Enwex rulebook - version 2025

for European indices

Enwex Energy Weather Indices are created to meet the optimized balance between (i) accuracy of represented weather development data and (ii) simplicity for a sufficient understanding by traders and markets. Enwex is registered a trademark (EUIPO reg. Nr. 018892447).

The indices are published in immutable yearly versions pursuant to the following methodology:

1.) Index basics

- Generally, any Enwex Index is representing a certain predefined territory (market region or countrywide).

- A predefined territory, if possible, the largest political unit, e.g. provinces or federal states, with their fraction of supply (wind, solar) or demand (via population for temperature products) determine the weighting of the representative grid point.

- These grid points per territory are determined as the nearest one to the middle of a territory. For each parameter the same grid point per territory is used.

- The spatial resolution of the grid is 0,25° Lat Lon, the temporal resolution is hourly.
  This temporal resolution will persist in case of markets allowing 15-minute resolution of prices, as weather models are decisive for Enwex. So for derivatives on Enwex, e.g. market values, the power prices will be averaged for the forecasted hour and then multiplied by the utilisation figure of Enwex.

- Weather parameters currently translated into Enwex Indices:
  a) Temperature: by population weight per region.
  b) Wind: by installed capacity per region along transparent datasets as listed in **Appendix 1**. Please note: When using the data source „the wind power", set filter on status to „in production ". Wind indices are just representing onshore capacities, except for the UK (also including offshore).
  c) Solar: by installed capacity per territory along sources as listed in **Appendix1**.

- Day ahead settlement data of Enwex Indices are generally published at 10:00 AM local time at www.enwex.com .
  Exception is for the UK (09:00 AM local time).

2.) Index update routine (yearly)

- Index weightings for renewables need a yearly versioning due to newly built installations. Therefore, total and regional installed capacities are based on most recent available figures at 1st of September of each year with maximum time lag accepted of eight months (= end of previous calender year). If there is no update on regional installed capacities more recent than 31st of December of previous year, the weighting for the affected country stays unchanged the current yearly version.

- New yearly versions will be calculated on the back of published capacity and their spatial distribution data and published by Enwex at each 1st of October in its API with the new ending, e.g. for 2026 named "…_v26".

- For Wind and Solar the underlying weightings are updated in a yearly routine, for Temperature in a 5-year routine with the next update for the version of 2030 (note: for reasons of consistency, actual temperature timeseries will also be named along the current trading years, e.g. v26).

- The day ahead settlement publications will change their underlying weighting with the change of each calender year, so in this example from 1st of January 2026. The period in Q4 is used for review by the market participants on the potential changes.

- For backtesting purposes, each yearly version has an updated backward calculation available for (a) from 1979 to present for reanalysis data and (b) from 2013 to present for EC oper day ahead data.
  ⇨ For backtest data, the underlying weighting stays unchanged through the years.

- For settlement data, each parameter & country combination has one curve ID in the API which is named "settlement" and continuously contains the current actual weighted capacity. So its underlying is shifting with the day ahead settlement for 1st of January to the next yearly version with its weighting.
  ⇨ For settlement data, curve ID's stay unchanged through the years.

- Previous yearly versions (e.g. v24) will continuously be calculated until no trade concluded is referring to it anymore with a maximum of five years backward, e.g. in year 2030 the v25 timeseries will not be updated anymore.

- Countrywide means and their actual weightings are calculated as regional MW installed divided by total MW installed in the territory. Current values for weighting within a country are listed in **Appendix 3.**

3.) Weather model specifications

- Weather model of choice is the operational model of European center for medium range forecast (ECMWF; https://www.ecmwf.int/en/about/what-we-do) in its 0.25 degree spatial resolution and the 00 UTC update.

- Model parameters used from ECMWF oper are:
  a) Temperature: 2m temperature
  b) Wind: windspeed in m/s out of 100m level of u-wind and v-wind
  c) Solar: Incoming shortwave radiation at surface

- Timesteps: Hourly resolution for the forecast period day ahead in local time (e.g. for Germany in wintertime H+25 to H+49).

- Fallback routine:
  In case of ECMWF model delay, fallback solution for index calculation is with identical method and parameters but using ECMWF operational with basis 12 hours before (12 UTC). This means for e.g. Germany (wintertime) then timesteps H+37 to H+61.

- Reanalysis data in API timeseries from 1979 onwards are calculated out of ERA5 models, https://cds.climate.copernicus.eu/datasets/reanalysis-era5-single-levels?tab=overview , using the same weather parameters, spatial and temporal resolution as from EC oper.

