# Modelling and planning for a climate-resilient pan-European grid: the data perspective

ENTSO-E & RGI Conference on Adaptation & Resilience - Ensuring the energy transition is built on resilient infrastructure – Mar 14, 2023

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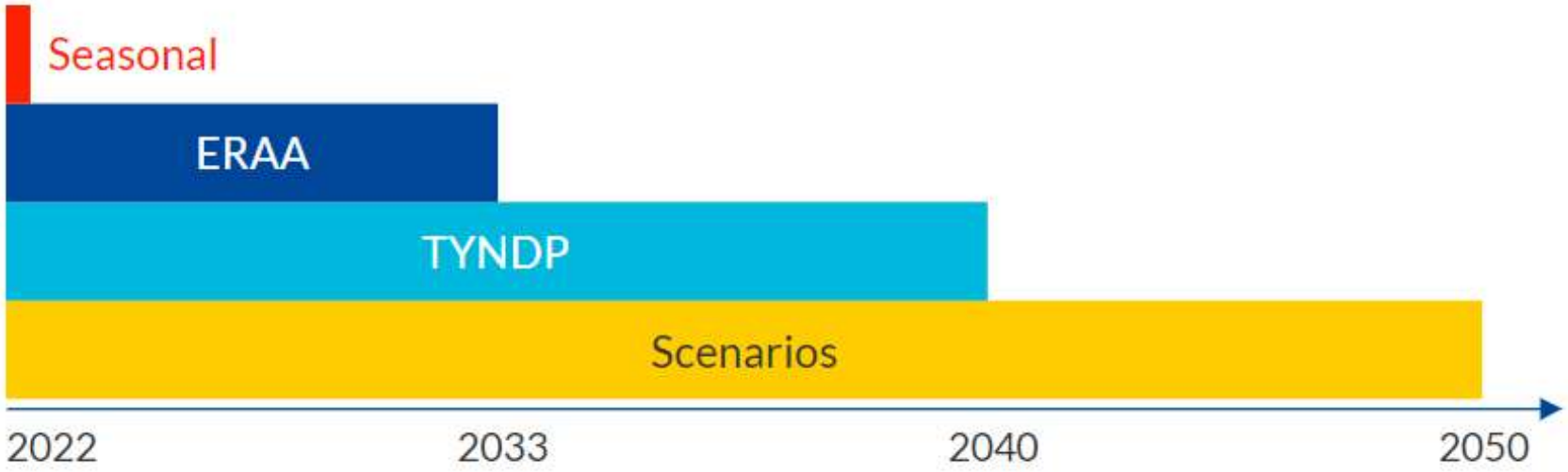
Reliable Sustainable Connected

