

European Electricity Review 2022:

Methodology

This annual report analyses electricity data from European countries to give the first accurate view of the European electricity transition in 2021. It includes generation data by fuel by country from 2000 to 2021. 32 countries have full-year data to 2021, including all EU-27 members except Malta; other countries have full data as far as 2019. The report also includes data on generation capacity over time, as well as emissions from electricity generation.

Data is assembled from a number of sources, none of which is perfect. Every effort has been made to ensure accuracy, and where possible we compare multiple sources to confirm their agreement. We take no responsibility for errors. If you notice an issue or have any suggestions, please do contact us at data@ember-climate.org.

Definitions

Fuel data is mapped into ten generation types: Biomass, Gas, Hard Coal, Hydro, Lignite, Nuclear, Other Fossil, Other Renewables, Solar, and Wind. More information on mapping for different sources and countries can be viewed below. For the purpose of analysis these generation types are aggregated into the following categories:

- Hard Coal
- Lignite
- Gas
- Other Fossil
- Nuclear
- Bioenergy
- Solar
- Wind
- Hydro
- Other Renewables

For the purposes of this report, renewables are classified in line with the IPCC and include bioenergy. However, the climate impact of bioenergy is highly dependent on the feedstock, how it was sourced and what would have happened had the feedstock not been burnt for energy. The current EU bioenergy sustainability criteria do not sufficiently regulate out high-risk feedstocks and therefore electricity generation from bioenergy cannot be automatically assumed to deliver similar climate benefits to other renewables sources (such as wind and solar) over timescales relevant to meeting the commitments of the Paris Agreement. For more information please see Ember's reports: [Understanding the Cost of the Drax BECCS Plant to UK Consumers](#) (May 2021), [The Burning Question](#) (June 2020), and [Playing with Fire](#) (December 2019).

Generation and Imports

Overview

Data up to the end of 2019 is taken from the European Commission's [Eurostat](#) annual data for all countries included in this report. This data is thoroughly quality assured and represents *gross* generation, including auxiliary power used in generator function. Historical net import data is also acquired from Eurostat for all countries.

More recent data is gathered as monthly *net* generation, and excludes auxiliary power. Year-on-year changes in generation per fuel type from this data are added onto 2019 Eurostat data to obtain estimates for gross generation in 2020 and 2021. Net import data for 2020 and 2021 is derived in the same way.

For a few countries, monthly data was not available up to the end of 2021 at the time of publication; these are noted both below and in the dataset. In these cases, incomplete months are projected based on both seasonal and interannual trends. Given the unusual nature of power generation during European COVID-19 lockdowns, we use 2019 rather than 2020 as a point of reference.

The majority of monthly data is taken from the [ENTSO-E](#) transparency platform. In some cases data is unavailable, and in others there are known quality issues which make using another source necessary for some or all fuel types. Nationally reported sources are preferred; in three cases we use Eurostat monthly data and project several months forward. In one case (Malta), acceptable data is not available from any source. Here we carry 2019 data forward. All countries using any non-ENTSO-E sources or projections are described below.

Individual Country Monthly Data

Cyprus

Data is taken from Eurostat monthly generation, with November and December data projected forward. Nationally reported data is available from the Cyprus Transmission System Operator ([TSOC](#)), but it is not sufficiently disaggregated by fuel type.

Germany

German gas data is provided to Ember by [Agora Energiewende](#). Our estimated coal value for 2021 differs from annual analysis performed by others; at present it is unclear why. It is possible that some ENTSO-E coal generation data in 2021 has been misclassified, with some reported generation in fact being gas rather than coal. However, we do not have clear evidence that this is the case at this time.

Spain

Spanish import data is incomplete in ENTSO-E, as it does not include trade with non-EU countries such as Morocco. It is provided by the Spanish System Operator Information System ([eSIOS](#)).

Finland

Finnish data in ENTSO-E is known to undercount bioenergy, and to show low volatility compared to expectation. We take bioenergy, solar, gas, wind and hydro from Eurostat monthly data, projecting November and December. Data is also available in national [Finnish Energy](#) statistics, which Eurostat figures are taken from.

United Kingdom

Since Brexit, Great Britain no longer reports generation data to ENTSO-E. Data for all fuel types and imports is taken from the monthly Elexon Sum Plus Embedded Net Imports ([ESPENI](#)) publication by the University of Birmingham Energy Informatics Group.

Northern Ireland continues to report generation to ENTSO-E. This data is combined with ESPENI data to produce an aggregate value for the UK.

Italy

ENTSO-E reported bioenergy, solar, and imports are known to be inaccurate. We take data for these from the Italian Grid Operator ([Terna](#)) transparency platform.

Luxembourg

Luxembourg generally does not report to ENTSO-E. As such, all data is taken from Eurostat monthly data, with November and December projected forward.

Malta

No acceptable monthly data could be gathered for Malta. Eurostat data does not include solar, while national data is published on too long a lag to be useful. In this case, 2019 annual data has been carried forward.

Netherlands

ENTSO-E renewables data seems to contain significant double counting. All monthly data is therefore taken from the Statistics Netherlands ([CBS](#)) API, with October, November and December projected.

Poland

Polish solar data is taken from [Instrat](#). November and December are projected.

Turkey

Both generation and import data for Turkey are provided by national source [EPIAS](#).

Capacity

Capacity represents the maximum nameplate output for different fuel types in a country. It is very rare for high quality capacity data to be available from national sources for 2000-2021 inclusive. Additionally, national data tends to be aggregated inconsistently across countries, making it difficult to compare.

As such, we take our data from two sources:

The **International Renewable Energy Agency (IRENA)** publishes capacity data for all countries, split for each renewable type and for nuclear. We have confirmed that this data matches well with most national datasets. Fossil capacity is less complete or reliable; we use “other fossil” for all countries, but it should be treated with care. The IRENA dataset is updated at the end of March for the previous year; data is therefore unavailable for 2021 at the time of publication.

Global Energy Monitor (GEM) publishes unit-by-unit coal and gas plant data that we aggregate into national annual data for coal and gas. Coal capacity matches very well with national sources, while gas capacity is at present somewhat less complete. The GEM dataset is updated in January for the previous year; data is therefore included for 2021 for these fuel types.

This data includes all on-grid sources, as well as off-grid and captive ones.

Carbon Intensity

Historic (2000-2019) direct greenhouse gas emissions from the power sector in the EU and by country are calculated as the product of greenhouse gas emission intensity of electricity generation from the [European Environment Agency \(EEA\)](#) and [Eurostat's gross electricity production](#). 2020 and 2021 EU direct greenhouse gas emissions from the power sector are estimated by calculating the percentage change in emissions between 2019 and both 2020 and 2021 using standard emissions factors and Ember's generation dataset - and then applying the calculated percentages to the historic EEA/Eurostat dataset described above. The standard (direct) emissions factors are as follows:

- Hard coal 830gCO₂eq/KWh
- Lignite 1100gCO₂eq/KWh
- Fossil gas 370gCO₂eq/KWh
- Other fossil fuels 700gCO₂eq/KWh.

The standard emissions factors reproduce recent historic emissions at an EU level, however, for a number of reasons these values will not be completely accurate at a country level. In particular, thermal plant efficiency and the carbon content of fuels varies by country, therefore country estimates have a lower confidence than the EU-wide estimates.

N.b. due to the methodology used by the EEA for the historic dataset, the values do not include CO₂eq emissions from the combustion of biomass; nor do they include upstream emissions (e.g. fugitive emissions due to methane leaks).