ERAA 2024 Public Webinar: Preliminary Input Data – Call for Evidence

14 March 2024

Lukas Galdikas (ENTSO-E), ERAA 2024 Project Manager

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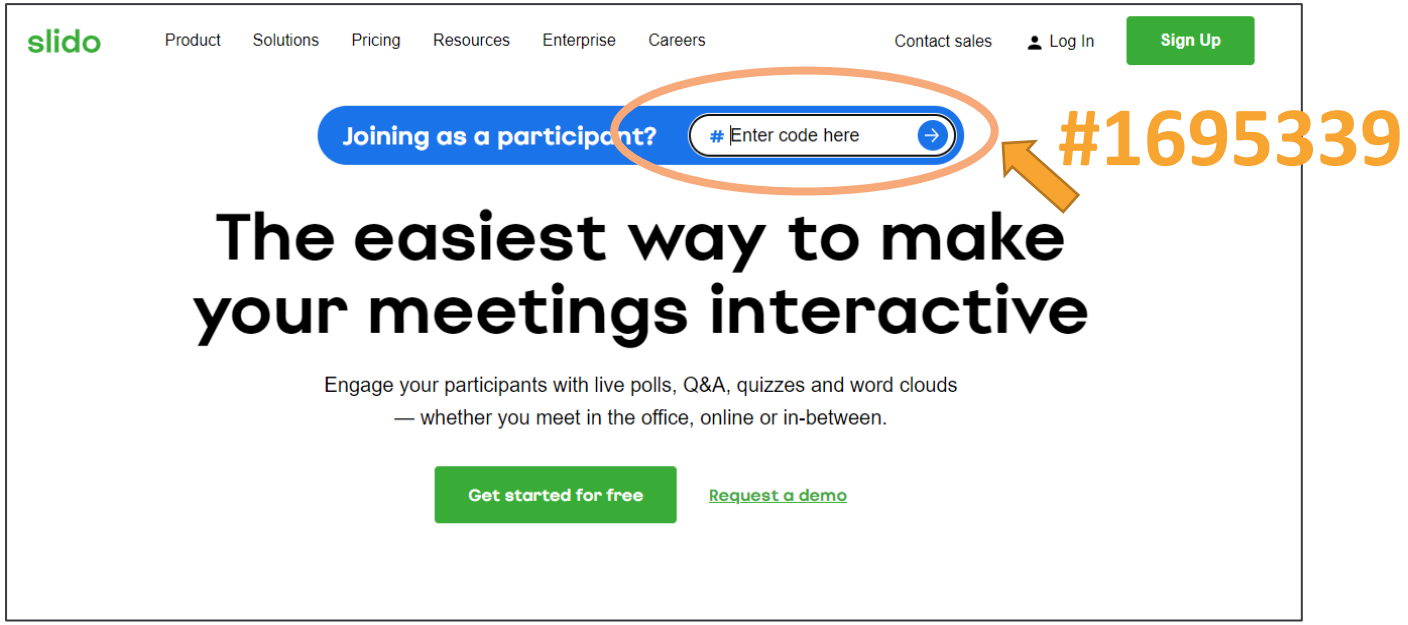
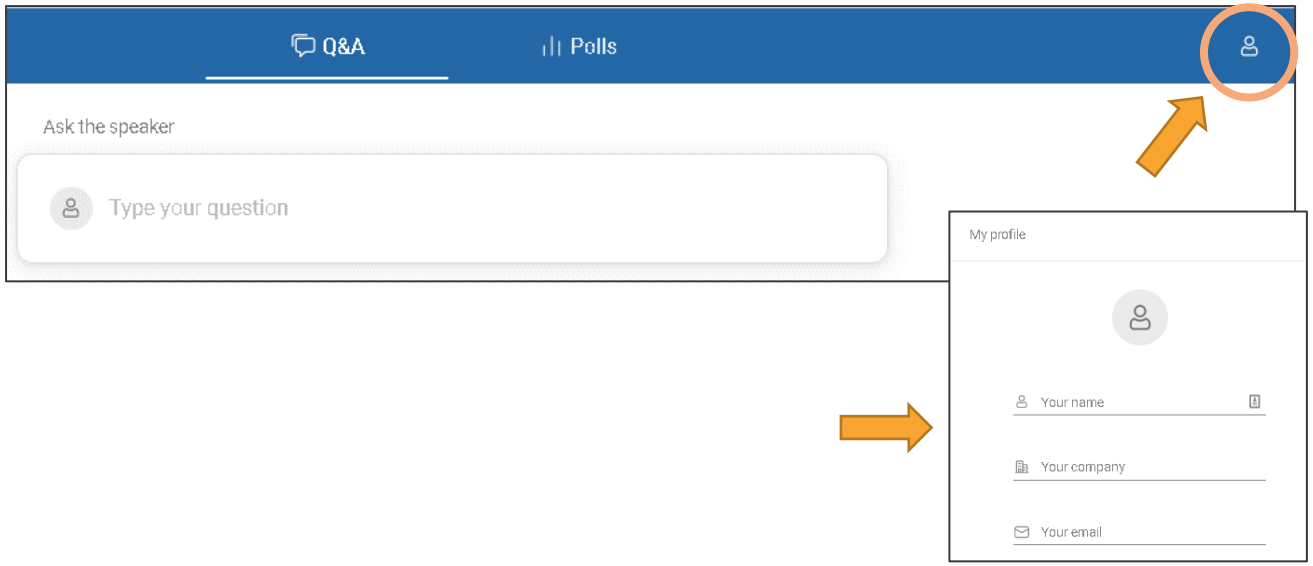
Housekeeping Rules

