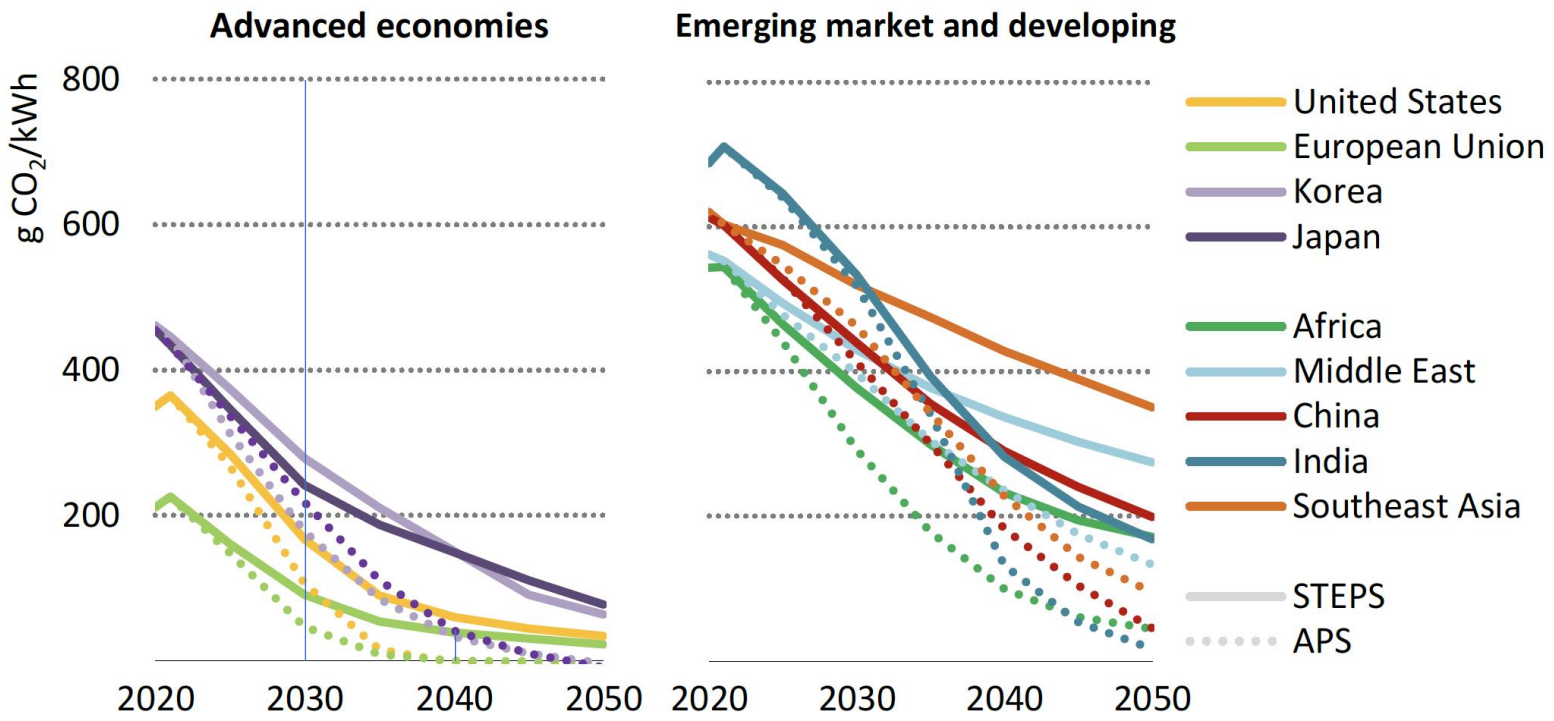
Data on Carbon Intensity of Electric Power

Benno List, DESY

Figure 6.14 ▷ Average CO_2 intensity of electricity generation for selected regions by scenario, 2020-2050



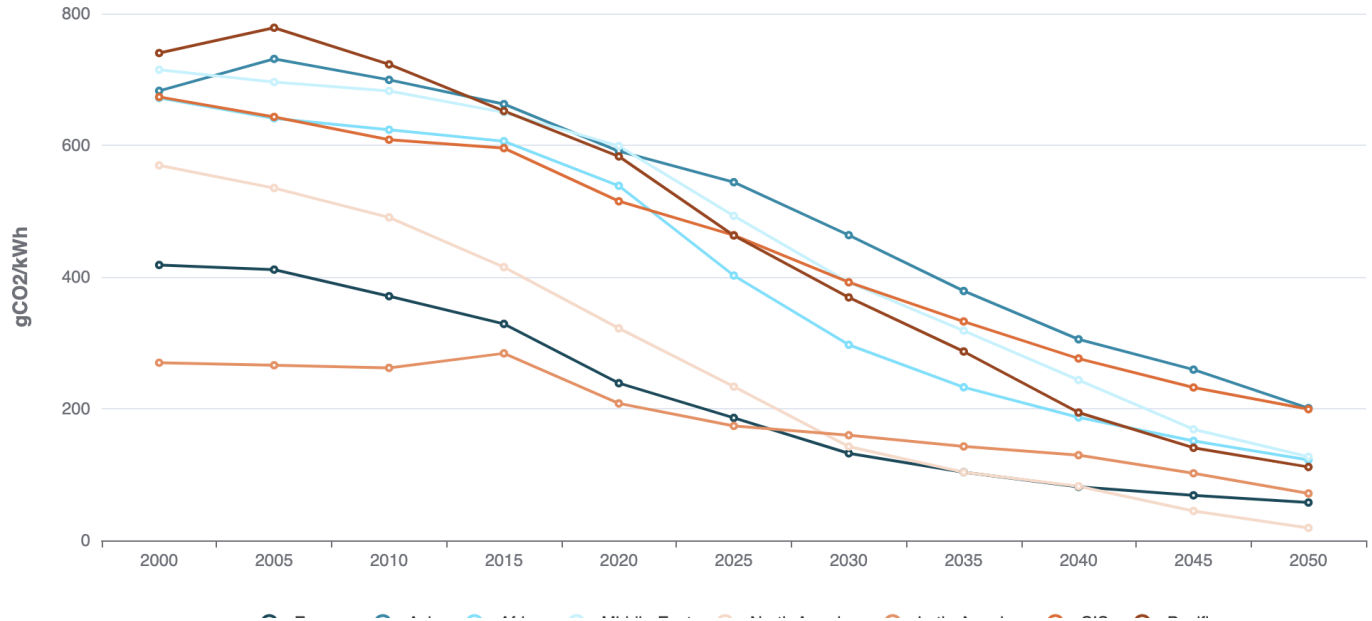
IEA. CC BY 4.0.