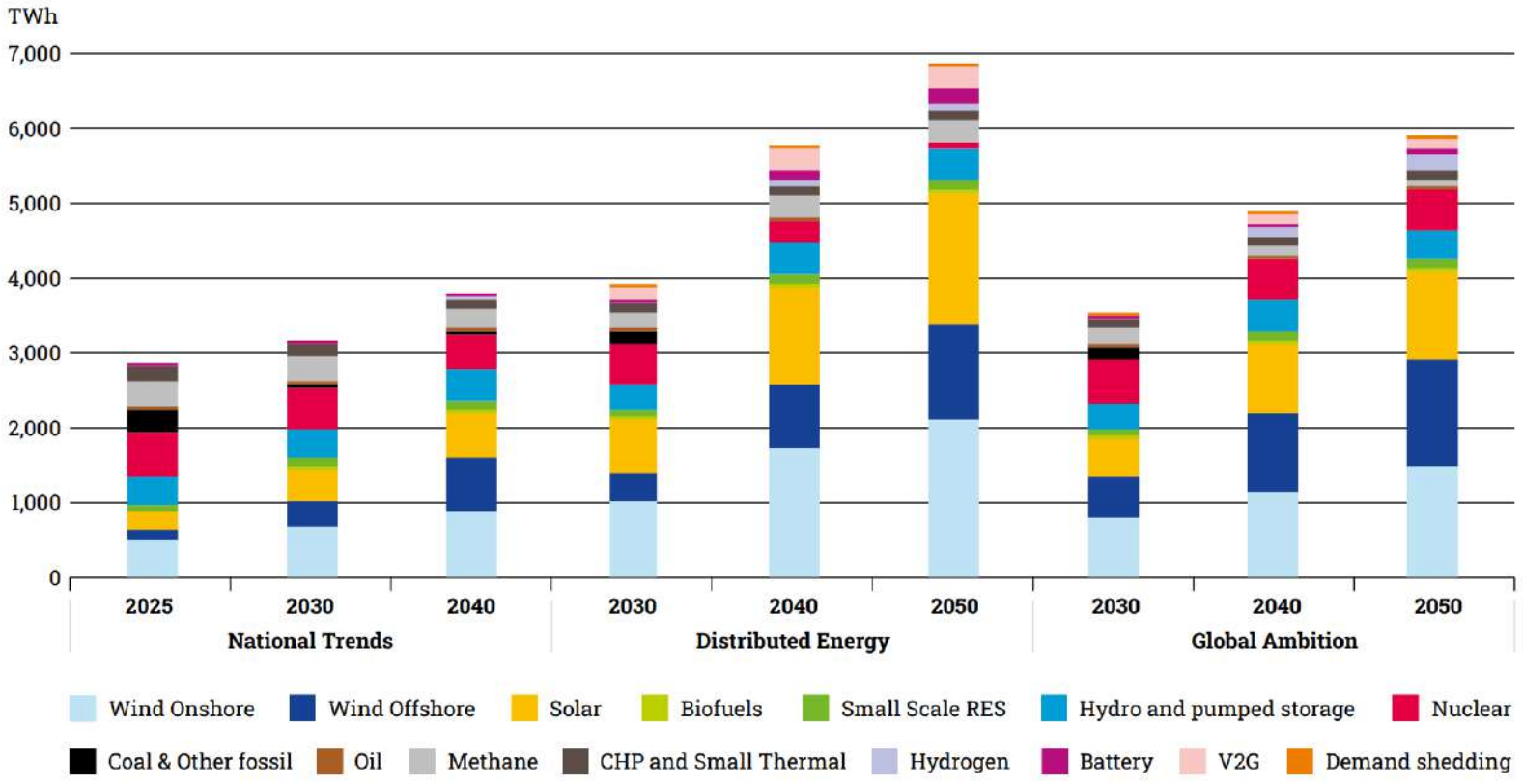
**ENTSO-E is legally mandated to periodically deliver pan-European outlooks of the power system in the short-, mid-, and long-term. This allows the TSO community to coordinate actions in an integrated fashion and provides technically-sound and consolidated information to policymakers and stakeholders that supports their decision-making.**




| Seasonal Outlook | ERAA | TYNDP | Scenarios |
|---|---|---|---|
| Analysis of possible risks for the security of supply in Europe twice a year: for the summer and winter periods. | A pan-European assessment of adequacy - the ability of power system to cover demand in all conditions - 10 yr ahead. | A study that investigates system needs (create max value for EU, ensure access to electricity & comply w/ climate agenda) in 2030/40. | A prerequisite for any study analysing the future of the EU energy system, describing possible EU energy futures up to 2050. |

Source: ENTSO-E

**The variable nature of RES makes the planning and operation of power systems an ever-more challenging task. Considering the swift uptake of RES contribution to the European electricity mix, the role of climate data in such assessments is crucial for an accurate estimation of system states/needs. Moreover, changes in climate patterns expected over the next decades make things even more complicated.**




Electricity generation mix per scenario, target year and technology
Source: ENTSO-E (2022 TYNDP Scenarios results, Fig 25 in final Scenarios Report

# What climate data is ENTSO-E currently leveraging in its models?

**The Pan-European Climate Database (PECD) fulfills the needs of ENTSO-E study teams for climate data, a cornerstone of SO, ERAA or TYNDP over the past years. However, this dataset relies solely on data representing historical climate conditions.**

