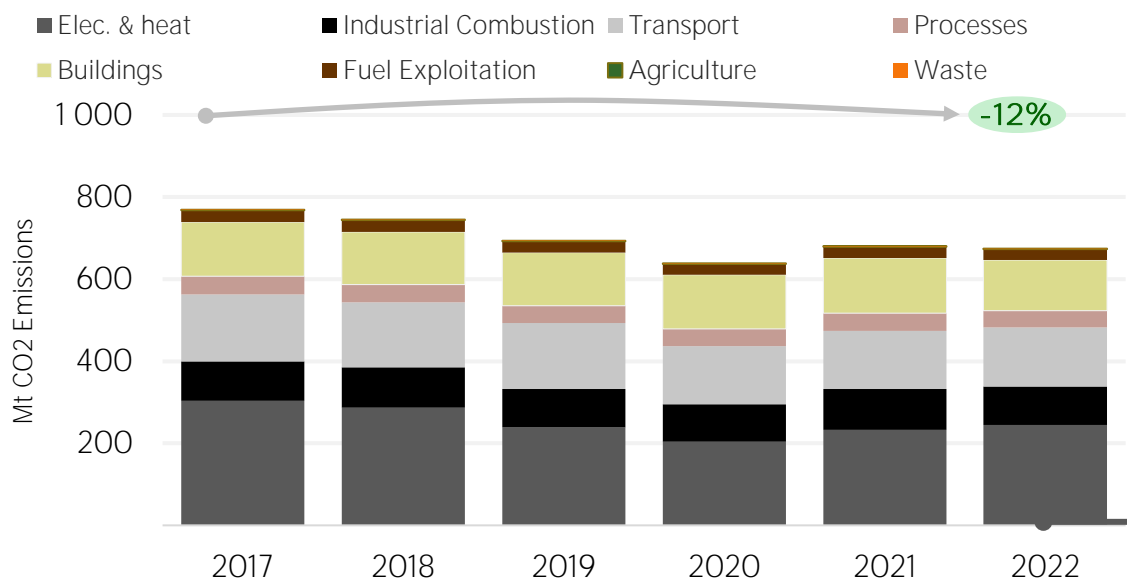
Avoided emissions from renewable elec. & heat

Emitted CO2, RE Avoided CO2
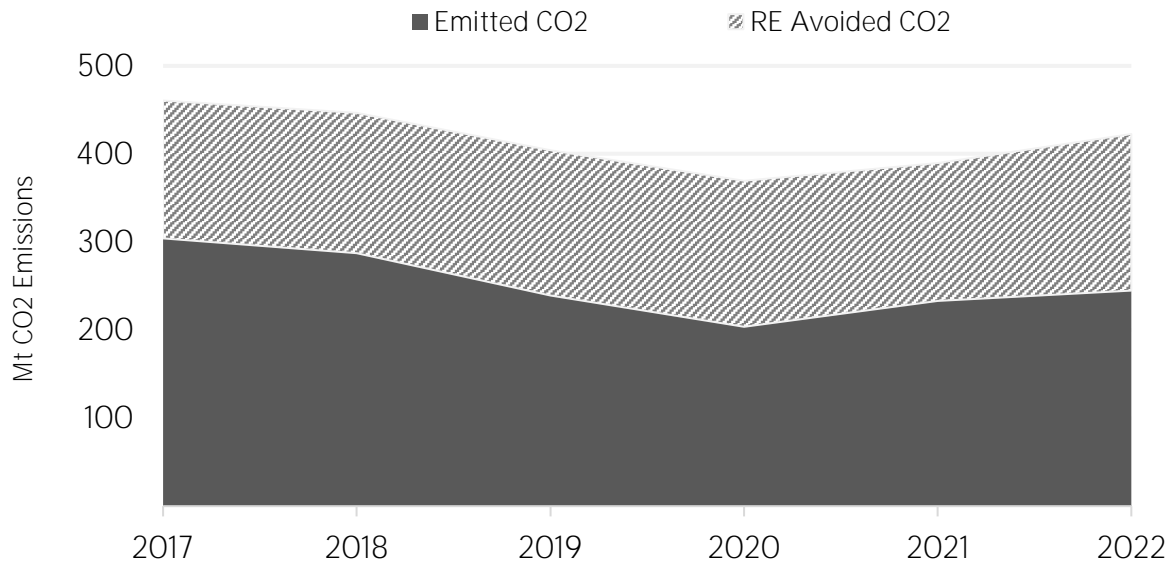
Mt CO2 Emissions