CO_2 intensity of electricity generation varies widely today, but all regions see a decline in future years and many have declared net zero emissions ambitions by around 2050

Trend over 2000 - 2050 - EnerBlue scenario

World

Benchmark countries

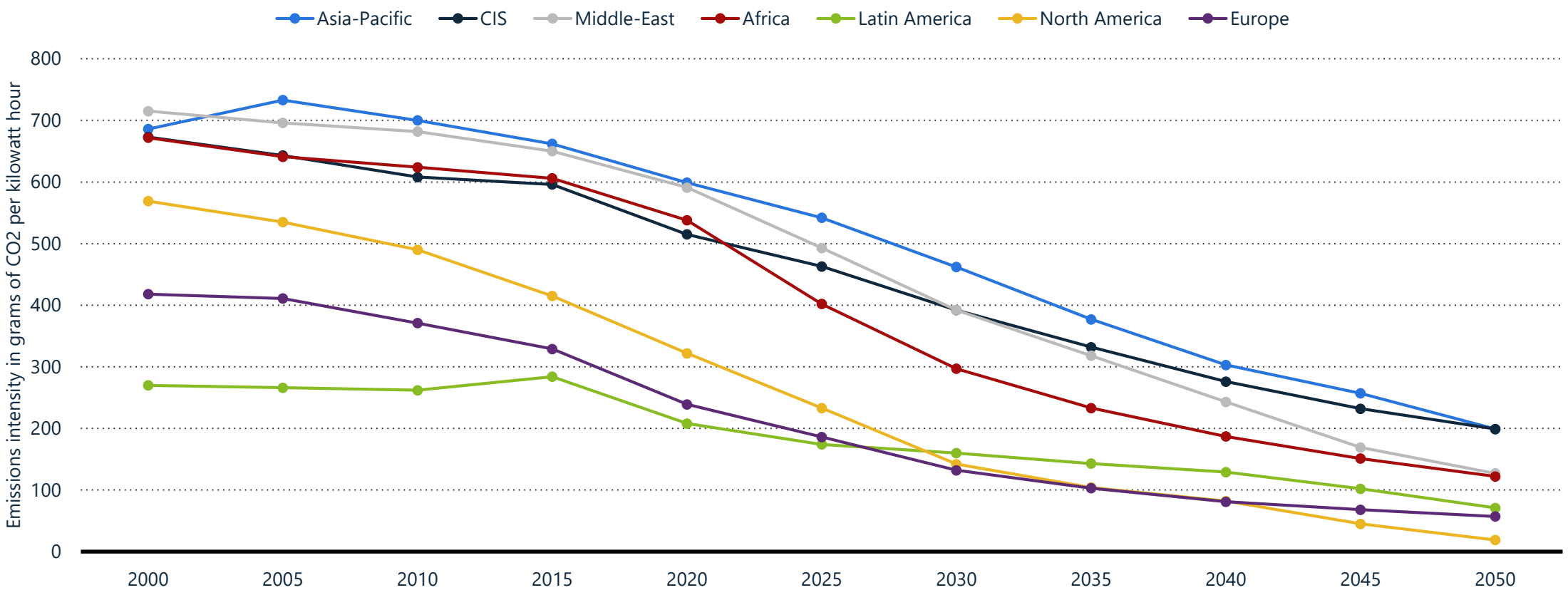


https://eneroutlook.enerdata.net/forecast-world-co2-intensity-of-electricity-generation.html

Europe 2040: 81g/kWh

Forecasted CO2 intensity of electricity generation worldwide from 2000 to 2050, by region (in grams of carbon dioxide per kilowatt hour)*

CO2 intensity of electricity generation worldwide 2000-2050, by region



Note(s): Worldwide; 2022

Further information regarding this statistic can be found on page 8.

Source(s): Enerdata; ID 1257765

Forecasted CO2 intensity of electricity generation worldwide from 2000 to 2050, by region (in grams of carbon dioxide per kilowatt hour)*

