Weather data for energy analysis

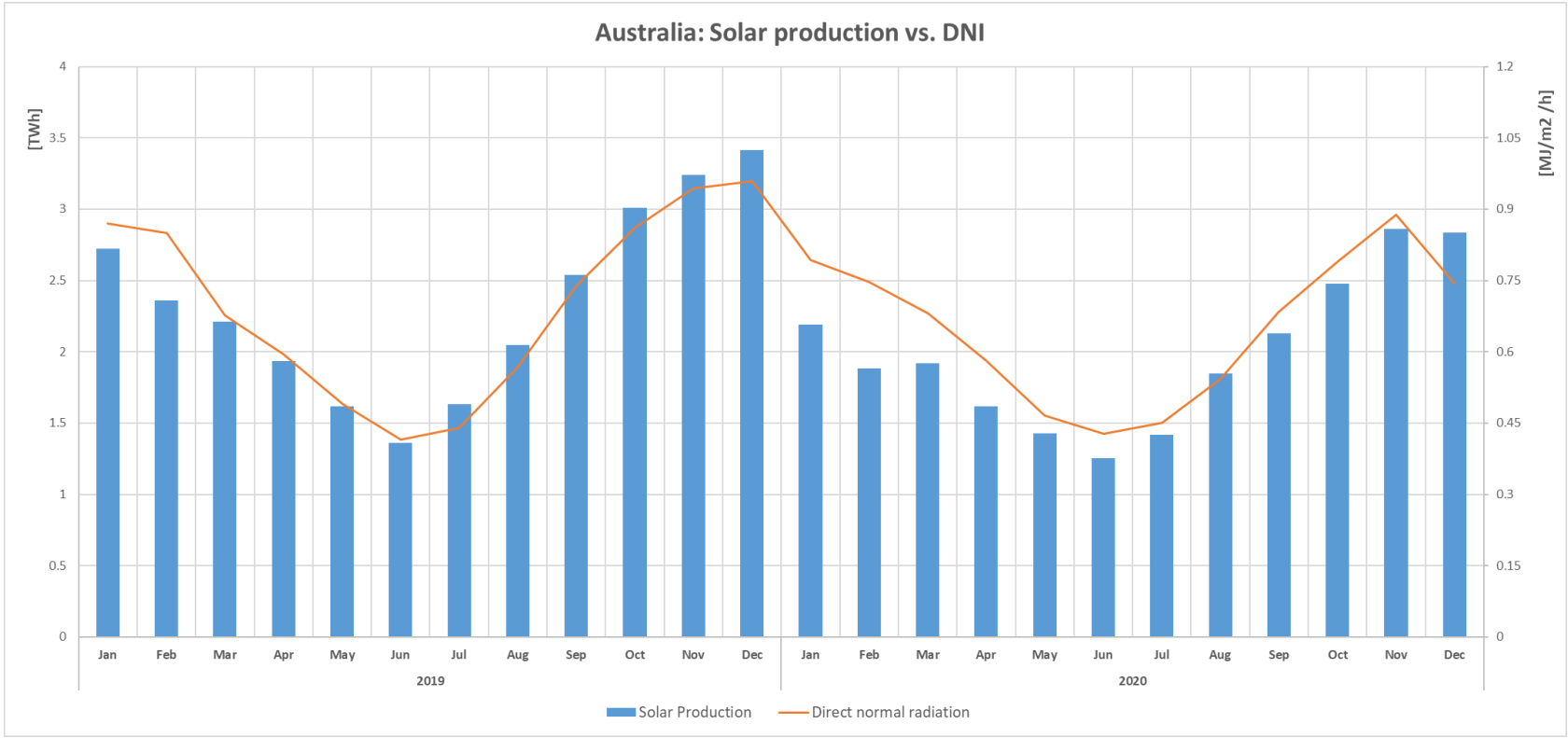
23th February 2022

International Energy Agency

Why weather data matter for energy analysis ?