Avoided emissions based on fossil fuel mix used for power
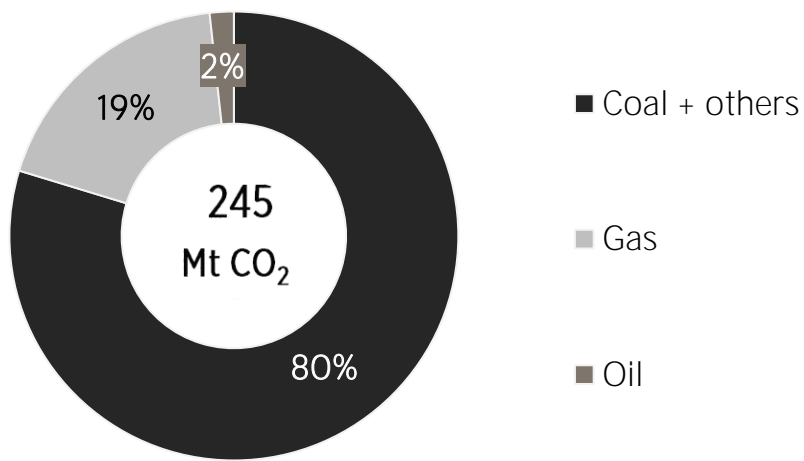
CO_2 emission factor for elec. & heat generation

DEU, Europe, World

tCO_2/GWh

395, 358
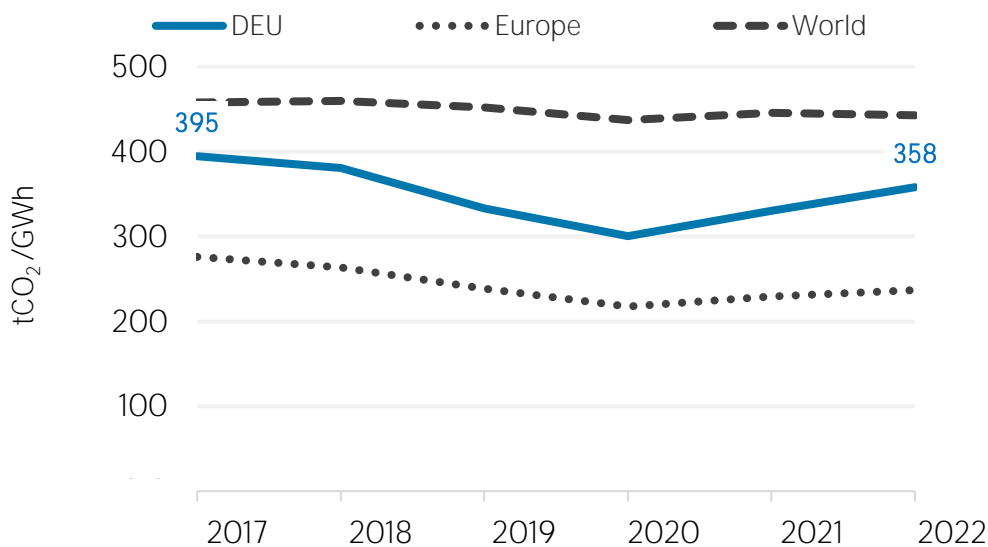
Calculated by dividing power sector emissions by elec. + heat gen.