CO2 intensity of electricity generation worldwide 2000-2050, by region

Source and methodology information

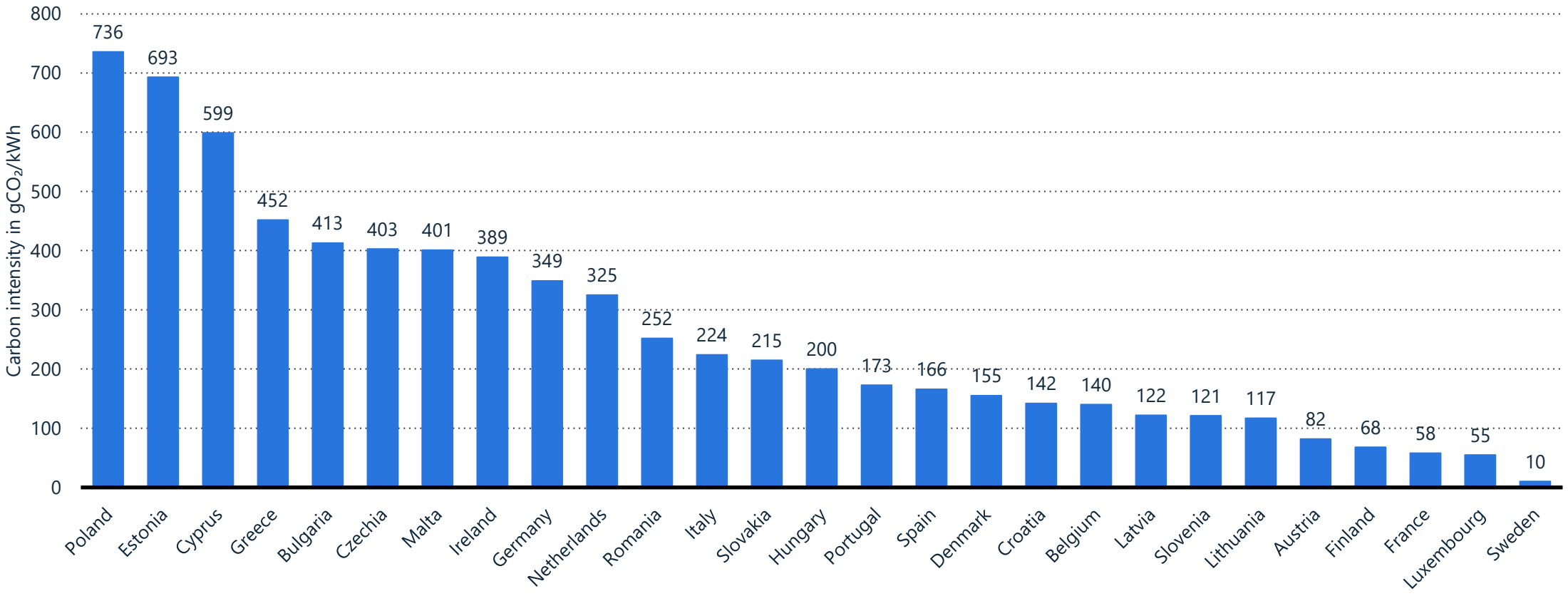
Source(s)	Enerdata
Conducted by	Enerdata
Survey period	2022
Region(s)	Worldwide
Number of respondents	*n.a.*
Age group	*n.a.*
Special characteristics	*n.a.*
Published by	Enerdata
Publication date	June 2022
Original source	EnerOutlook 2050, 2022 Edition
Website URL	visit the website
Notes:	*CO2 intensity of electricity generation represents the amount of anthropogenic CO2 emissions associated to the generation of one kilowatt-hour of electricity. Forecast is based on the successful achievement of NDCs (Nationally Determined Contributions) announced in the 2015 Paris agreement (not incl [...] For more information visit our Website*

Description

The carbon intensity of electricity generation has fallen in all regions since the turn of the century, and this trend is expected to continue in the coming decades. As of 2020, the Asia-Pacific region had the highest CO2 intensity from electricity generation of any region, at 599 grams of CO2 per kilowatt-hour. Projections show that by 2050, should all NDCs be successfully achieved, the CO2 intensity in the Asia-Pacific region will have decreased to 199 grams of CO2 per kilowatt-hour. North America is forecast to have the lowest emissions intensity by 2050, at 19 grams of CO2 per kilowatt-hour. The United States accounts for the majority of electric power emissions in North America.

Carbon intensity of the power sector in the European Union in 2021, by country (in grams of CO_2 per kilowatt-hour)

Power sector carbon intensity in the European Union 2021, by country



Note(s): EU; 2021

Further information regarding this statistic can be found on page 8.

Source(s): Ember; ID 1291750

Carbon intensity of the power sector in the European Union in 2021, by country (in grams of CO_2 per kilowatt-hour)

Power sector carbon intensity in the European Union 2021, by country

Source and methodology information

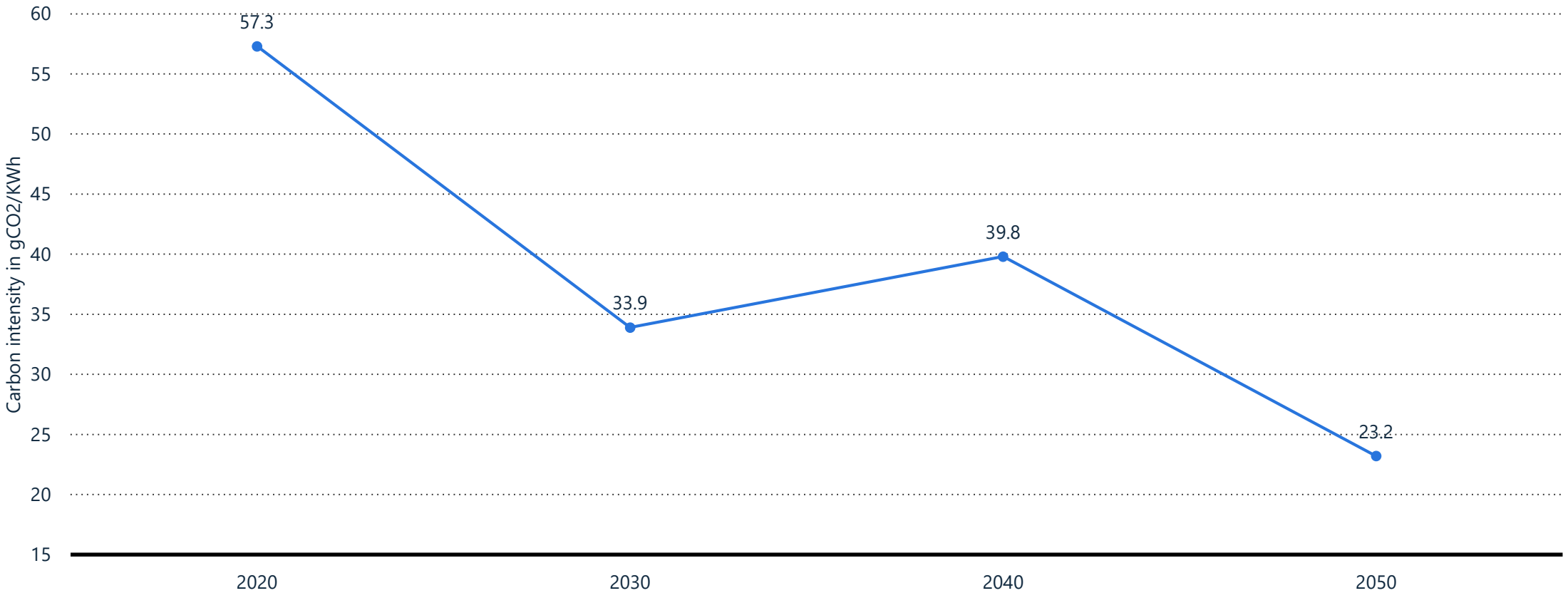
Source(s)	Ember
Conducted by	Ember
Survey period	2021
Region(s)	EU
Number of respondents	*n.a.*
Age group	*n.a.*
Special characteristics	*n.a.*
Published by	Ember
Publication date	February 2022
Original source	ember-climate.org
Website URL	visit the website
Notes:	*Figures are estimates.*

Description

In 2021, Poland recorded the largest power sector carbon intensity in the European Union, estimated at 736 grams of CO_2 per kilowatt-hour of electricity generated. Estonia followed in close second, with almost 700 gCO_2/kWh. Meanwhile, Sweden's power sector was the least carbon-intensive in the EU, with 10 gCO_2/kWh.