- **The Webinar will be recorded**
- **Ask questions directly through sli.do**
  - Log-in method in next slide
- **Enter your name & company details**
- **Vote for the most relevant questions**
- **The moderator will select most relevant questions and ask the speakers to comment**
- **The teams "chat" and "hand raising" features will not be used.**

Sli.do QR code

Go to www.sli.do and enter **#1695339** or scan QR code below





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Today's Agenda

Subject	TIME	WHO
Welcome and scope of webinar	10.00 – 10.05	**Lukas Galdikas (ENTSO-E),** ERAA 2024 Project Manager
Introduction	10.05 – 10.20	**Marlene Petz (APG)** ERAA 2024 Steering group convener
ACER's perspective on the importance of ERAA and stakeholder feedback	10.20 – 10.30	**Aleksander Glapiak (ACER)** Policy Officer – Electricity
Data collection process at ENTSO-E	10.30 – 10.45	**Daniel Keogh (ENTSO-E)** Working group Data & Models, Data Quality Task Force
Methodological improvements of climate data (PECD)	10.45 – 11.00	**Alberto Troccoli (ICS)** CEO at Inside Climate Service srl
Insights on ERAA 2024 preliminary data	11.00 – 11.30	**Gregorio Iotti (APG)** ERAA 2024 Market Study Team Convener
Q&A	11:30 – 11.45	**Lukas Galdikas (ENTSO-E)** ERAA 2024 Project Manager
Conclusions and next steps	11.45 – 12.00	**Lukas Galdikas (ENTSO-E)** ERAA 2024 Project Manager

Introduction

Marlene Petz (APG), ERAA steering group convener

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Background

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- ERAA is an ENTSO-E **legal mandate**, which aims to understand how the rapid changes to our energy system will affect security of supply.
- It **supports decision-makers** in ensuring secure, affordable and sustainable energy to citizens and industries.
- It is a **full pan-European monitoring assessment** of power system resource adequacy, based on a state-of-the-art, globally unparalleled **probabilistic analysis** looking up to a decade ahead.
- **ERAA 2024** builds upon the 2023 edition with **continuous improvements** towards the full implementation of the methodology.
- ERAA 2024 aims to be an effective tool to **identify adequacy risks.**
- ERAA is built on **the latest and transparent pan-European reference dataset** emerging from two main domains: data driven by the national and European policies; and cutting-edge common pan-European dataset.

Role of the ERAA

Assess potential adequacy risks of the European power system in medium term

With focus on TY 2026, 2028, 2030, 2035

Inform decision makers and stakeholders

Common basis for MS to introduce capacity mechanisms

Strengthen Europe's trajectory to net-zero

Strengthen and complement system planning activities

ENTSO-E is committed to Net-Zero

NET ZERO

CO2

Objective of net-zero by 2050 structures all activities.