- Historical data by EC oper and ERA5 for Enwex in the current and previous year's versions can be downloaded via Enwex API. For access and further information mailto info@enwex.com

- Handling weather models generation switch:

  a) EC oper: Direct implementation of new model versions after official release by ECMWF with unchanged spatial and temporal resolution. Historical Data in API stay unchanged and are always reflecting the latest state of EC oper model at day ahead settlement.
  b) ERA5: With planned new generation of ERA6 (from end 2026?), all historical timeseries will be published with the next year's version (2027?) in ERA6 and ERA5 for comparison. The year after, those historical data series will just be available in the new ERA version.

4.) Index calculation per parameter

Weather parameters used and the formula per country for calculation of wind and solar utilization are part of the yearly update routine. To handle potential biases driven e.g. by technological improvements on the efficiency factor or the other way round, by aging effects, there is a technology coefficient.
For biases exceeding 0,5% in backtesting of the previous period from July$_{(year-1)}$ until June$_{(year)}$ observation data (usually ENTSO-E, for Germany Netztransparenz), it will be modified by full % figure, e.g. +1,6% bias will lead to a technology coefficient of 1,02.
A review of the complete formula for each parameter and its coefficients is scheduled for the Enwex version v30, valid in 2030.

a) Temperature:

Enwex temperature = 2m temperature in ° Celsius

b) Solar:

Enwex solar = Utilization of installed solar capacity = technology coefficient * (factor * shortwave radiation / 1000)

with:
technology coefficient = 1,00 (neutralizing general biases)
factor = varying per country (e.g., Germany 0,71)
shortwave radiation = ECMWF operational model output for incoming radiation at surface

c) Wind:

Enwex wind = Utilization of installed capacity = technology coefficient * ((maximum utilization + util addition) / (1,0 + exp (start wind speed – slope * (windspeed – X-axis shift) – constant)) – util addition)

with:
technology coefficient = 1,00 (neutralizing general biases)
Maximum utilization = Max average power output per installed capacity, usually below 1,00 due to e.g., outages, revisions
Util addition = modifies slope, subtracted at end of formula to avoid influence on maximum
Start wind speed = average turbine start speed
Slope = Steepness of exponential function
Windspeed = ECMWF operational model output for windspeed in 100m height
X-axis shift = Shift to avoid negative values with low wind

Constant = average roughness length of landscape

Note:
windspeed values smaller than start wind speed of turbines in this formula providing negative results, therefore need to be replaced by 0.

Coefficients for renewables per country can be found in **Appendix 2**.

Appendix 1: Data sources on installed capacities

Germany:

- https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/ErneuerbareEnergien/EE-Statistik/start.html (wind & solar, update from 16.9.24)

Netherlands:

- Wind: http://www.thewindpower.net (global dataset, update from 17.8.24)
- Solar: https://opendata.cbs.nl/statline#/CBS/nl/dataset/85005NED/table?ts=1668421767653 (Centraal Bureau voor de Statistiek, update including 1st half 2024)

Belgium:

- Wind: http://www.thewindpower.net (global dataset, update from 17.8.24)
- Solar: https://www.elia.be/en/grid-data/generation-data/solar-pv-power-generation-data (grid operator; data as visualized on 01.09.2024)

France:

- Wind: http://www.thewindpower.net (global dataset, update from 17.8.24)
- Solar: https://odre.opendatasoft.com/explore/dataset/parc-regional-annuel-prod-eolien-solaire (Open Data Réseaux Energies, update including 2023)

Spain:

- Wind: http://www.thewindpower.net (global dataset, update from 17.8.24)
- Solar: https://www.sistemaelectrico-ree.es/en/renewable-energies-report/sun/installed-capacity/photovoltaic-solar-sunpower (Red electrica, based on January 2024)

Italy:

- Wind: http://www.thewindpower.net (global dataset, update from 17.8.24)
- Solar: https://www.statista.com/statistics/888529/installed-capacity-of-solar-power-plants-by-region-in-italy/ (Statista, installed 2023)

United Kingdom:

- Wind: http://www.thewindpower.net (global dataset, update from 17.8.24, onshore + offshore)
- Solar: https://www.gov.uk/government/statistics/energy-trends-section-6-renewables (not updated before 1.9.2024 => unchanged values from end 2022, v24)

Appendix 2: Coefficients for renewable utilization

Solar

Belgium:
Solar(BEL) = 1,00 * (0,82 * shortwave radiation / 1000)

France:
Solar(FRA) = 1,00 * (0,76 * shortwave radiation / 1000)