Carbon intensity outlook of the power sector in France from 2020 to 2050 (in grams of CO2 per kilowatt-hour)

Power sector carbon intensity outlook in France 2020-2050



Note(s): France; 2020

Further information regarding this statistic can be found on page 8.

Source(s): Aurora Energy Research; ID 1190067

Carbon intensity outlook of the power sector in France from 2020 to 2050 (in grams of CO2 per kilowatt-hour)

Power sector carbon intensity outlook in France 2020-2050

Source and methodology information

Source(s)	Aurora Energy Research
Conducted by	Aurora Energy Research
Survey period	2020
Region(s)	France
Number of respondents	*n.a.*
Age group	*n.a.*
Special characteristics	*n.a.*
Published by	Aurora Energy Research
Publication date	October 2020
Original source	auroraer.com
Website URL	visit the website
Notes:	*n.a.*

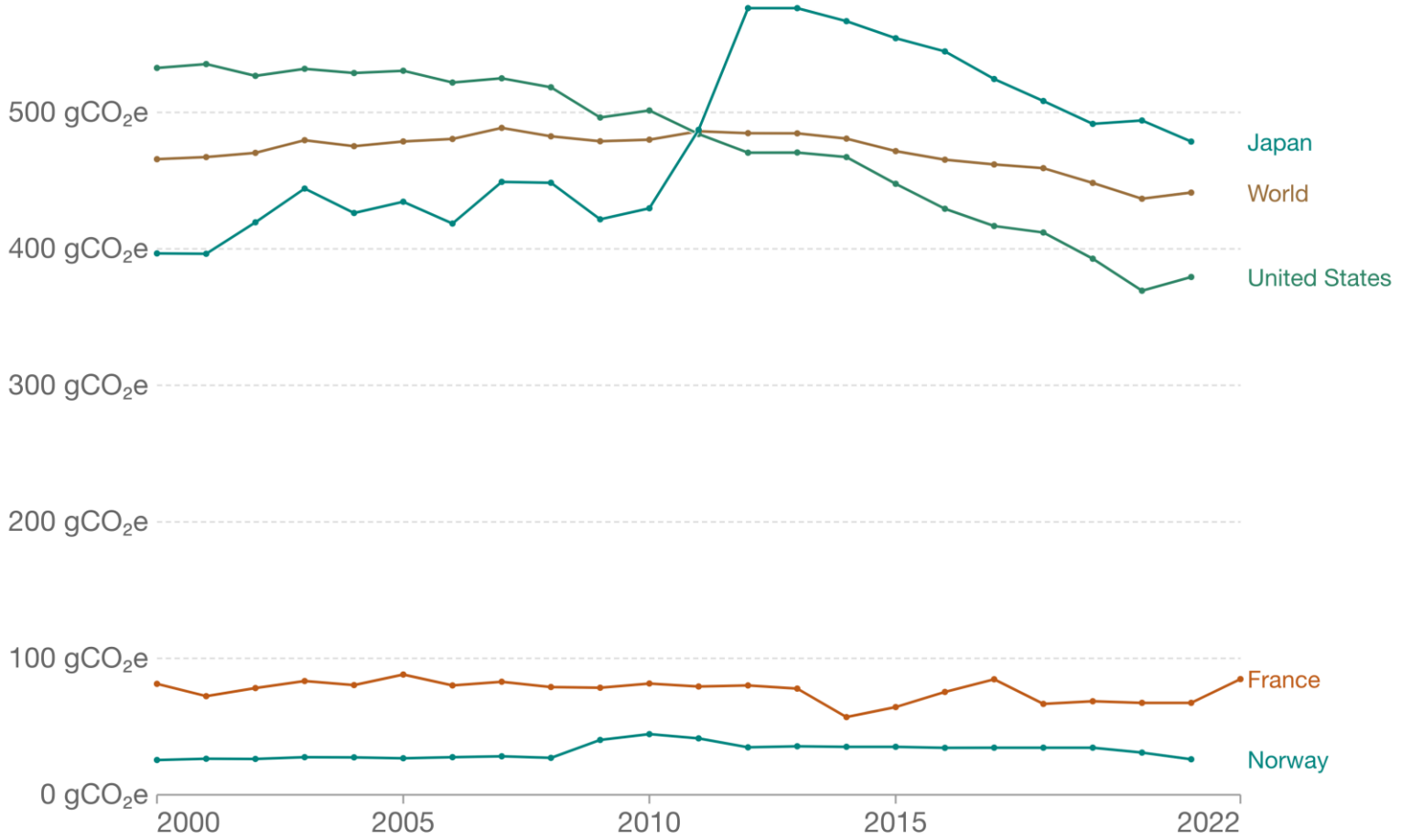
Description

The power sector in France emitted 57.3 grams of carbon dioxide per kilowatt-hour (gCO2/KWh) of electricity generated in 2020. Projections show that in 2050, France's power sector will emit roughly 70 gCO2/KWh. One reason for France's relatively low carbon intensity is its use of nuclear power. Unlike fossil fuels such as coal, nuclear power does not produce direct CO2 emissions. Nuclear power in France accounts for more than 70 percent of the country's total power generation.

Carbon intensity of electricity, 2000 to 2022

Carbon intensity is measured in grams of carbon dioxide-equivalents[1] emitted per kilowatt-hour of electricity.