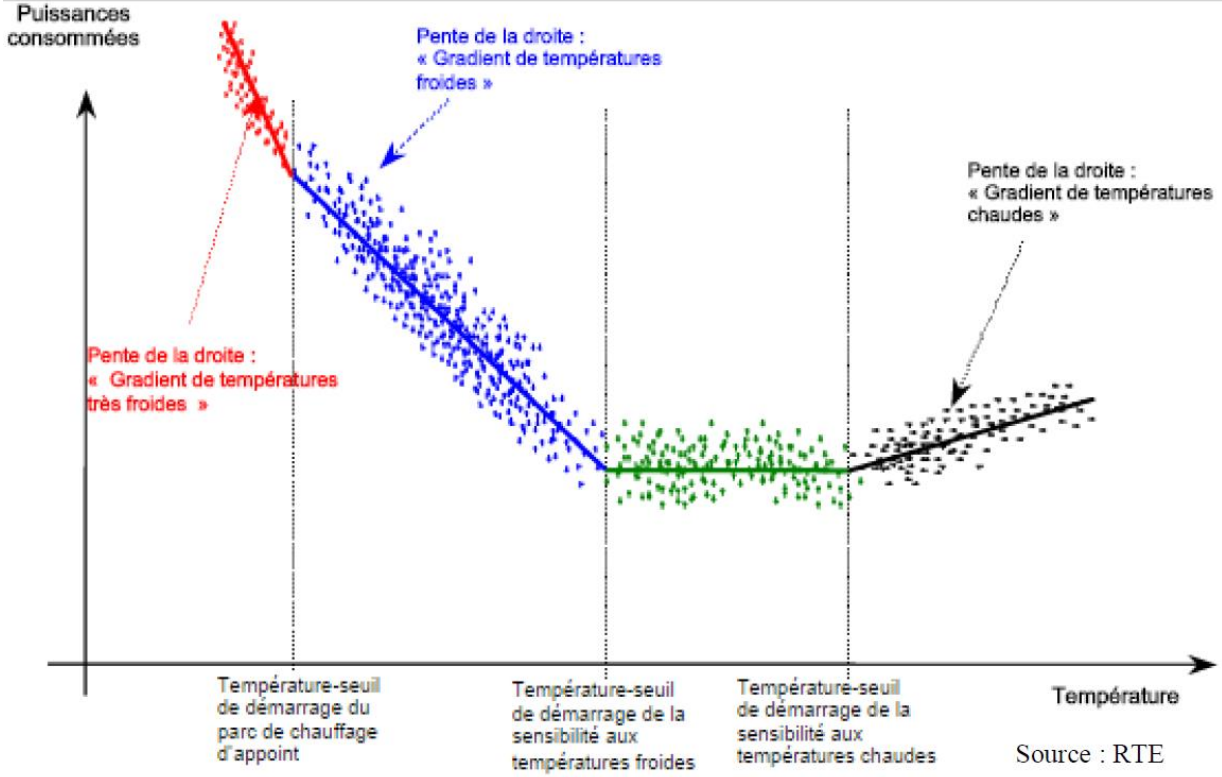
Solar electricity generation – Weather correlation

- Granular weather data can be used as starting point to model solar electricity generation



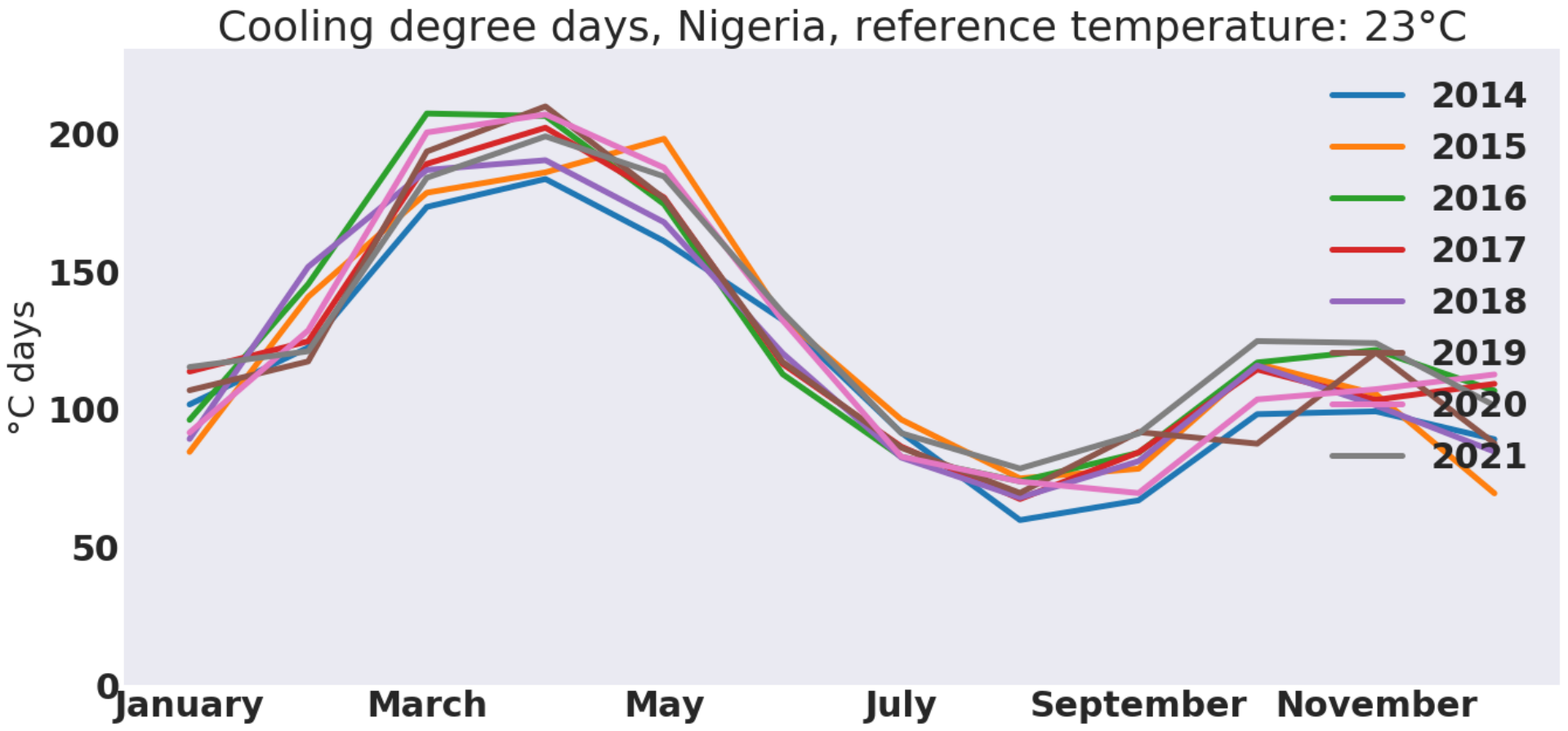
Data sources: IEA Weather for Energy Tracker, IEA Monthly Electricity Statistics