Germany:
Solar(GER) = 1,00 * (0,71 * shortwave radiation / 1000)

Italy:
Solar(ITA) = 1,00 * (0,59 * shortwave radiation / 1000)

Netherlands:
Solar(NLD) = 1,00 * (0,85 * shortwave radiation / 1000)

Spain:
Solar(ESP) = 1,00 * (1,25 * shortwave radiation / 1000) (under review)

United Kingdom:
Solar(GBR) = 1,00 * (0,79 * shortwave radiation / 1000)

Wind

Belgium:
Wind(BEL) = 1,00 * ((0,76 + 0,05) / (1,0 + exp(3,1 – 0,5 * (wind – 2,6) – 0,0074)) – 0,05)

France:
Wind(FRA) = 1,00 * ((0,9 + 0,05) / (1,0 + exp(3,0 – 0,52 * (wind – 2,5) – 0,0074)) – 0,05)

Germany:
Wind(GER) = 1,00 * ((0,92 + 0,05) / (1,0 + exp(3,2 – 0,529 * (wind – 2,5) – 0,0074)) – 0,05)

Italy:
Wind(ITA) = 1,00 * (0,85 / (1,0 + exp(2,9 – 0,64 * (wind – 2,5) – 0,0074)))

Netherlands:
Wind(NLD) = 1,00 * ((0,91 + 0,04) / (1,0 + exp(3,3 – 0,53 * (wind – 2,5) – 0,0074)) – 0,04)

Spain:
Wind(ESP) = 1,00 * ((0,8 + 0,04) / (1,0 + exp(3,0 – 0,53 * (wind – 1,9) – 0,0074)) – 0,04)

United Kingdom:
Wind(GBR) = 1,00 * ((0,68 + 0,06) / (1,0 + exp(3,3 – 0,53 * (wind – 2,1) – 0,0074)) – 0,06)

Appendix 3: Countrywide means and their actual (v25) weightings

Belgium

Province	Latitude	Longitude	temperature	wind	solar
Antwerp	51,25	4,50	16,3	15,1	17,3
Brussels Capital Region	50,75	4,25	10,7	0,0	3,1
East Flanders	51,00	3,75	13,3	18,5	17,3
Flemish Brabant	51,00	4,50	10,1	2,0	9,8
Hainaut	50,50	4,00	11,7	18,0	7,6
Limburg	50,75	5,50	7,6	10,5	13,5
Liège	50,00	5,75	9,6	10,5	7,1
Luxembourg	50,50	5,50	2,5	2,9	2,2
Namur	50,50	5,00	4,3	10,7	3,6
Walloon Brabant	50,75	4,75	3,5	3,5	2,5
West Flanders	51,00	3,00	10,4	8,3	16,0

France

Province	Latitude	Longitude	temperature	wind	solar
Auvergne-Rhône-Alps	45,50	4,50	12,6	3,2	11,7
Burgundy-Free-County	47,00	4,50	2,5	5,0	4,2
Brittany	48,00	-3,00	5,3	6,0	2,7
Central - Vale of the Loire	47,50	1,75	4,0	7,8	5,1
Corsica	42,00	9,00	0,5	0,1	1,2
Greater East	48,75	5,75	8,7	23,0	7,7
Heights-of-France	50,00	2,75	9,4	27,3	2,9
Isle-of-France	48,50	2,50	19,1	0,5	1,7
Normandy	49,00	0,25	5,2	4,8	1,7
New Aquitaine	44,75	-0,50	9,4	8,2	23,6
Occitania	43,75	1,00	9,3	7,6	19,1
Lands of the Loire	47,50	-0,75	6,0	6,1	6,4
Provence - Alps - Azure Coast	44,00	6,00	8,0	0,4	12,0

Germany

Province	Latitude	Longitude	temperature	wind	solar
Baden-Württemberg	48,50	9,00	13,4	2,9	12,6
Bavaria	49,00	11,50	15,9	4,3	26,9
Brandenburg & Berlin	52,50	13,50	7,5	14,2	8,0
Hesse	50,50	9,00	7,6	4,2	4,6
Lower Saxony & Bremen	52,50	9,00	10,5	20,7	8,9
Mecklenburg-Vorpommern	53,75	12,50	1,9	6,1	4,3
North Rhine-Westphalia	51,50	7,50	21,5	12,1	12,1

Rhineland-Palatine & Saarland	50,00	7,25	6,1	7,4	6,3
Saxony	51,00	13,50	4,8	2,2	4,7
Saxona-Anhalt	52,00	11,75	2,6	8,7	4,8
Schleswig-Holstein & Hamburg	54,25	9,75	5,7	14,3	3,9
Thuringia	51,00	11,00	2,5	2,9	2,9