Our World in Data



Source: Ember Climate (from various sources including the European Environment Agency and EIA)

OurWorldInData.org/energy • CC BY

1. Carbon dioxide-equivalents (CO_2eq): Carbon dioxide is the most important greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers express them in 'carbon dioxide-equivalents' (CO_2eq). This takes all greenhouse gases into account, not just CO_2. To express all greenhouse gases in carbon dioxide-equivalents (CO_2eq), each one is weighted by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO_2. CO_2 is given a GWP value of one. If a gas had a GWP of 10 then one kilogram of that gas would generate ten times the warming effect as one kilogram of CO_2. Carbon dioxide-equivalents are calculated for each gas by multiplying the mass of emissions of a specific greenhouse gas by its GWP factor. This warming can be stated over different timescales. To calculate CO_2eq over 100 years, we'd multiply each gas by its GWP over a 100-year timescale (GWP100). Total greenhouse gas emissions – measured in CO_2eq – are then calculated by summing each gas' CO_2eq value.

https://ourworldindata.org/grapher/carbon-intensity-electricity?tab=chart&country=FRA~EU-27~OWID_WRL~NOR~JPN~USA

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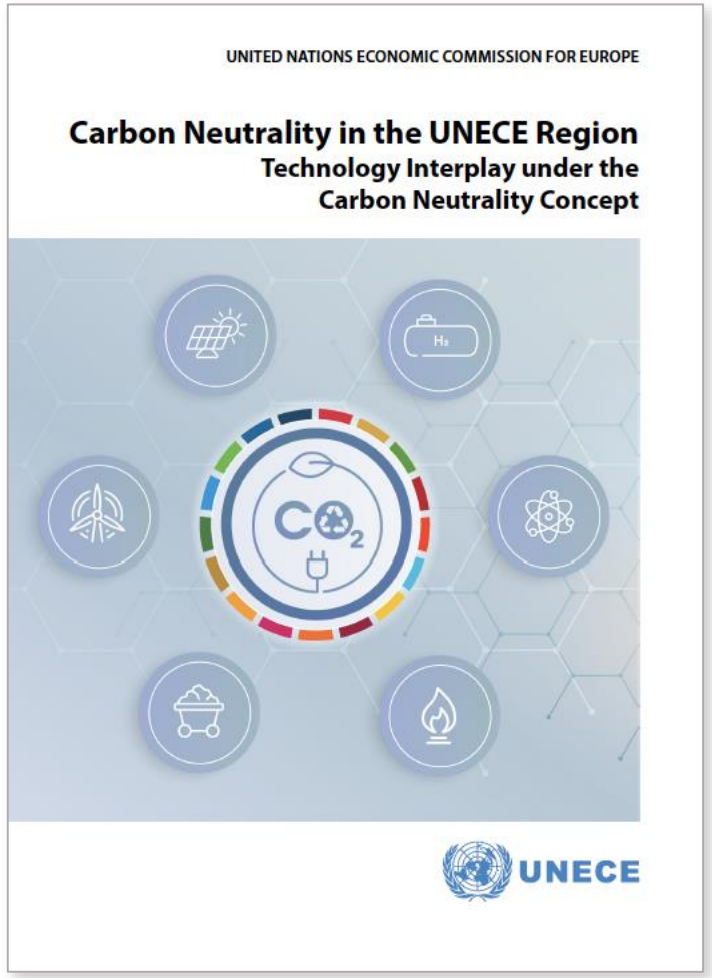
Carbon intensity of electricity, 2000 to 2022

Carbon intensity is measured in grams of carbon dioxide-equivalents emitted per kilowatt-hour of electricity.

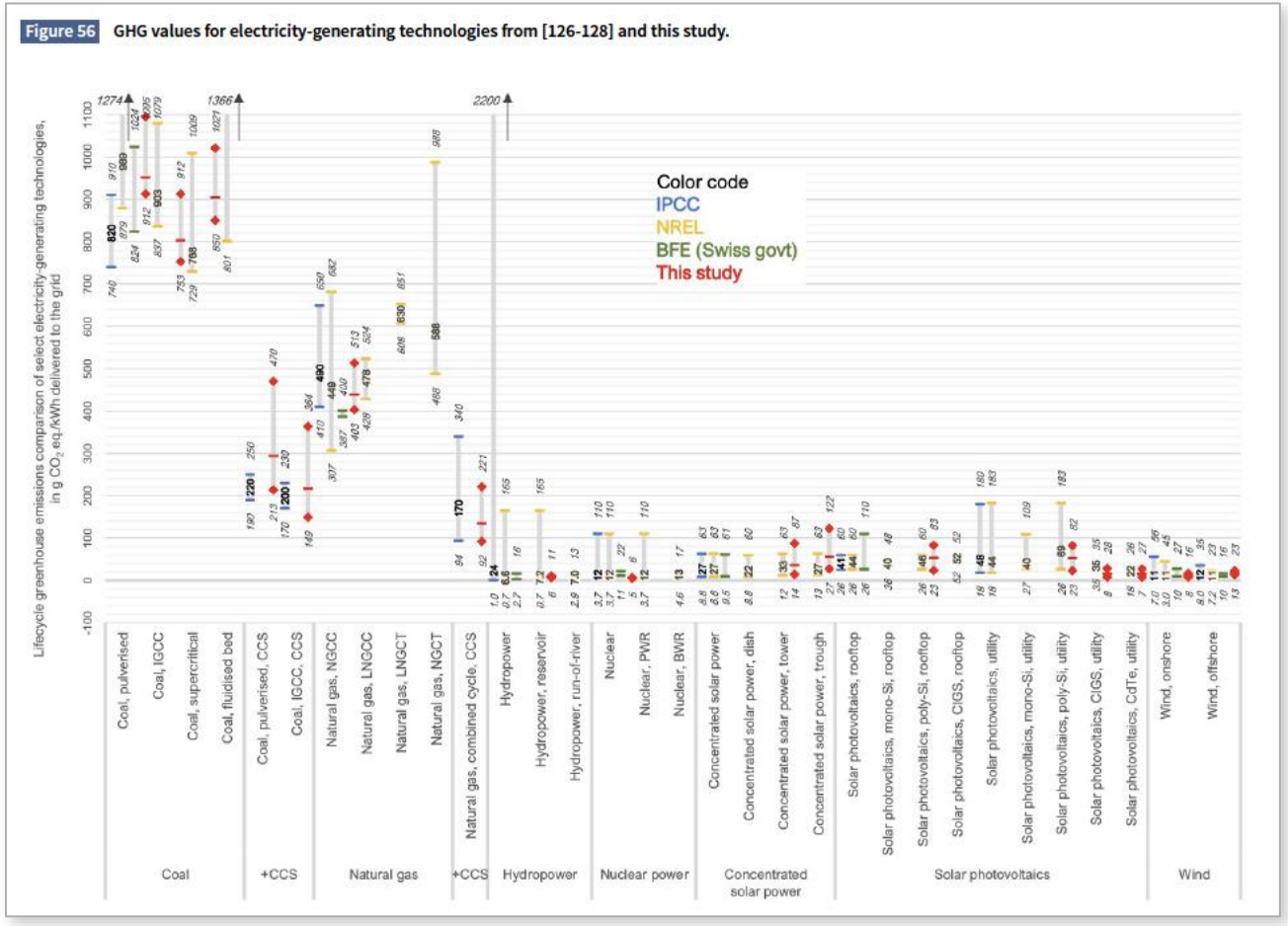
Source: Ember Climate (from various sources including the European Environment Agency and EIA)