Central role of electricity means TSOs must manage an increasingly complex system.

FLEXIBILITY

Wide range of factors influence resource adequacy.

New trends require forecasting adequacy years in advance.

EFFICIENT PLANNING

Public support for the energy transition requires security of supply at the lowest cost in the long run.

Sharing of resources in integrated markets enables this.

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Continuous improvement

Model

- *Further improve consistency of the Economic Viability Assessment and Adequacy models*
- *Established dedicated development stream*

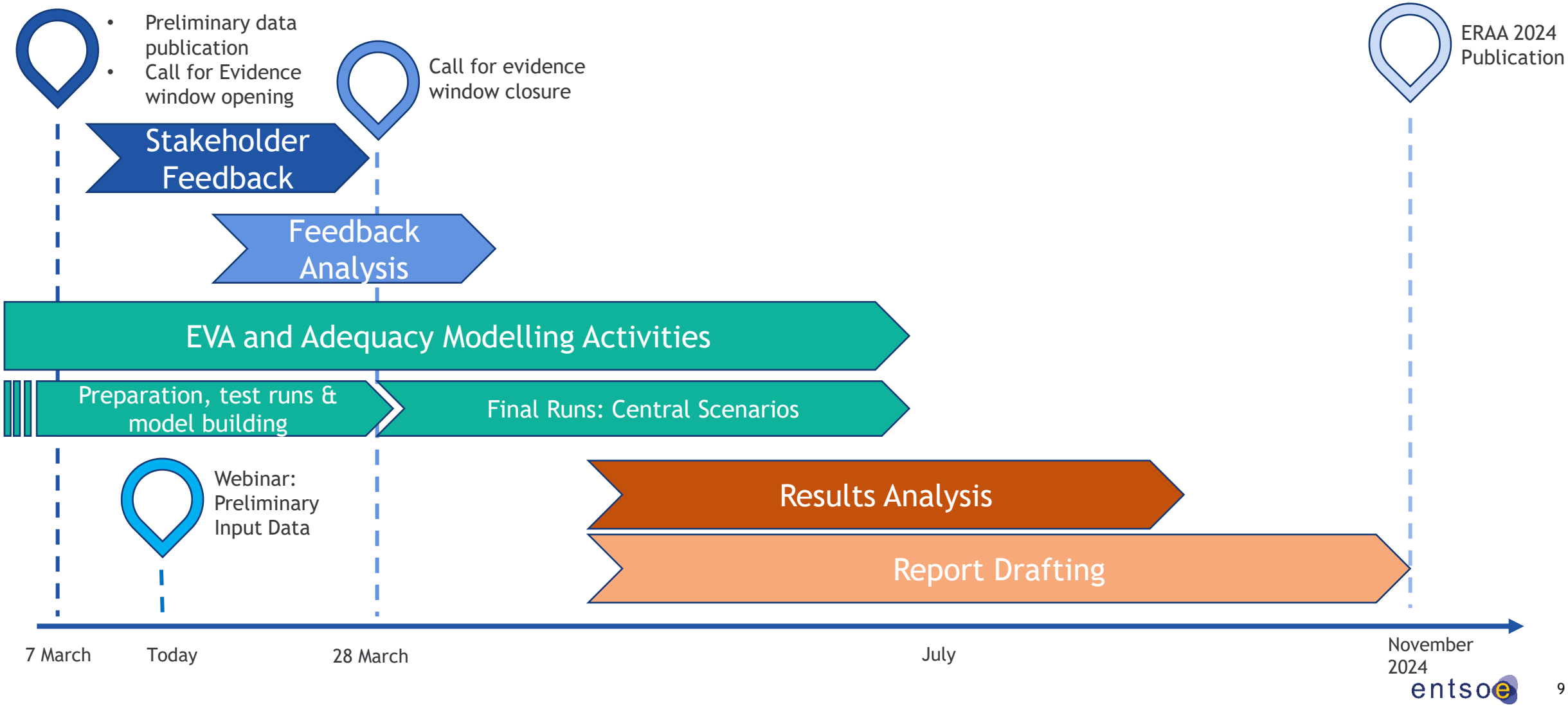
Climate data

- *New Pan-European Climate Database (PECD)*
- *Improved climate changes representation*