- 38 years of historical data (ERA5 reanalysis)
- dataset covering all relevant climate variables
- 16 RES technologies available to convert climate variables into capacity factors

October 19, 2022 Dataset Open Access

## ENTSO-E Pan-European Climatic Database (PECD 2021.3) in Parquet format

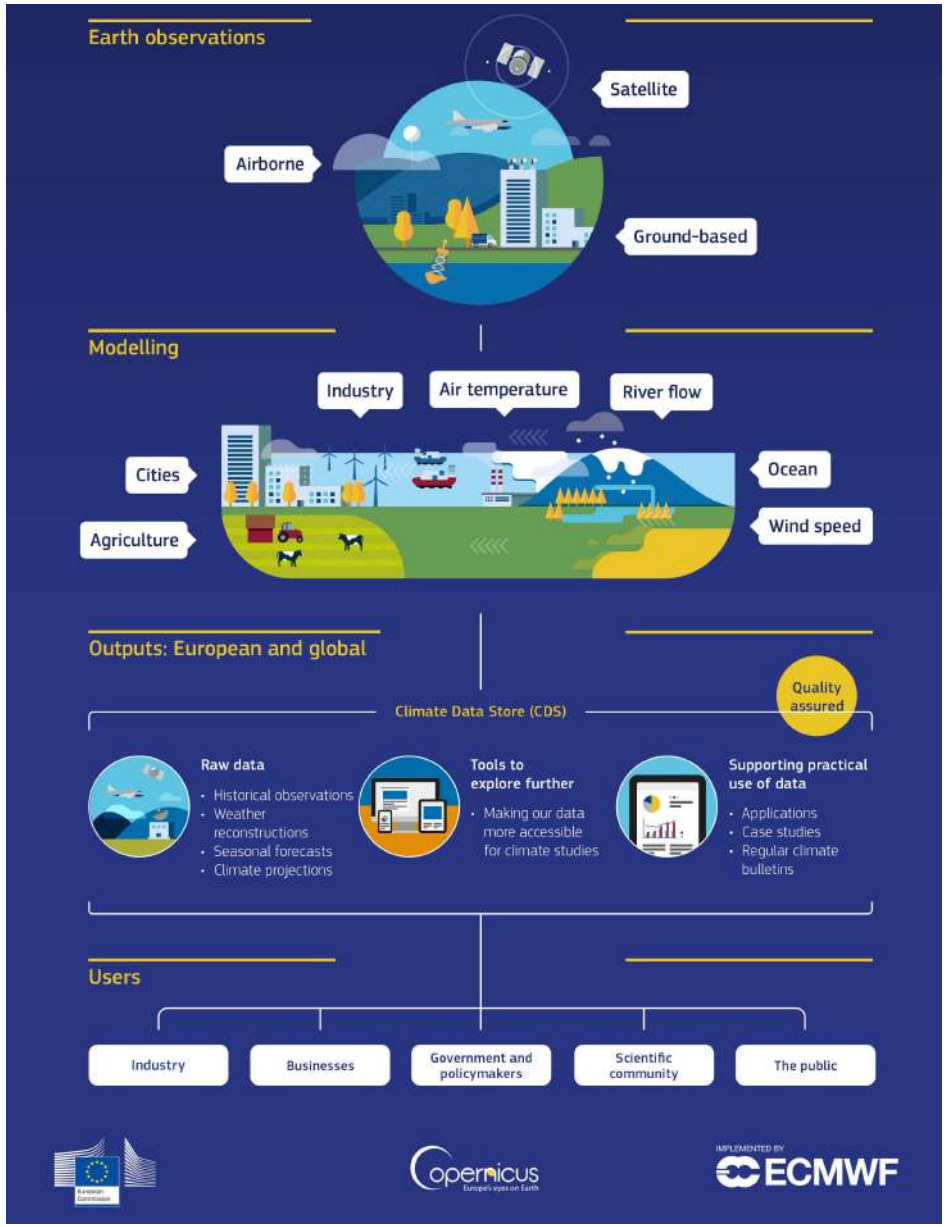
De Felice, Matteo

**ENTSO-E Pan-European Climatic Database (PECD 2021.3) in Parquet format**

**TL;DR**: this is a tidy and friendly version of a subset of the PECD 2021.3 data by ENTSO-E: hourly capacity factors for wind onshore, offshore, solar PV, hourly electricity demand, weekly inflow for reservoir and pumping and daily generation for run-of-river. All the data is provided for >30 climatic years (1982-2019 for wind and solar, 1982-2016 for demand, 1982-2017 for hydropower) and at national and sub-national (>140 zones) level.

**UPDATE (19/10/2022):** updated the demand files due after fixing a bug in the processing code (the file for 2030 was the same for 2025) and solving an issue caused by a malformed header in the ENTSO-E excel files.