Energy consumption is highly correlated to weather indicators

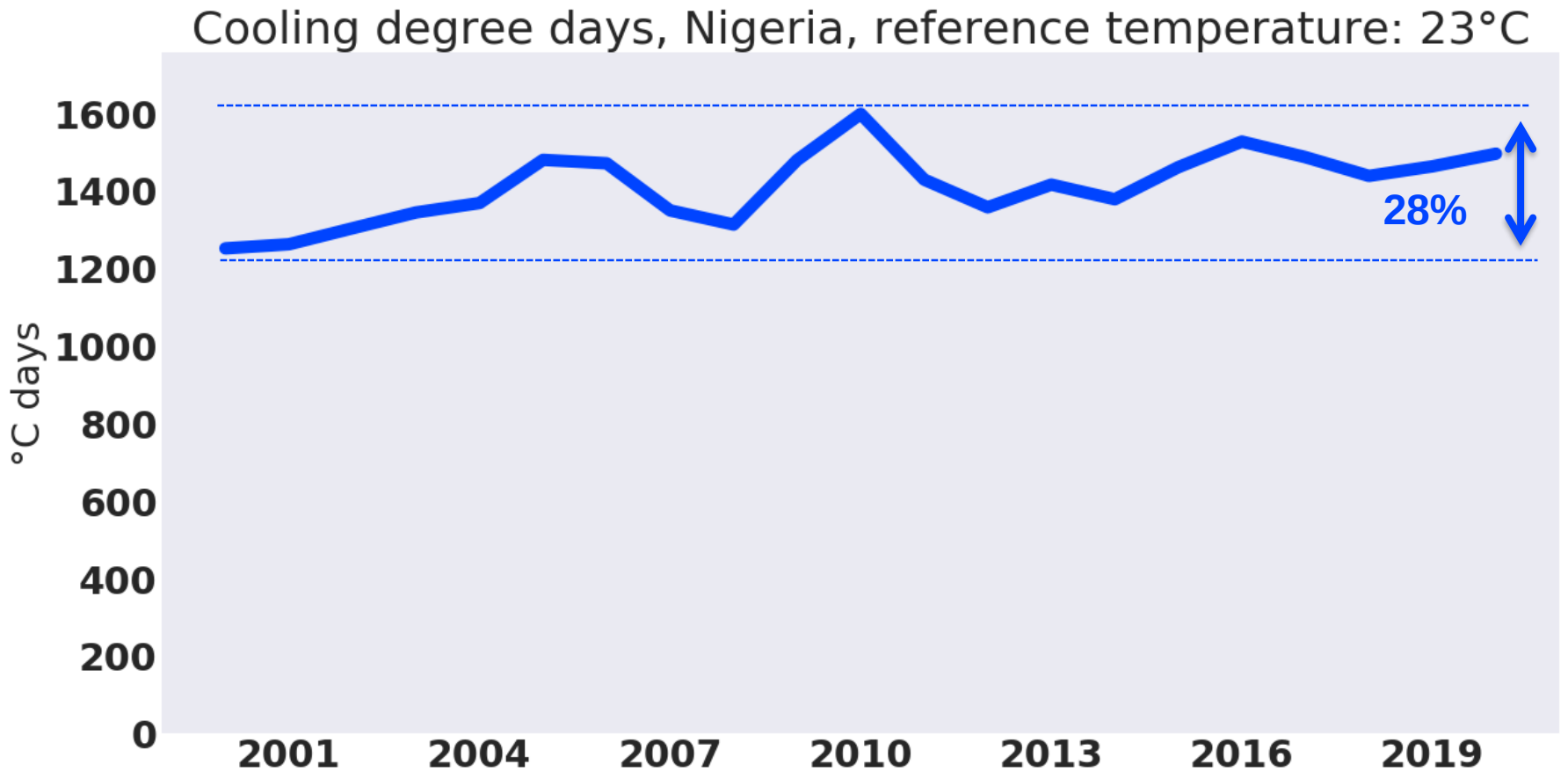


- This graph shows France electricity consumption (y-axis) versus temperature (x-axis)
- Space heating and cooling requirements show linear correlation with heating and cooling degree days, reflected in country total power figures
- The profile varies depending on the countries