Italy

Province	Latitude	Longitude	temperature	wind	solar
Abruzzo	42,25	13,50	2,2	2,5	3,3
Aosta Valley	45,75	7,25	0,2	0,0	0,1
Apulia	41,00	16,25	6,7	20,3	11,1
Basilicata	40,50	15,75	0,9	9,7	1,7
Calabria	39,00	16,50	3,1	10,9	2,4
Campania	40,75	14,25	9,6	13,3	4,1
Emilia-Romagna	44,50	11,25	7,6	0,3	10,1
Friuli-Venezia Giulia	45,50	13,75	2,0	0,0	2,8
Lazio	42,00	12,50	9,8	0,9	6,8
Liguria	44,50	9,00	2,6	0,9	0,6
Lombardy	45,50	9,25	17,1	0,0	13,4
Marche	43,50	13,50	2,5	0,1	4,5
Molise	41,50	14,75	0,5	3,7	0,7
Piedmont	45,00	7,75	7,3	0,1	8,3
Sardinia	39,25	9,00	2,7	10,0	4,5
Sicily	37,50	14,00	8,2	25,8	6,8
Trentino - South Tyrol	46,00	11,00	0,9	0,0	2,2
Tuscany	43,75	11,25	6,3	1,1	4,1
Umbria	43,00	12,50	1,5	0,3	2,1
Veneto	45,50	12,25	8,3	0,1	10,4

Netherlands

Province	Latitude	Longitude	temperature	wind	solar
Drenthe	53,00	6,50	2,8	4,2	6,7
Flevoland	52,50	5,50	2,5	24,5	4,8
Friesland	53,25	5,75	3,7	4,1	5,1
Gelderland	52,00	6,00	12,0	4,0	12,8
Groningen	53,25	6,75	3,3	16,0	6,7
Limburg	51,25	6,00	6,3	2,2	7,7
North Brabant	51,50	5,25	14,7	7,2	17,3
North Holland	52,75	5,00	16,6	12,0	9,5
Overijssel	52,50	6,50	6,6	1,9	8,0
South Holland	52,00	4,50	21,5	13,0	12,2
Utrecht	52,00	5,25	7,8	0,6	5,5
Zeeland	51,50	3,75	2,2	10,3	3,7

Spain

Province	Latitude	Longitude	temperature	wind	solar
Andalusia	47,50	-4,50	19,4	12,1	21,5
Aragon	41,50	-0,75	3,0	15,9	9,6
Asturias	43,25	-6,00	2,3	2,4	0,0
Basque country	43,00	-2,50	5,0	0,5	0,2
Cantabria	43,25	-4,00	1,3	0,1	0,0
Castilla - La Mancha	39,50	-3,00	4,7	16,7	24,6
Castile and Léon	41,75	-4,75	5,4	22,6	7,6
Catalonia	41,75	1,50	17,8	4,5	1,2
Extremadura	39,25	-6,25	2,4	0,3	25,7
Galicia	42,75	-8,00	6,1	13,2	0,1
La Rioja	42,25	-2,50	0,7	1,5	0,4
Madrid	40,50	-3,75	15,3	0,0	0,3
Region of Murcia	38,00	-1,50	3,5	0,9	6,3
Navarre	42,75	-1,50	1,5	4,8	0,7
Valencian Community	39,50	-0,50	11,6	4,5	1,8

United Kingdom

Province	Latitude	Longitude	temperature	wind	solar
East Midlands	53,00	-0,75	7,4	1,3	11,2
East of England	52,50	0,75	9,6	1,6	15,8
London	51,50	0,00	13,8	0,0	1,7
N Scotland	58,50	-3,50	4,2	15,0	0,0
NorthEast	55,00	-2,00	11,3	1,6	1,9
NorthWest	54,00	-2,75	8,4	1,8	4,8
S Scotland	56,00	-4,00	14,2	28,3	3,5
SouthEast	51,25	-1,00	8,7	0,4	16,4
SouthWest	50,75	-3,50	4,9	1,0	24,1
Wales	51,75	-3,50	9,1	4,5	8,8
West Midlands	52,50	-2,25	8,4	0,1	7,0
Yorkshire	53,50	-1,25	0,0	2,5	4,8
offshore SE	51,75	1,75	0,0	11,6	0,0
offshore E	53,75	1,25	0,0	20,2	0,0
offshore NW	54,00	-3,75	0,0	10,1	0,0