Interconnection

- *Flow-Based representation*
- *Transmission capacity evolution*

Call for Evidence timeline to ensure a robust basis for ERAA 2024



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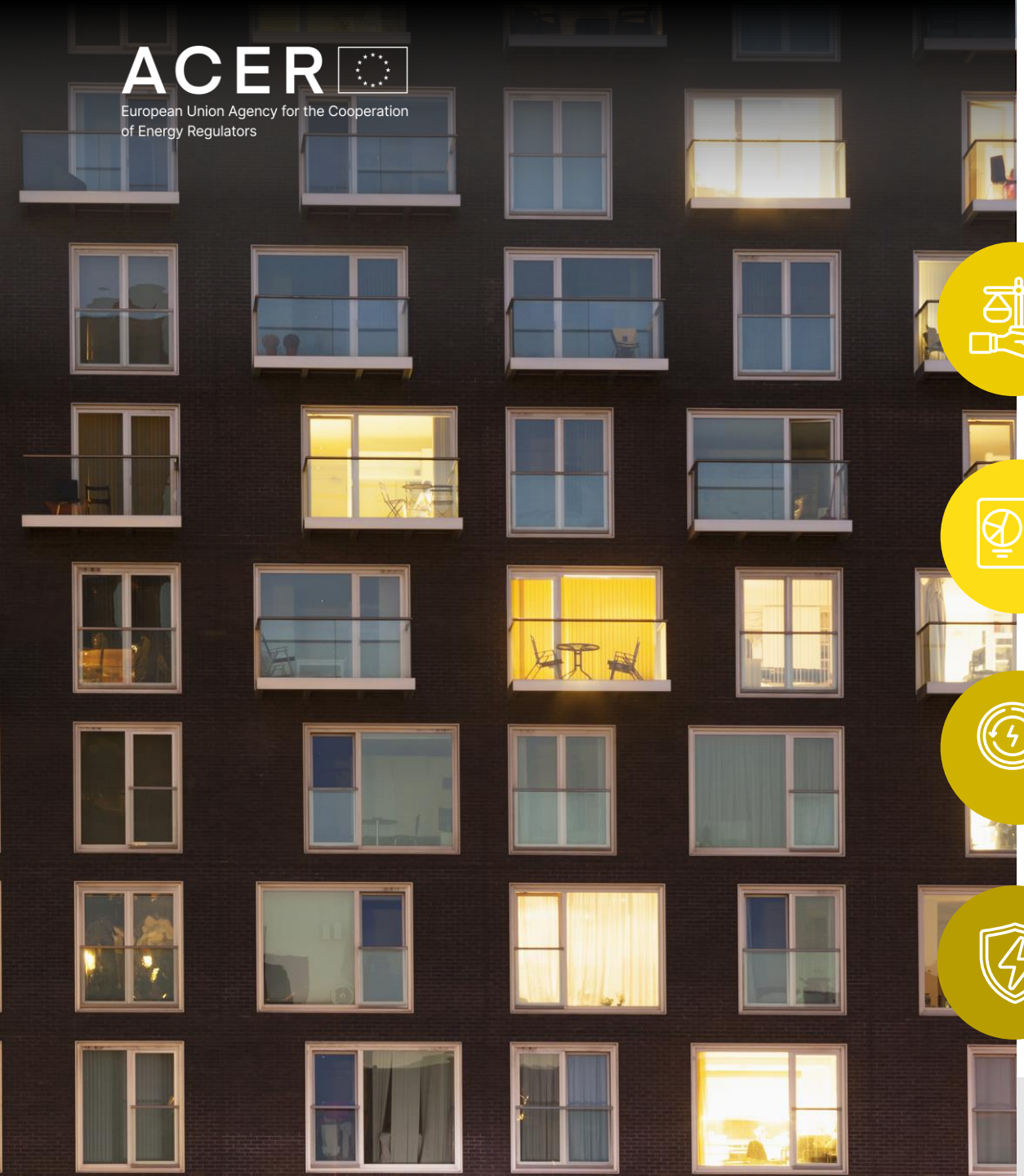
European Union Agency for the Cooperation of Energy Regulators