Variability of weather indicators



Variability of weather indicators



The weather indicators are key to analyse or exclude the significant effect of weather on energy consumption

Temperature correction methodology to exclude effect of weather

Temperature correction

$$E_i^{TC} = E_i^{act} \cdot \frac{\overline{HDD}}{HDD_i}$$

where:

E_i^{TC} is the temperature-corrected energy consumption for the year *i*,

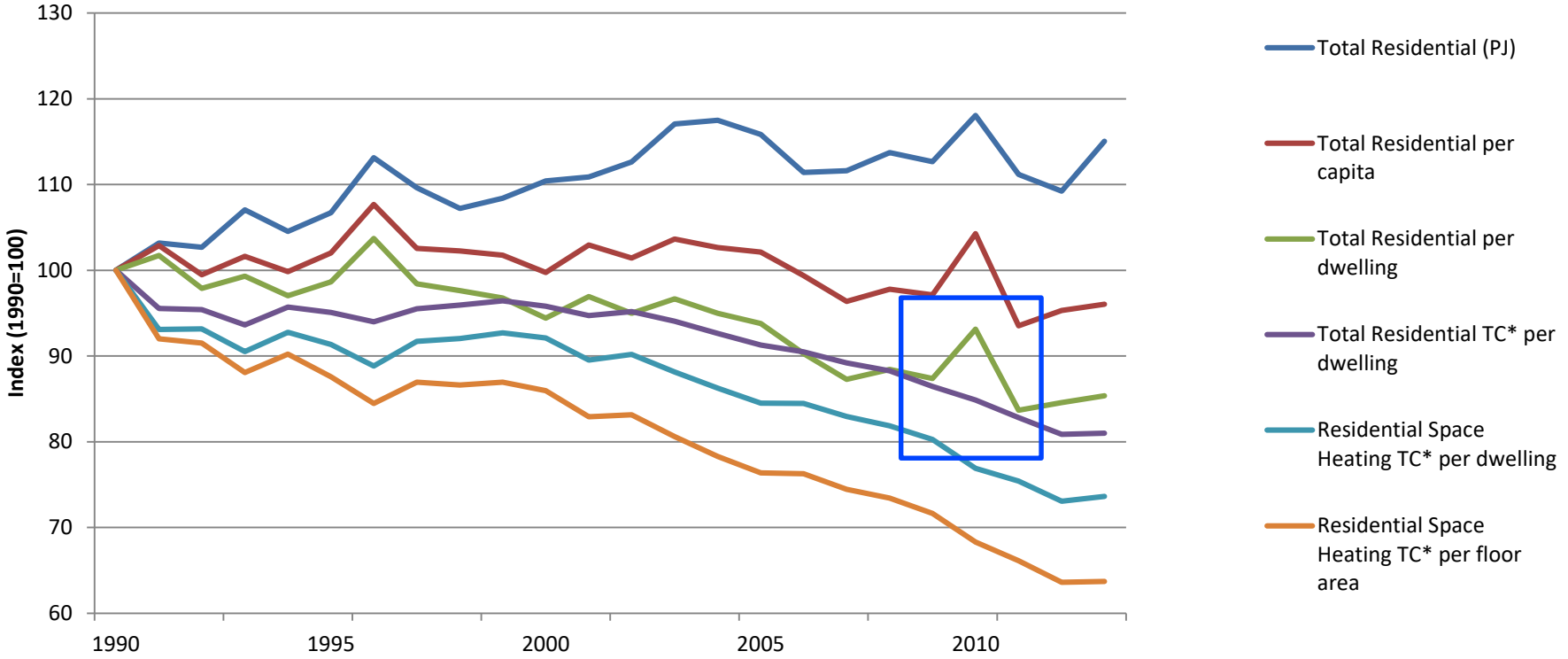
E_i^{act} is the actual energy consumption in year *i*,

$\overline{HDD}$ is the average heating degree days of the given period (2000-latest year), and

HDD_i is the total heating degree days in the year *i*.