Distribution of solar potential

Legend: World | Germany

Proportion of land area (y-axis): 100%, 80%, 60%, 40%, 20%

Annual generation per unit of installed PV capacity (MWh/kWp) (x-axis): <1.2, 1.2 - 1.4, 1.4 - 1.6, 1.6 - 1.8, 1.8 - 1.9, 1.9 - 2.0, >2.0
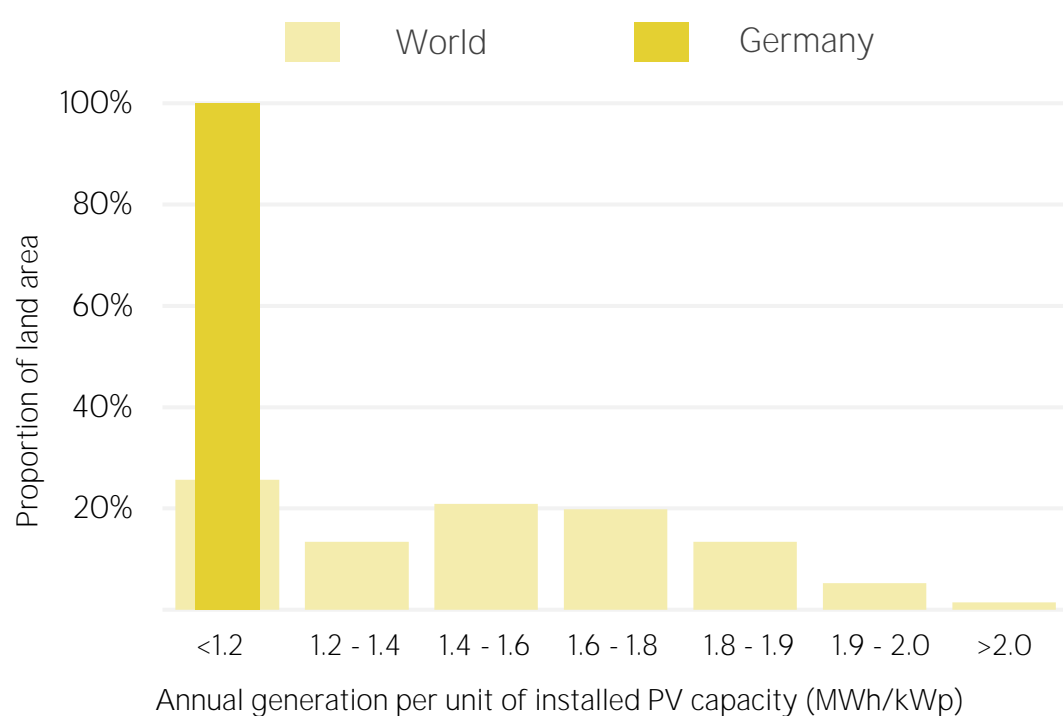
Distribution of wind potential