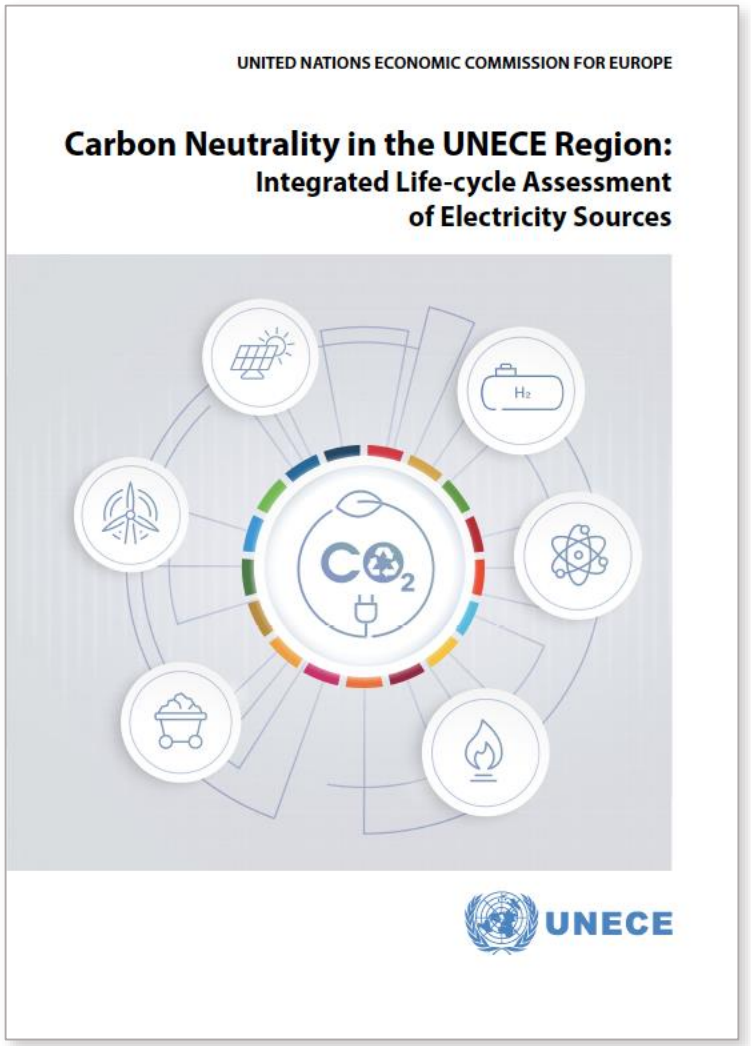
This UNECE (UN Economic Commission for Europe) gives full life cycle analyses for various energy types



https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

Carbon Intensity of Electricity Technologies





https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

Figure 53 Normalised, weighted, environmental impacts of the generation of 1 TWh of electricity