Stakeholder engagement and robustness of ERAA

ENTSO-E's ERAA webinar
14 March 2024

Aleksander Glapiak, Policy Officer – Security of supply



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European assessment in the common adequacy framework

DEFINE NECESSARY LEVEL
- reliability standard set by the Member States

MONITOR RESOURCE ADEQUACY
- Member States' obligation

IDENTIFY ADEQUACY CONCERN
- robust assessment of the expected adequacy

IMPROVE RESOURCE ADEQUACY
- selection of measures

see Chapter IV of the Regulation (EU) 2019/943

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Importance of stakeholder engagement

Two key areas of stakeholders' participation in the ERAA development, crucial for transparency:

1. Data and assumptions
2. Technical aspects of the methodology

ACER is inviting stakeholders to actively engage in the consultation and process.

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ACER and regulators' priorities for ERAA 2024

CONSISTENCY OF MARKET RULES AND INVESTOR BEHAVIOUR

Improve how ERAA reflects investor's risk aversion transparently via hurdle rates and applies current market rules.

CONSISTENCY OF THE ERAA MODEL

Adopt an iterative approach in modelling investment decisions as a structural solution to ensure robust results.

ACER's data focus in 2024

CONSISTENCY OF CROSS-ZONAL CAPACITIES

Model cross-border electricity flows as system operators calculate them, using a flow-based approach.

Thank you.
Any questions?

The contents of this document do not necessarily reflect the position or opinion of ACER.

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European Union Agency for the Cooperation of Energy Regulators