Energy consumption temperature-corrected

Temperature correction – example on end-use indicators



Data for IEA 20 (Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Slovakia, Spain, Sweden, Switzerland, UK, USA).
* Temperature correction using heating degree days
Data source: IEA, *Energy efficiency indicators, All rights reserved.*

Selected examples of use of the database by IEA analysts

- Heating, cooling degree days and humidity indicators are used for energy modelling feeding World Energy Outlook and Global Energy Review reports in order to:
  - Normalise energy demand for basis for projections
  - Understand the impact of weather on energy demand and emissions
  - Assess distribution of population in need to cooling

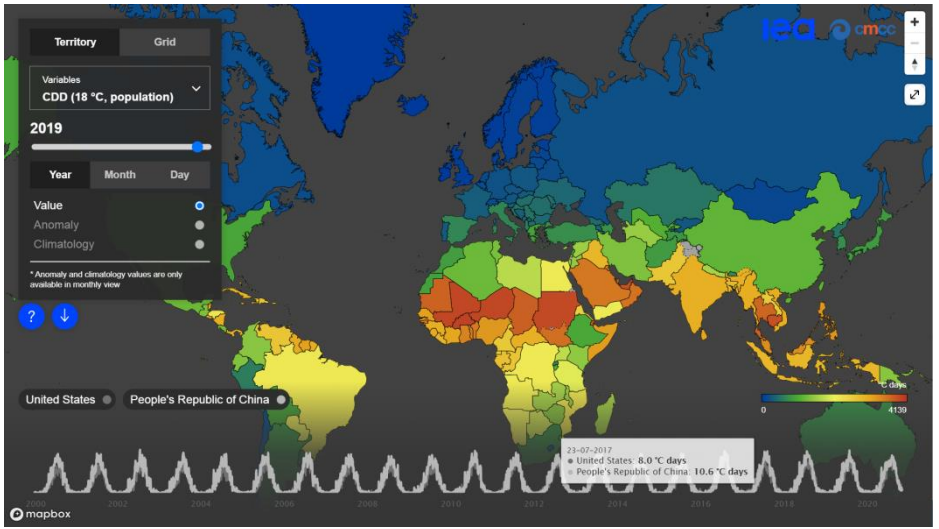
- Temperature, heating and cooling degree days are used for assessment in the Climate Resilience Policy Indicator report

- Irradiation and wind speed indicators to derive technical generation potentials for solar and wind generation at the hourly level.

The Weather for Energy Tracker database

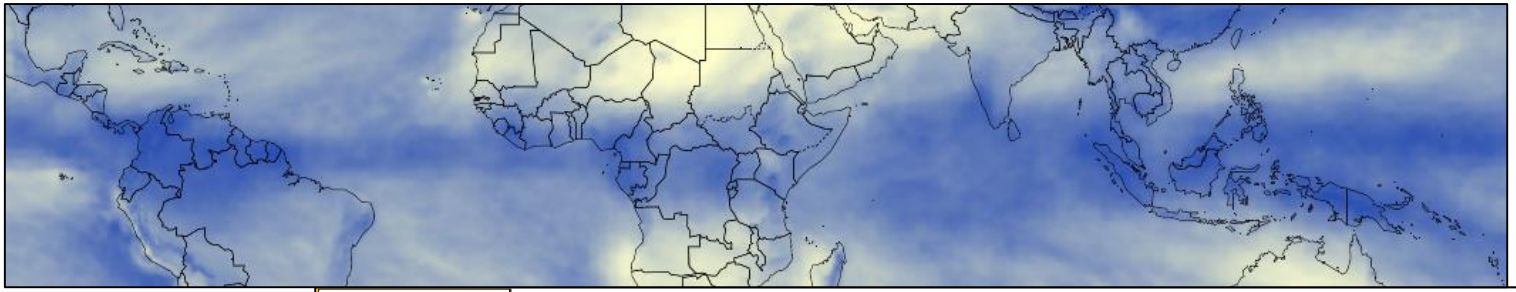
The Weather for Energy Tracker database

- Free platform providing high resolution weather indicators relevant to the energy sector. Extensively used by modellers.
- Reliable, consistent and easily accessible data on an expanded portfolio of weather variables, e.g. temperatures, degree days, solar radiation, precipitation, are becoming more and more important.
- Help statisticians, researchers, modellers and analysts around the world, as well as a broader audience interested in the energy sector.
- Developed by the IEA in collaboration with Fondazione Euro-Mediterraneo sui Cambiamenti Climatici (CMCC).
- Primary weather variables extracted from ECMWF Copernicus Climate Change Service information (2022).
- Updated every January, April, July and October