Legend: World | Germany

Proportion of land area (y-axis): 100%, 80%, 60%, 40%, 20%

Wind power density at 100m height (W/m²) (x-axis): <260, 260-420, 420-560, 560-670, 670-820, 820-1060, >1060
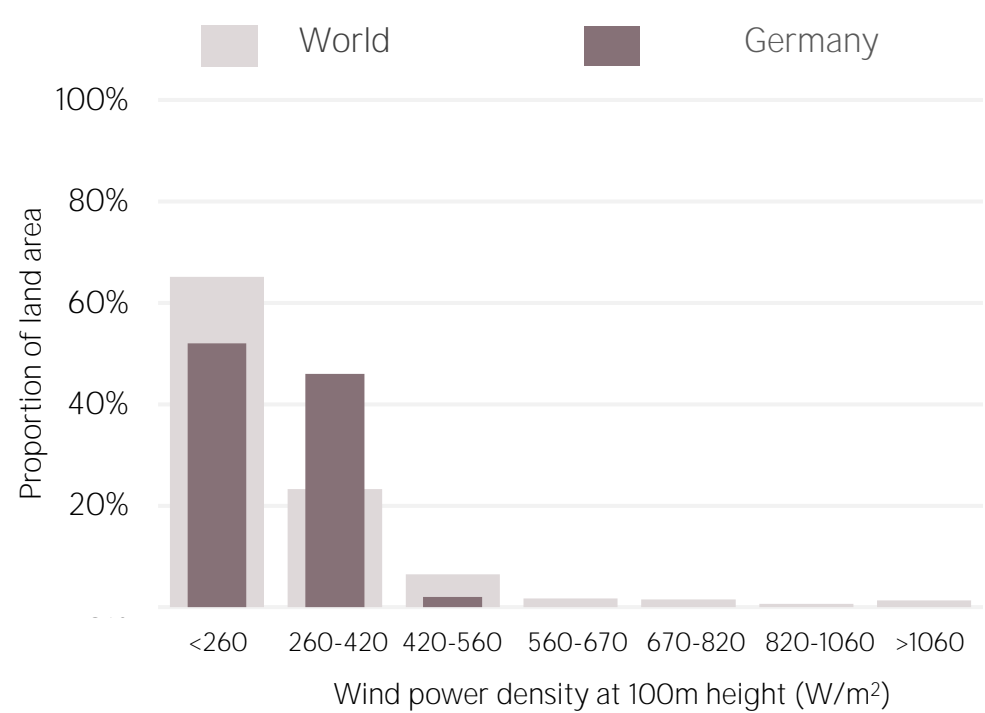
Biomass potential: net primary production

5.5
tC/ha/yr

● = Global average of 3-4 tC/ha/yr
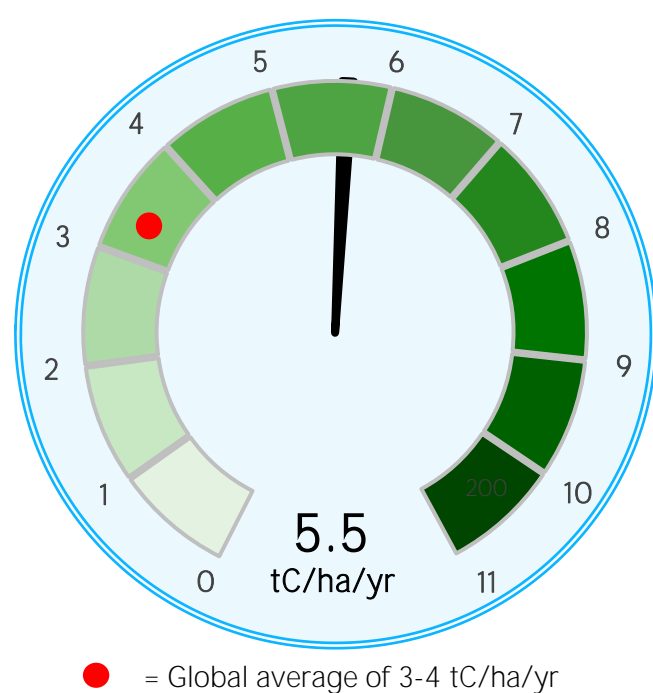
Indicators of renewable resource potential

Solar PV: Solar resource potential has been divided into seven classes, each representing a range of annual PV output per unit of capacity (kWh/kWp/yr). The bar chart shows the proportion of a country's land area in each of these classes and the global distribution of land area across the classes (for comparison).

Onshore wind: Potential wind power density (W/m²) is shown in the seven classes used by NREL, measured at a height of 100m. The bar chart shows the distribution of the country's land area in each of these classes compared to the global distribution of wind resources. Areas in the third class or above are considered to be a good wind resource.

Biomass: Net primary production (NPP) is the amount of carbon fixed by plants and accumulated as biomass each year. It is a basic measure of biomass productivity. The chart shows the average NPP in the country (tC/ha/yr), compared to the global average NPP of 3-4 tonnes of carbon

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