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Data Collection Process

Dan Keogh (ENTSO-E), Market Modelling Expert

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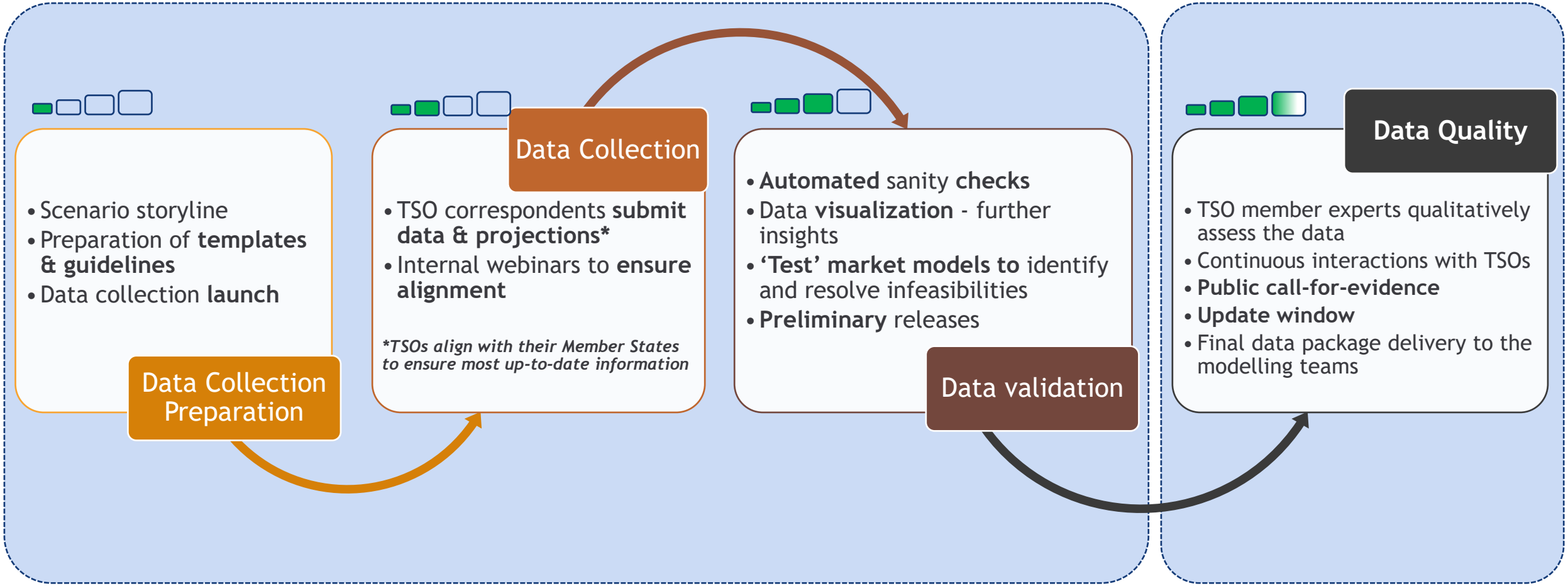
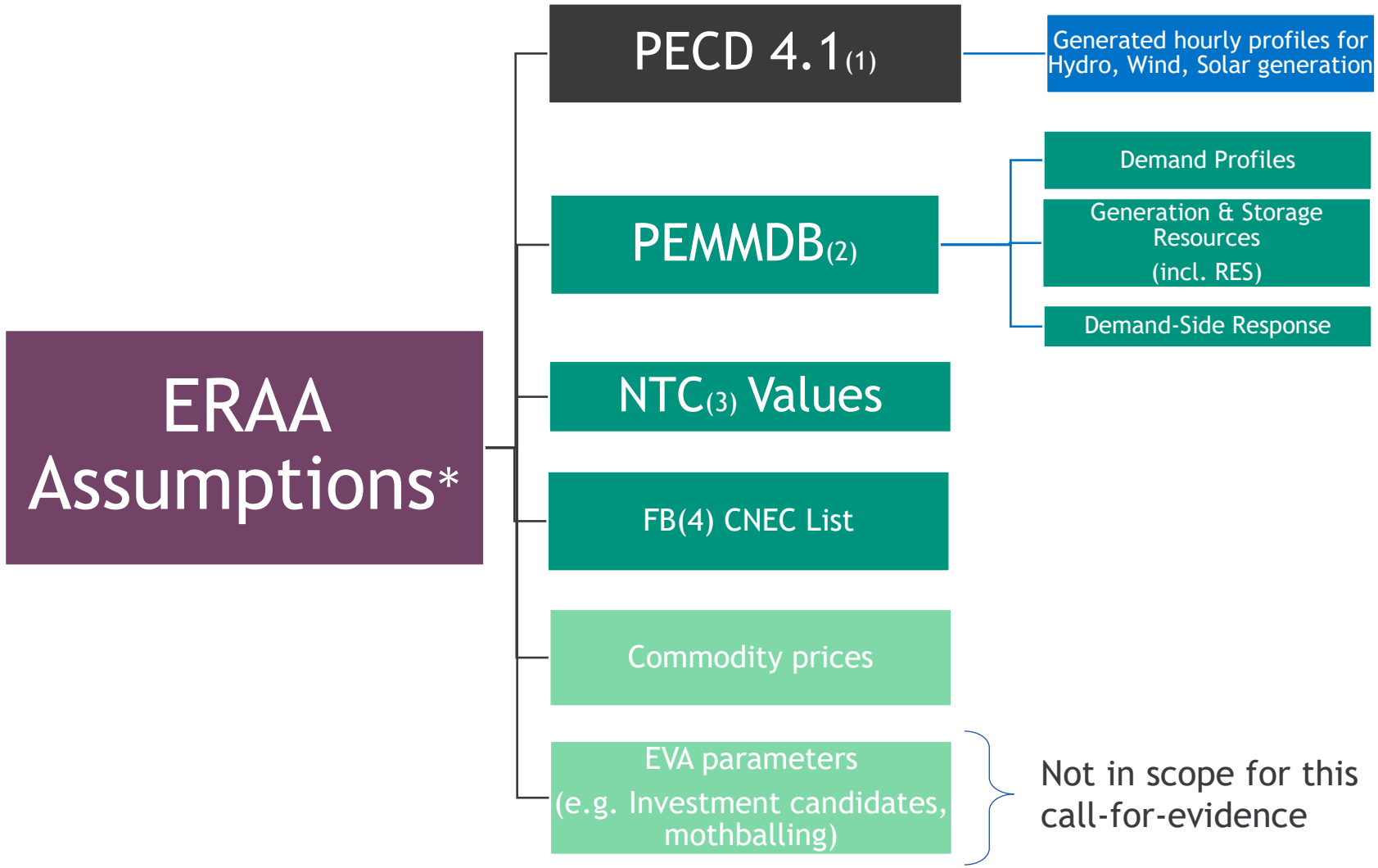
Data collection process