iea.org/articles/weather-for-energy-tracker

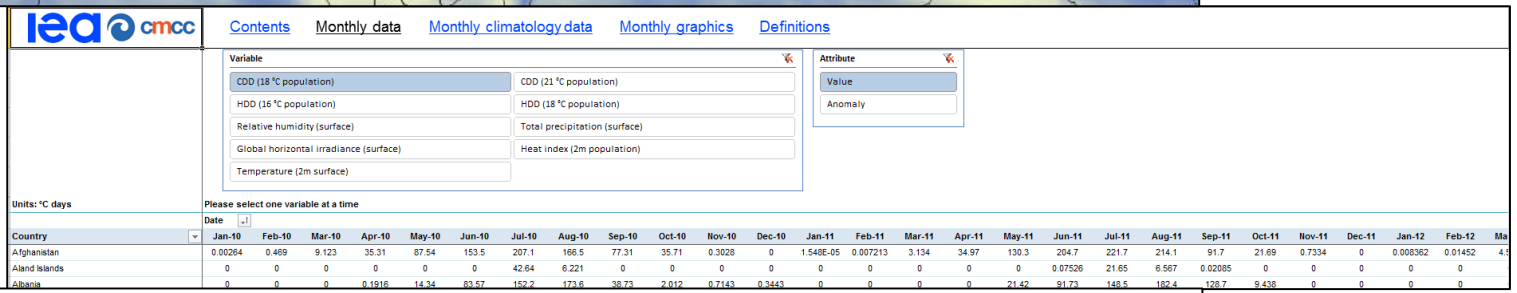
Three free tools to access the Weather for Energy data



Interactive map And customisable CSV download

Configure download

Interactive excel file



Contents | Monthly data | Monthly climatology data | Monthly graphics | Definitions

Variable

CDD (18 °C population)	CDD (21 °C population)
HDD (16 °C population)	HDD (18 °C population)
Relative humidity (surface)	Total precipitation (surface)
Global horizontal irradiance (surface)	Heat index (2m population)
Temperature (2m surface)	

Attribute: Value | Anomaly

Units: °C days

Please select one variable at a time

Date

Country	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Ma
Afghanistan	0.00264	0.469	9.123	35.31	87.54	153.5	207.1	166.5	77.31	35.71	0.3028	0	1.548E-05	0.007213	3.134	34.97	130.3	204.7	221.7	214.1	91.7	21.69	0.7334	0	0.008362	0.01452	4.5
Aland Islands	0	0	0	0	0	0	42.64	6.221	0	0	0	0	0	0	0	0	0	0.07526	21.65	6.567	0.02085	0	0	0	0	0	
Albania	0	0	0	0.1916	14.34	83.57	152.2	173.6	38.73	2.012	0.7143	0.3443	0	0	0	0	21.42	91.73	148.5	182.4	128.7	9.438	0	0	0	0	

Data repository

IEA_CMCC_CDD10anomalyallmonths.nc	31-Jan-2022 15:17	1094880203
IEA_CMCC_CDD16anomalyallmonths.nc	31-Jan-2022 15:18	1094880203
IEA_CMCC_CDD18anomalyallmonths.nc	31-Jan-2022 15:18	1094880203
IEA_CMCC_CDD21anomalyallmonths.nc	31-Jan-2022 15:18	1094880203
IEA_CMCC_CDD23anomalyallmonths.nc	31-Jan-2022 15:19	1094880203
IEA_CMCC_CDD26anomalyallmonths.nc	31-Jan-2022 15:19	1094880203
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IEA_CMCC_CDDThold23anomalyallmonths.nc	31-Jan-2022 15:08	1094880203
IEA_CMCC_CDDVaranomalyallmonths.nc	31-Jan-2022 15:09	1094880203
IEA_CMCC_CDDanomalyallmonths.nc	31-Jan-2022 15:03	1094880203
IEA_CMCC_CDDhum10anomalyallmonths.nc	31-Jan-2022 15:21	2189741003
IEA_CMCC_CDDhum16anomalyallmonths.nc	31-Jan-2022 15:22	2189741003
IEA_CMCC_CDDhum18anomalyallmonths.nc	31-Jan-2022 15:23	2189741003
IEA_CMCC_CDDhum21anomalyallmonths.nc	31-Jan-2022 15:23	2189741003

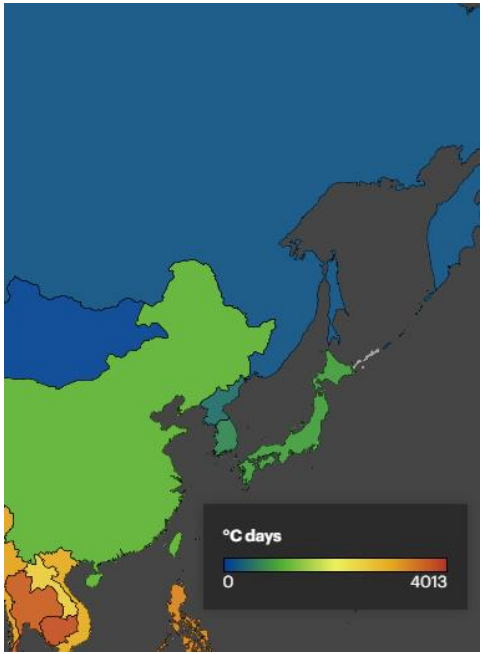
Over 50 weather indicators

50+ primary weather variables and derived indicators

Temperature	average, min, max, dew, wet bulb, humidex, heat index
Heating and cooling degree days	methodologies: standard, Eurostat, humidity corrected, wet-bulb temperature based, wind speed corrected Reference temperatures: 65°F, 16, 18 and 20°C for HDD and 65°F, 10, 16, 18, 21, 23 and 26°C for CDD
Wind	wind direction, intensity, wind turbine capacity factor
Sun	direct normal radiation, global horizontal irradiance, duration of sun light
Other primary indicators	relative humidity, precipitation, snowfall, runoff, evaporation, cloud coverage, pressure