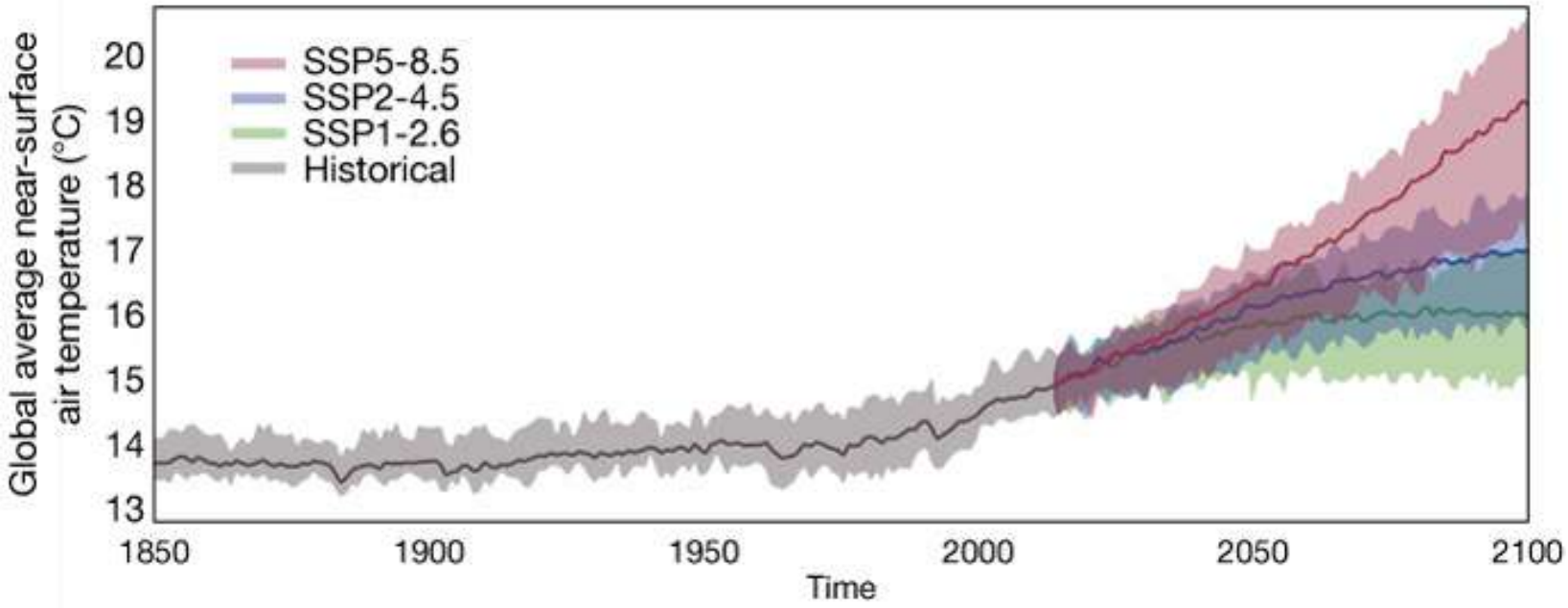
doi: 10.5281/zenodo.7224854



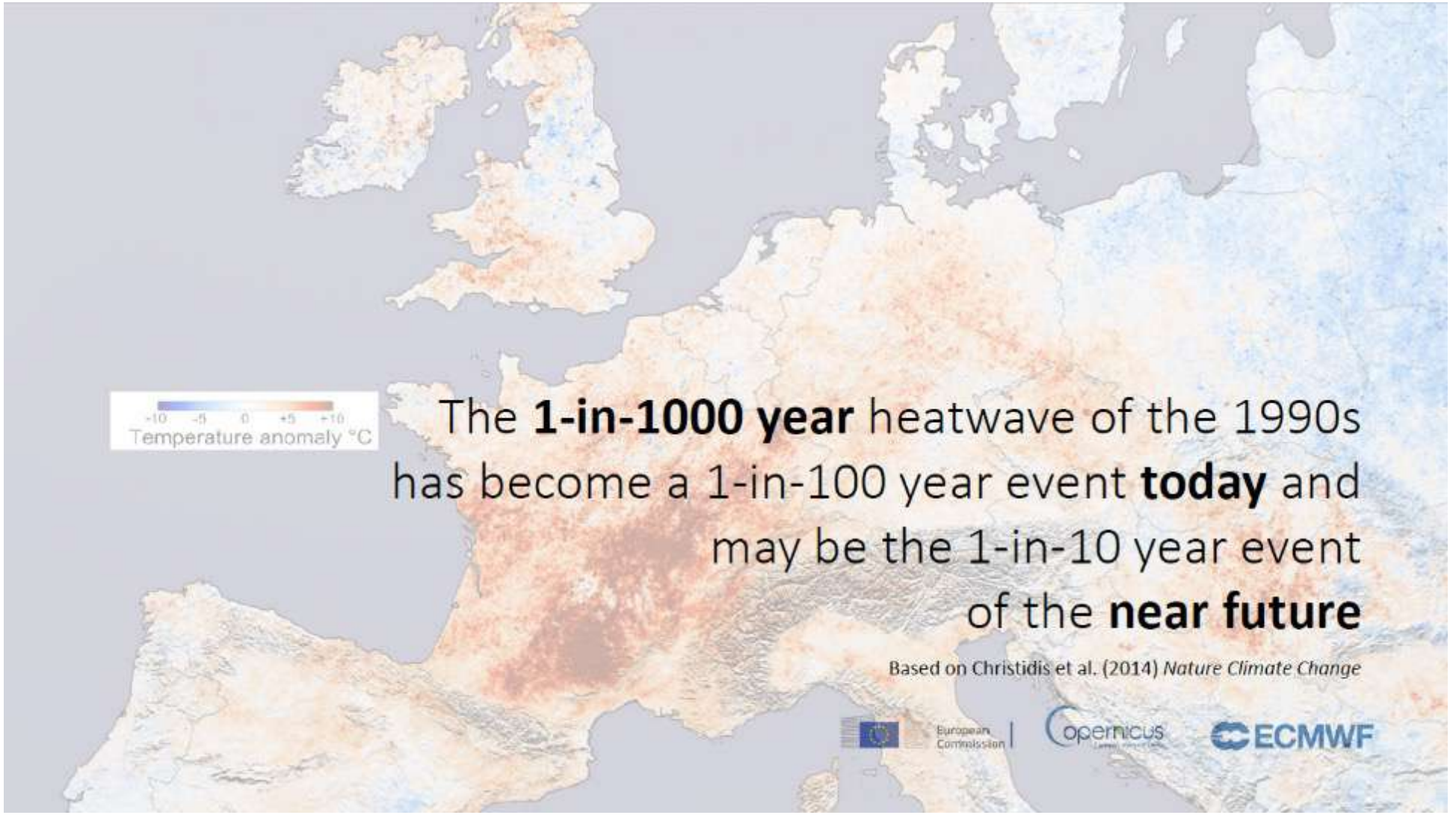

Source: How C3S works, climate.copernicus.eu

# But is this enough for the planning of a climate-resilient pan-EU grid?

**Especially in long-term planning studies, we need to be aware of the climate conditions with decades lead time, so that the system needs are properly identified. This aspect is valid for both the demand side (electricity load is temperature-dependent and will be even more so), as well as for the supply side (with patterns for wind and solar expected to change due to climate change)**