Data Structure



*ERAA scenarios are published by ENTSO-E, see ERAA Downloads

(1) **P**an-**E**uropean **C**limate **D**atabase
(2) **P**an-**E**uropean **M**arket **M**odelling **D**ata**B**ase
(3) **N**et **T**ransfer **C**apacities
(4) **F**low-**B**ased

PEMMDB, NTC & Demand

Key Dates:

- **PEMMDB and NTC** data collection ran from 13 December 2023 and 17 January 2024.
- **Demand** data collection ran from 20 November 2023 until 21 February 2024

Tools:

- **PEMMDB App** features automated validation checks and data cannot be submitted if datasets contain errors
- **Demand Forecasting Tool** creates forecast future demand profiles based on TSO input assumptions

Data Quality Taskforce Process:

- TSO and ENTSO-E staff were assigned market nodes (including their own, if applicable) to perform qualitative checks using a set of high-level visuals.
- Data correspondents were invited to correct issues during an update window in February 2024

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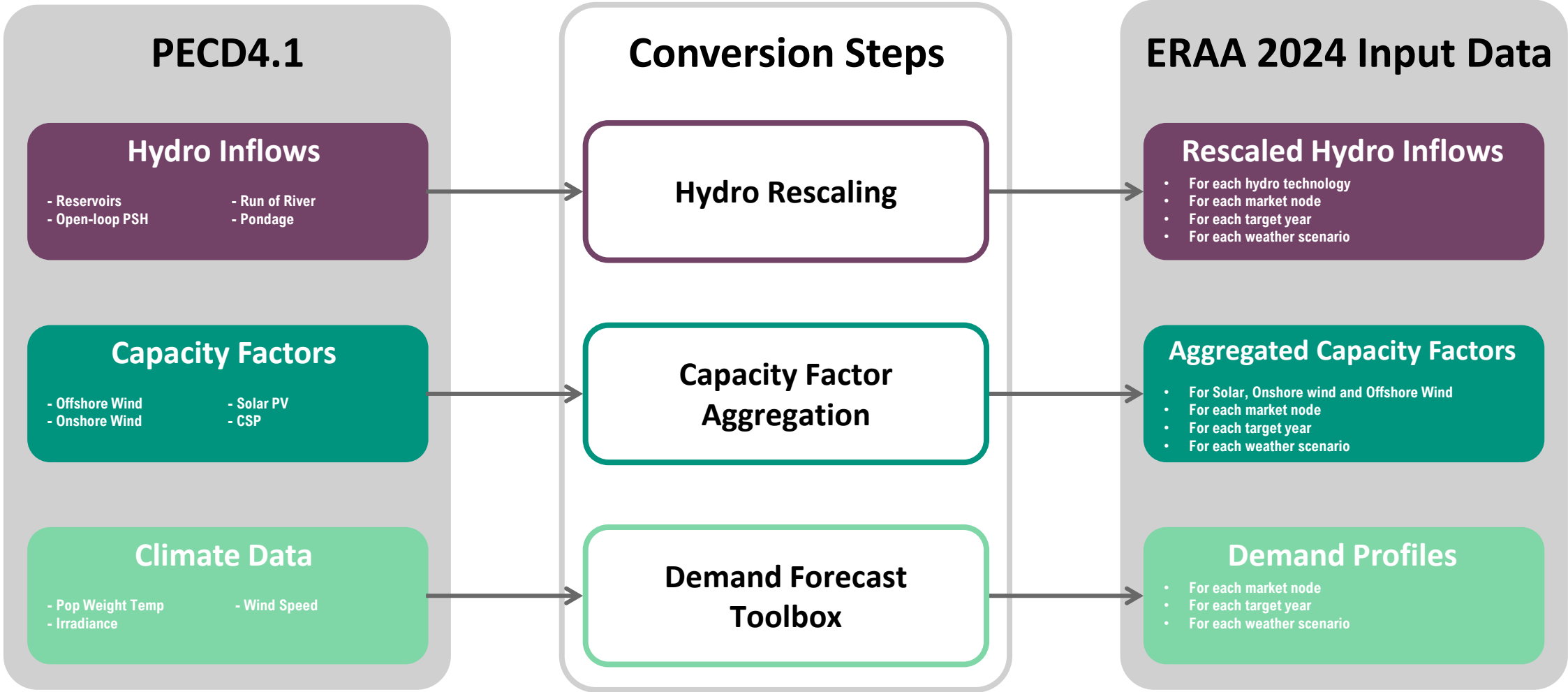
PECD 4.1



PECD 4.1 represents projected weather scenarios modelled by 3 different climate models that account for the impact of climate change.