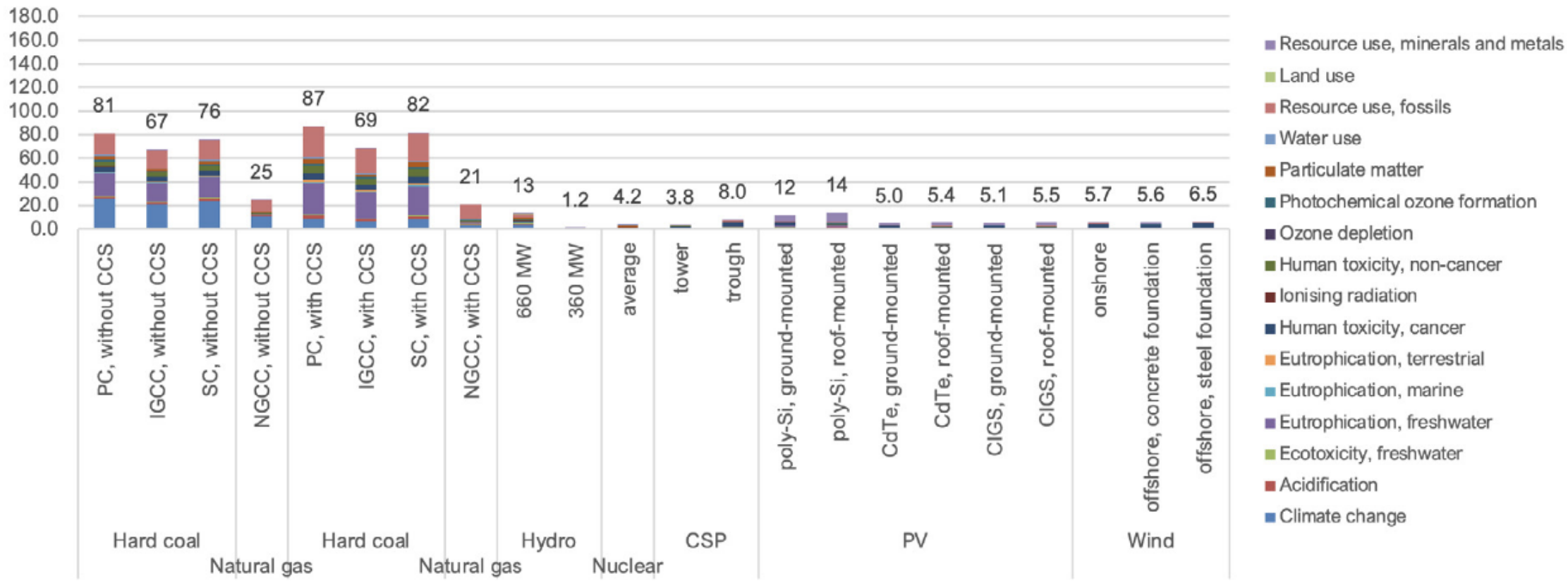
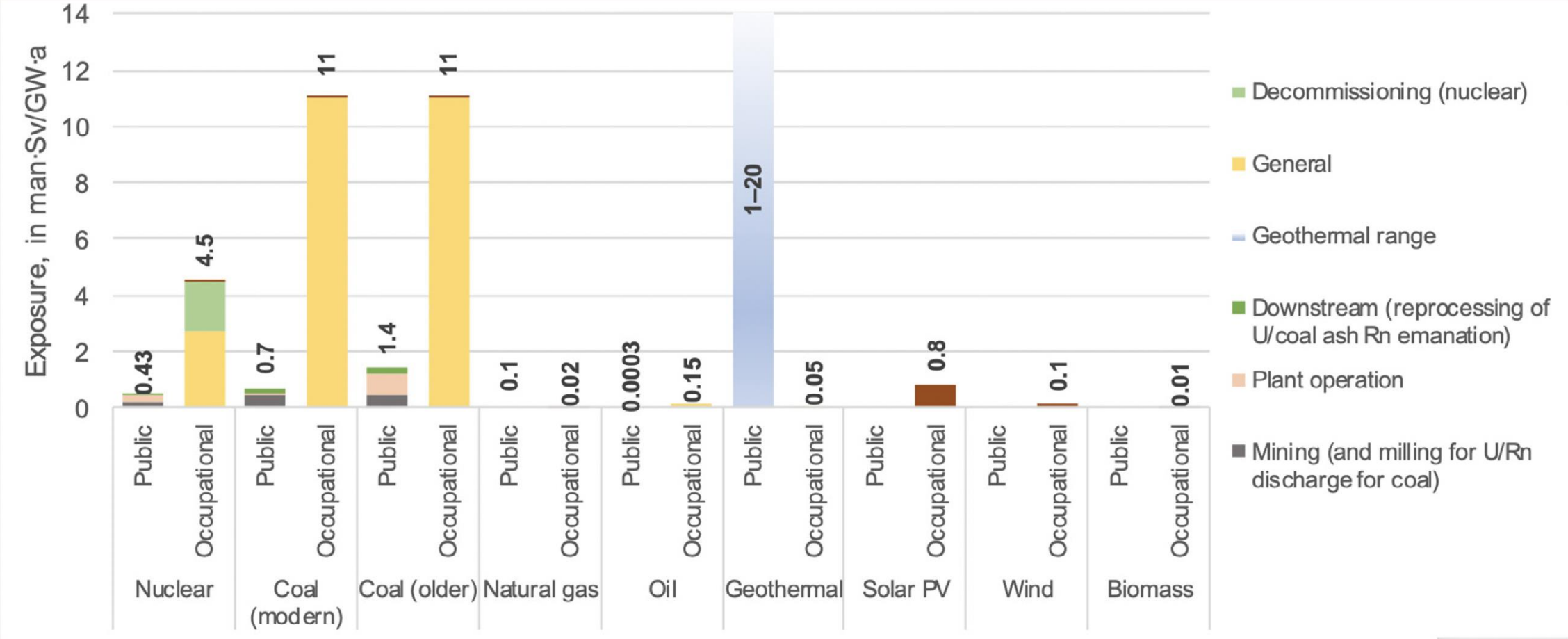