*Source: ECMWF*



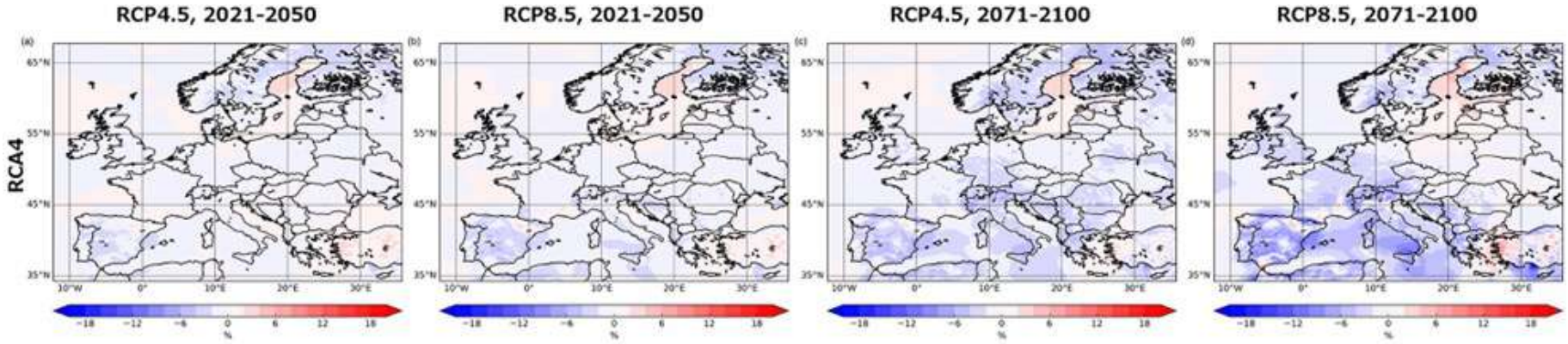

*Source: Erich Fischer, ETH Zurich, C3S 2021 General Asembly*

# What are the steps ENTSO-E is making in this direction?

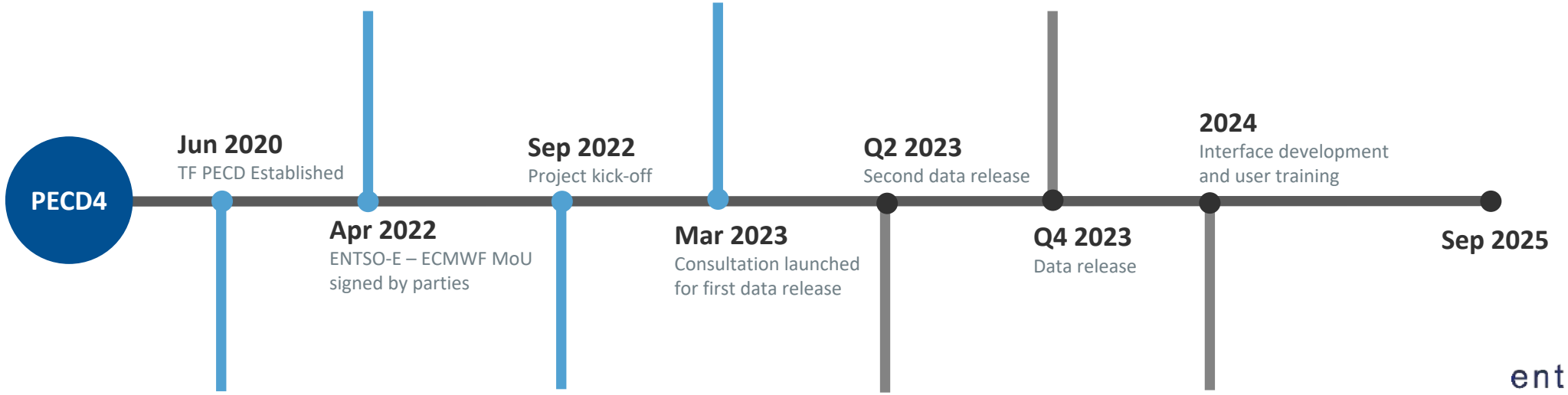
**Following requests from NRAs and other stakeholders (e.g. NGOs) to build a comprehensive meteorological database accounting for the impacts of climate change on demand and supply and the desire of study teams to improve the quality and robustness of their studies, the development of PECD v4 was initiated**

