Ember Methodology for India's subnational data

Ember's India electricity dataset provides the following information:

- Electricity **generation** (GWh)
- Power generation **capacity** (MW)
- **Emissions** from electricity generation ($ktCO_2e$)
- Carbon intensity of electricity generation (gCO2 per KWh)

As of Nov 17, 2022, the dataset covers the following geographies and time:

- 36 states/union territories in **India**
  - From 2019 to latest data available
  - Monthly and yearly data for all metric

Notes

- The "India total" provided in this Explorer is the aggregated sum of subnational data. This is not necessarily in line with the national yearly data provided in the global Data Explorer. The annual data is from BP and includes estimation for captive generation, which this dataset does not.
- Dadra & Haveli and Daman & Diu are treated as one state throughout the time series.
- Generation and capacity data for Ladakh and Jammu & Kashmir are reported as one state until July 2021 due to inconsistencies in national reporting. MNRE does not report its renewable capacity until July 2021, despite the fact that Ladakh is an Union territory of India independent from Jammu & Kashmir state as of 2019-10-31.

All data can be downloaded for free on Ember Data Catalogue or India Data Explorer. It is provided on an 'as is' basis, and is assembled using the best data available to us at any given time. 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, comments, or questions, please contact us at data@ember-climate.org.

Electricity Generation and Capacity

Fuels

- Hydro includes small hydro and conventional hydro.
- Solar is the reported total value of all solar solar generation and capacity, including ground-mounted, rooftop, in-hybrid and off-grid.
- Bioenergy is the reported total value of all bio generation and capacity, including bagasse, non-bagasse biomass cogeneration, waste-to-energy (on and off-grid).
- Other fossils include diesel.

List of sources

Conventional Fuels (Coal, Hydro, Nuclear, Gas, Other fossil)

- Central Electricity Authority, via OPM Report Archive
    - Generation and capacity data from 2019-2020

- Central Electricity Authority, via National Power Portal
    - Generation and capacity data from Data 2021 and onwards

Renewable Fuels (Small hydro, Wind, Solar, Bioenergy, Other renewables)

- Central Electricity Authority, via Monthly Archive for Renewable Generation Reports
    - Generation data for 2019

- Central Electricity Authority, via Renewable Generation Reports
    - Generation data from 2020-onwards

- Ministry of New and Renewable Energy
    - Capacity data from 2019 March and onwards. The MNRE provides data for every month, but an archive for historical time-series is not publicly available. This data was retrieved using an internet archive, “Wayback Machine“. For months without a historical archive, we retrieved data from Andrew, R. 2022: “Indian Energy and Emissions Data. Since no historical data is available for sub fuel type, we rely on the fuel-specific totals as reported by the source. For months for which there is no data, we interpolate the missing values by using the value at the closest data extreme.

Emissions from Electricity Generation

*Note that the below methodology is used only for our **global** emissions figures. In certain cases, such as our 2022 European Electricity Review, other approaches may be used. This will be noted where it is the case, and specific methodologies will be made available for such datasets.*

Overview

We report emissions values by fuel type, and emissions intensity by country. These values are calculated by multiplying our generation numbers by emissions factors taken from the IPCC 5th Assessment Report Annex 3 (2014). These figures aim to include full lifecycle emissions including upstream methane, supply-chain and manufacturing emissions, and include all gases, converted into CO_2 equivalent over a 100 year timescale.

The emissions intensities we use are below, in carbon dioxide equivalent emitted per kilowatt hour of electricity (gCO_2eqkWh^{-1}):

- *Coal*: 820
- *Gas*: 490
- *Other Fossil*: 700
- *Wind*: 11
- *Solar*: 48
- *Bioenergy*: 230
- *Hydro*: 24
- *Other Renewables*: 38 (in line with the IPCC's "geothermal")
- *Nuclear*: 12

Caveats

IPCC figures still represent the most comprehensive attempt to estimate global fuel emissions intensities. Nonetheless, these emissions factors may differ from reality for a variety of reasons. Some of these are listed below:

Fuel quality

Fuels used in different regions can have different characteristics and emissions profiles. *Coal* is one example: softer coal grades, such as lignite (brown coal), produce greater carbon emissions per kilowatt hour than harder grades like anthracite.

Methane

In IPCC figures, upstream methane emissions for gas and coal generation are calculated on a long-term basis assuming methane is x21 as potent as CO_2; the short-term impact of

methane is actually four times higher, at x86 the potency of CO_2. See this page for more information.

In recent years, interest in upstream methane leaks has also increased for both gas and coal, and IPCC figures may no longer reflect best understanding. These leaks also vary by fuel origin, increasing geographic differences in fuel quality.

Thermal power plant efficiency

Coal and gas plants use several different technologies, with more recent plants generally being more efficient. The incidence of different technologies varies between countries, and over time within countries. In particular, new Chinese coal plants are generally more efficient than the ones they replace, leading to an emissions intensity reduction through time that is not captured in our figures.

Solar and wind

Recent efficiency improvements have seen *Wind* and *Solar* emissions intensity drop, as energy output has increased relative to emissions from manufacturing. IPCC numbers may therefore be higher than reality.

Bioenergy

As mentioned in *Definitions*, the emissions intensity 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 IPCC figure we use is for dedicated energy crops and crop residues, rather than the more commonly used woody or forest biomass, which has been shown to carry a greater risk of high-carbon outcomes. In certain cases, bioenergy can have a carbon intensity significantly greater than coal.

Bioenergy is also frequently cofired with fossil fuels; we have disaggregated these wherever possible, but in certain cases recorded bioenergy generation may include some co-firing. In these circumstances, actual emissions will be higher than we estimate.

Gross versus net generation

IPPC emissions intensity factors are relative to net generation. For most countries we report net generation, but for European countries and certain others we report gross generation. Fossil emissions for such countries will be slightly high relative to the rest of our dataset. For more detail on gross and net reporting, please see the *Generation Key Sources* and *Country-specific Methodology* sections.

Combined heat and power (CHP)

In many cases, thermal power plants produce both heat and electricity; we have reported only the electricity produced by such plants, ignoring heat. IPCC factors assume that plants

are dedicated electricity producers; it may not therefore be fair for our dataset to include all emissions attributed to co-firing plants, which actually have greater efficiency than reported when considering total useful *energy* output.