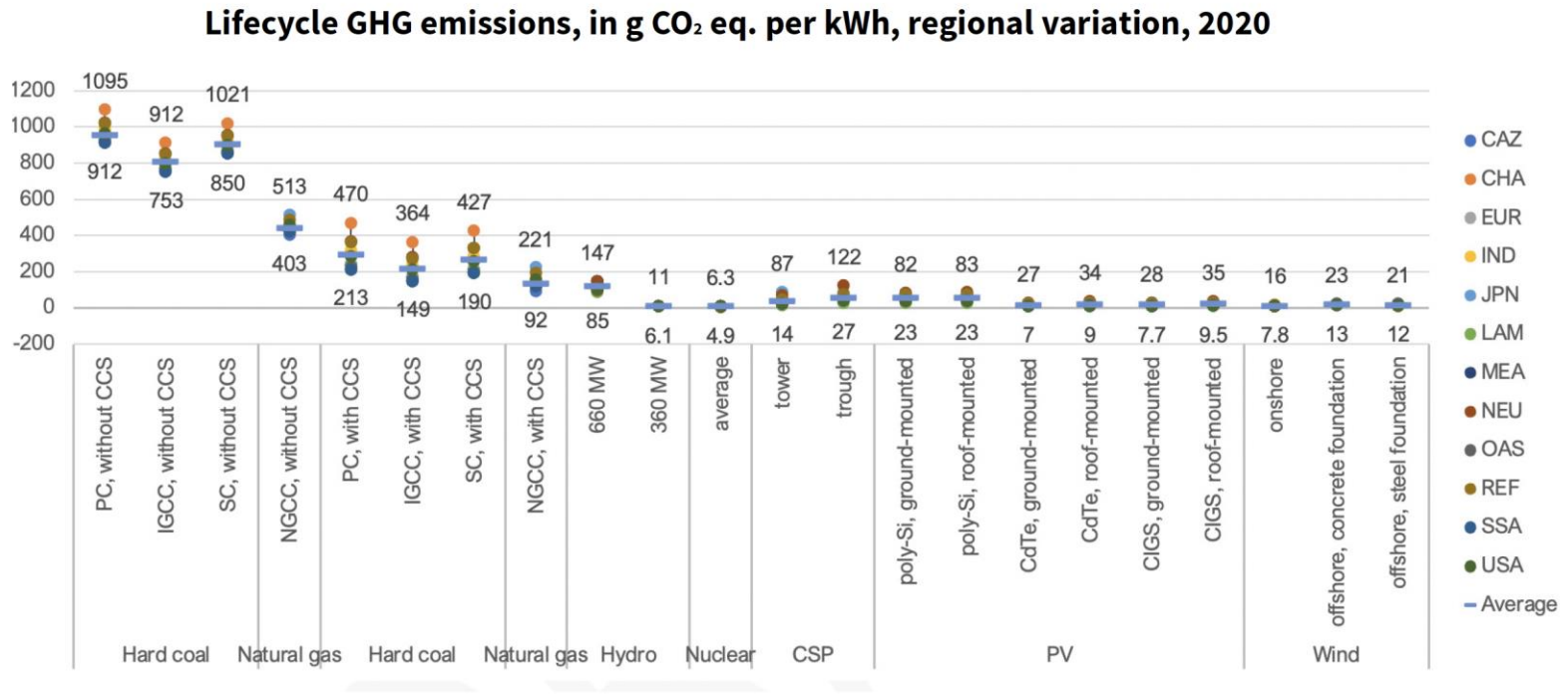
Figure 40 **Public and occupational exposures from electricity generation, normalized to electricity generated, in man-Sievert per GW-annum (8760 GWh).**



Source: *United Nations Scientific Committee on the Effects of Atomic Radiation [2].*

https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

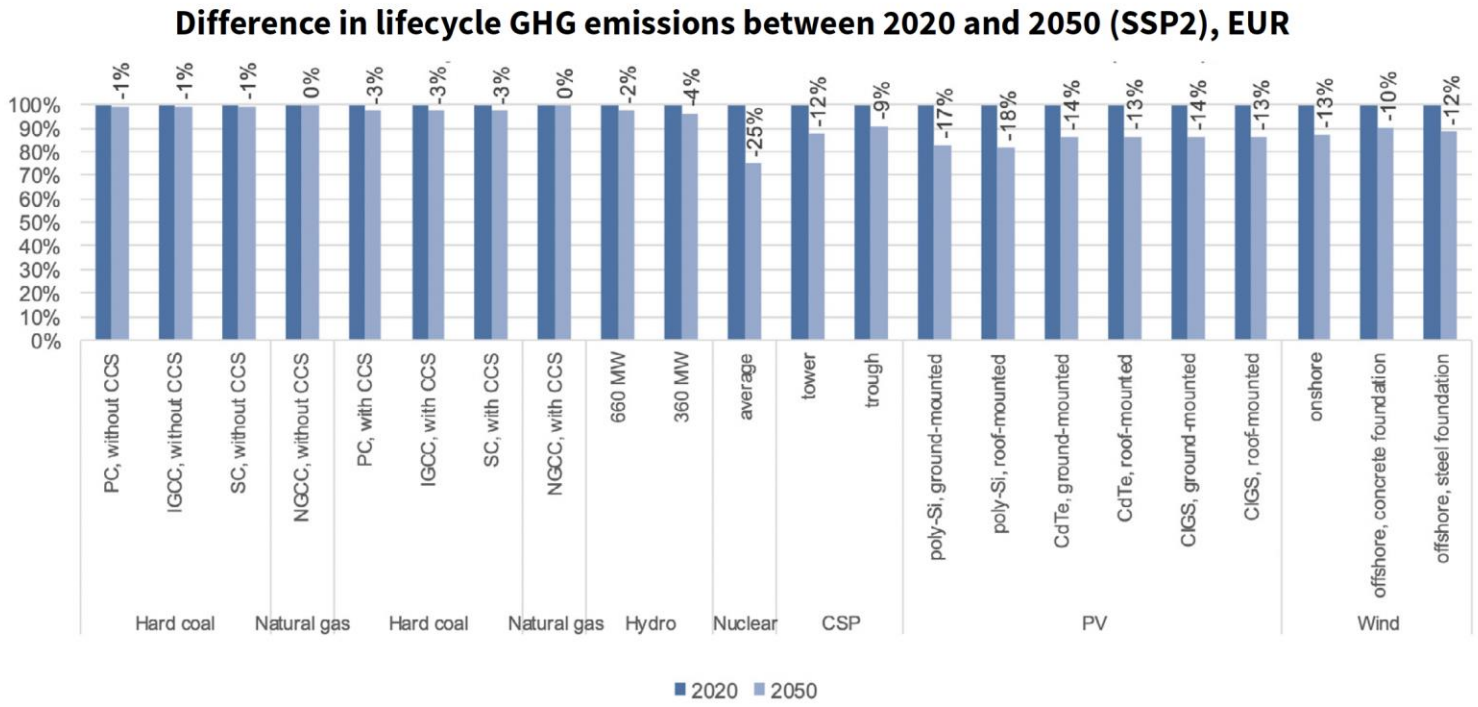
Figure 37 Lifecycle greenhouse gas emissions' regional variations for year 2020. Variability is explained by several factors: electricity mix (all regions), methane leakage rates (fossil fuels), load factors (renewables). Nuclear power is modelled as a global average except for back-end.



PC: Pulverized Coal
CCS: Carbon (dioxide) Capture and Storage
CSP: Concentrated Solar Power
PV: Photovoltaics

https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf

Figure 38 Differences in lifecycle greenhouse gas emissions between 2020 and 2050, due to the evolution of background electricity mixes and industrial processes. Please note that no change in the technology datasets themselves have been modelled for this figure.



https://unece.org/sites/default/files/2022-04/LCA_3_FINAL%20March%202022.pdf