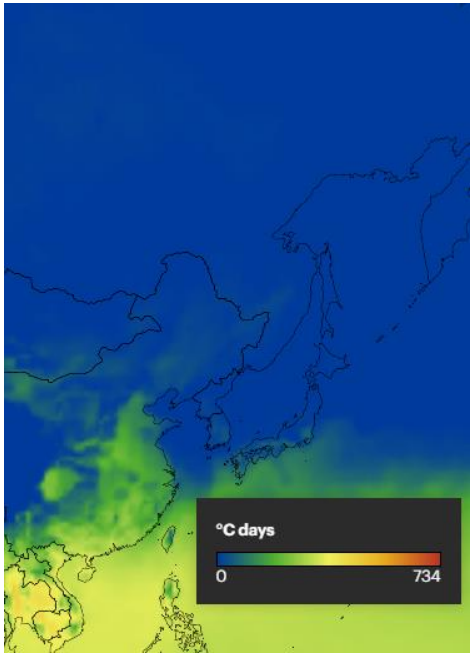
Data available at grid, national and sub-national level

National



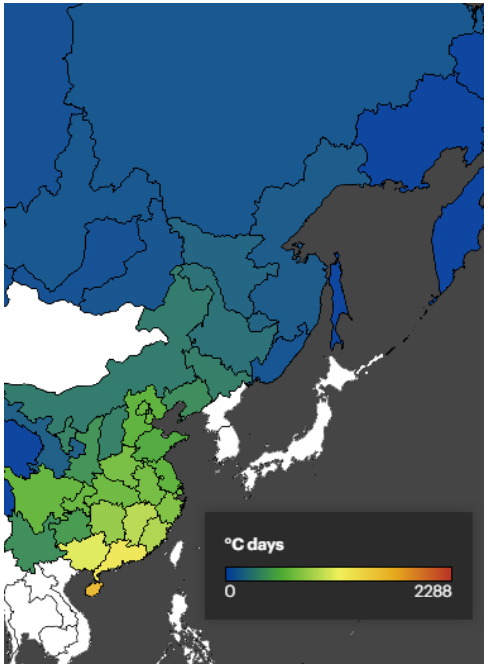
240 countries and territories

Grid



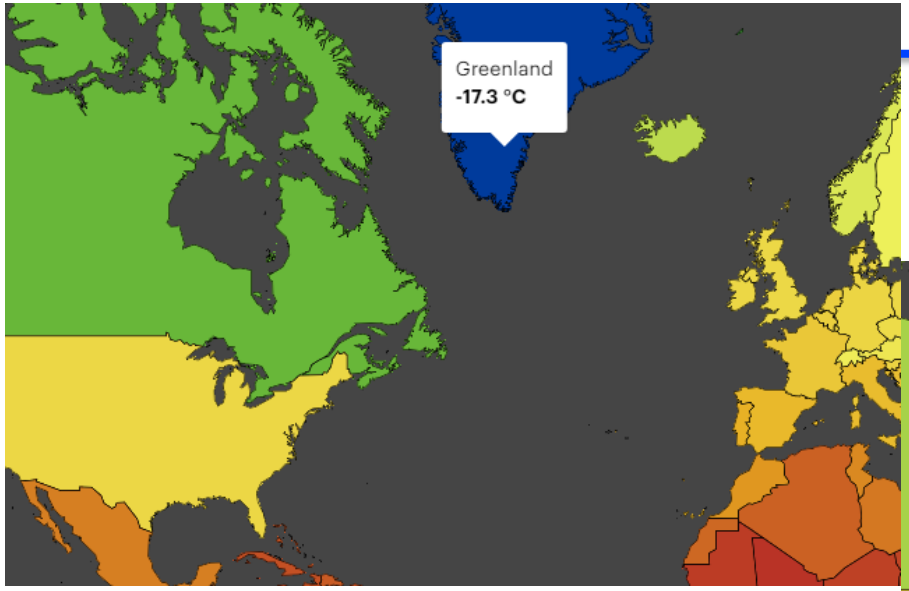
0.25° resolution

Sub-national

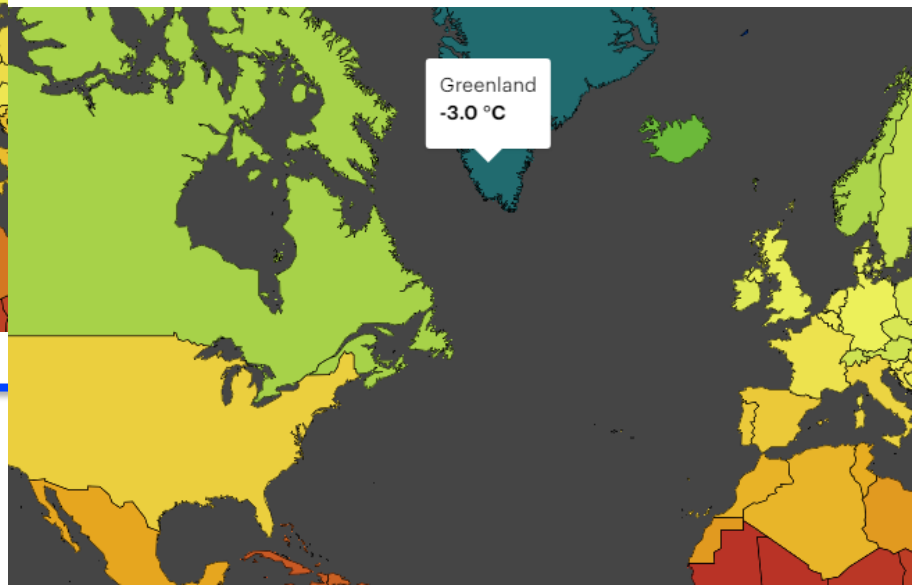


244 sub-national entities in 7 key countries

Two methodologies for computing national/sub-national indicators



Surface-weighted average
Indicators evenly distributed accross area (e.g. country sun irradiation potential)

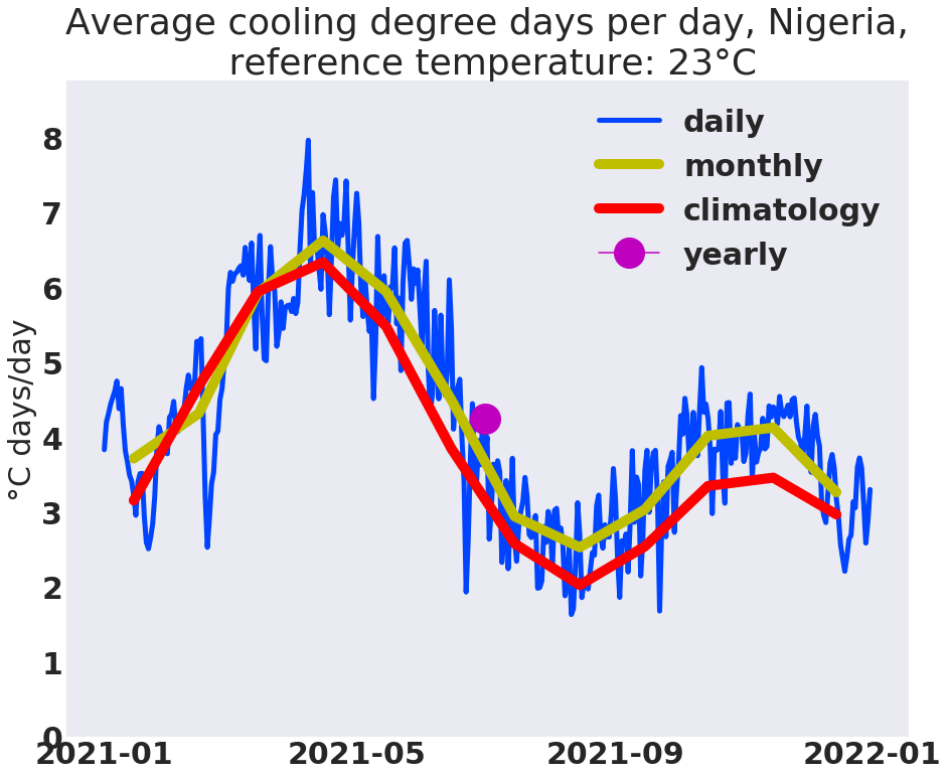


Population-weighted average
Indicators sensitive to population geographical distribution (e.g. cooling requirements)

Maps show 2020 mean temperature

Time granularity

- Data are available at different time granularity:
  - Yearly
  - Monthly
  - Daily
- Time series span from 2000 to latest available month
- The database also includes monthly climatologies and anomalies
- A climatology is the mean of a monthly indicator over the period 2000-2019
- Anomalies are the difference between monthly value and corresponding monthly climatology



Users Guide

- Users guide detailing:
  - How to access the data
  - Coverage and definitions
  - Sources
  - Methodology

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Please address any question to Emissions@iea.org

Humidex is calculated using the standard Humidex formula used by the Environment and Climate Change Canada[11]:

$$Humidex = T + C_1 * (C_2 * e^{C_3 * \left(\frac{1}{C_4} - \frac{1}{C_4 + T_{dew}}\right)} - 10) \quad (11)$$