- Q2 2022 – MoU signed between ENTSO-E and ECMWF
- Q3 2022 – C3S reached out to a consortium of academic and industrial partners to deliver:
  - >10 different climate models & emission scenarios (RCPs), based on EURO-CORDEX experiment and in line with IPCC's Assessment Report
  - Data covering all relevant climate variables (wind, solar, hydro, temperature) spanning 2006 to 2100
  - Enhancing the generation technologies models converting climate data to RES availabilities
  - Data provided under open-access license, hosted on the Climate Data Store w/ user interface

# Upon completion, the project aim is to provide, with open-access, a comprehensive view of climate conditions (wind, solar, hydro, demand-related) across Europe and the Mediterranean basin, that would account for multiple climate models and emission scenarios, in line with the 6th IPCC Assessment Report




*Changes in mean annual wind output for different climate models and RCP scenarios, compared to historical (1970-2000) data. Source: Future Changes of Wind Speed and Wind Energy Potentials in EURO-CORDEX Ensemble Simulations, J. Moemken et al.*



## Useful links:

Homepage | Copernicus

EURO-CORDEX

Power Outlooks (entsoe.eu)

## Questions? Reach out!

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# ENTSO-E Mission Statement

## Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the **association for the cooperation of the European transmission system operators (TSOs)**. The 39 member TSOs, representing 35 countries, are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E **brings together the unique expertise of TSOs for the benefit of European citizens** by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

## Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the **security of the interconnected power system in all time frames at pan-European level and the optimal functioning and development of the European interconnected electricity markets**, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

## Our vision

ENTSO-E plays a central role in enabling Europe to become the first **climate-neutral continent by 2050** by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires sector integration and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources. ENTSO-E acts to ensure that this energy system **keeps consumers at its centre** and is operated and developed with **climate objectives** and **social welfare** in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

# ENTSO-E Mission Statement

## Our values

ENTSO-E acts in solidarity as a community of TSOs united by a shared responsibility.

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by optimising social welfare in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and innovative responses to prepare for the future and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with transparency and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

## Our contibutions

ENTSO-E **supports the cooperation** among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its **legally mandated tasks**, ENTSO-E's key responsibilities include the following:

- Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;
- Assessment of the adequacy of the system in different timeframes;
- Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);
- Coordination of research, development and innovation activities of TSOs;
- Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in **the implementation and monitoring** of the agreed common rules.

**ENTSO-E is the common voice of European TSOs** and provides expert contributions and a constructive view to energy debates to support policymakers in making informed decisions.

Our values define who we are, what we stand for and how we behave.
We all play a part in bringing them to life.

## EXCELLENCE

We deliver to the highest standards. We provide an environment in which people can develop to their full potential.

## TRUST

We trust each other, we are transparent and we empower people. We respect diversity.

## INTEGRITY

We act in the interest of ENTSO-E

## TEAM

We care about people. We work transversal and we support each other. We celebrate success.

## FUTURE THINKING

We are a learning organisation. We explore new paths and solutions.

# We are ENTSO-E