Methodological improvements of climate data

Alberto Troccoli (ICS), CEO at Inside Climate Service srl

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Climate Change

Copernicus Climate Change Service (C3S) – Energy Service Lot 2

EERA 2024 Public Consultation

14 March 2024

Alberto Troccoli

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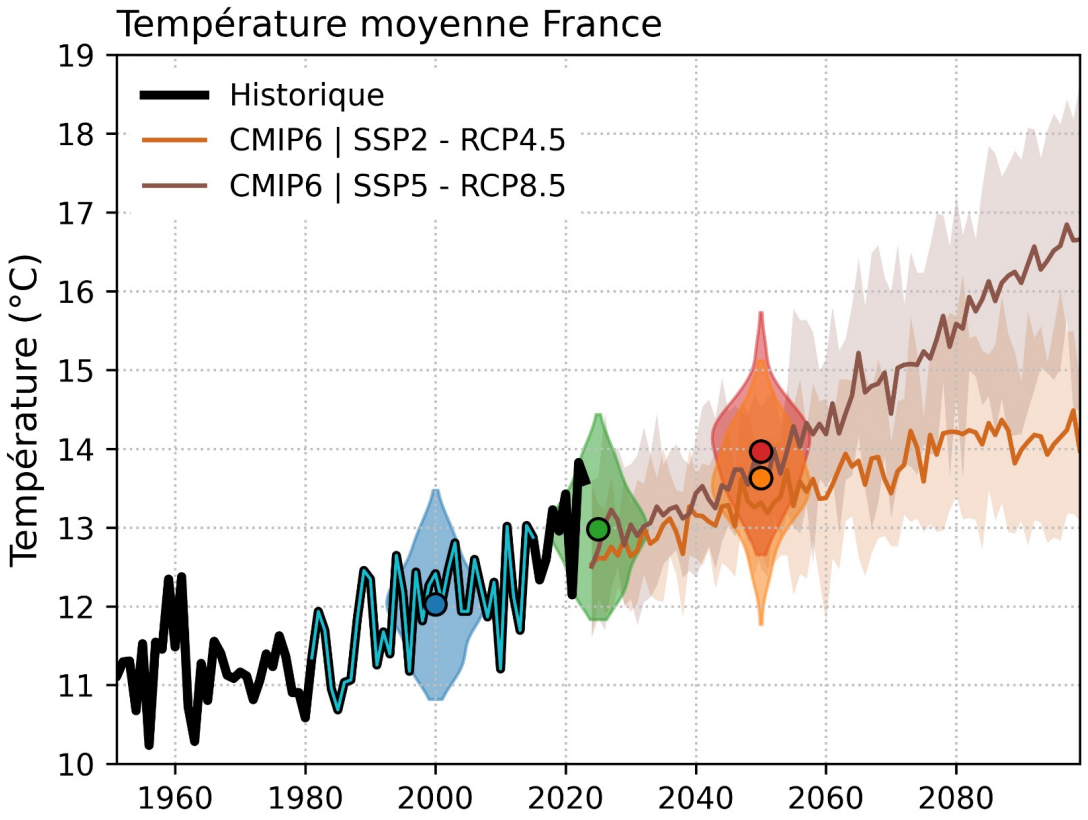
Update to the Pan European Climate Database – Motivation

Why the update?

- Need to account for climate change – Using state-of-the-art climate projections
- Open (public) data – Transparency in the process, also via publications



ENTSO-E :
1979-2023
PECDv3

RTE: simulations under different climate conditions

- Climat 2000
- Climat 2025
- Climat 2050 - RCP4.5
- Climat 2050 - RCP8.5

Adapted from Laurent Dubus (RTE)

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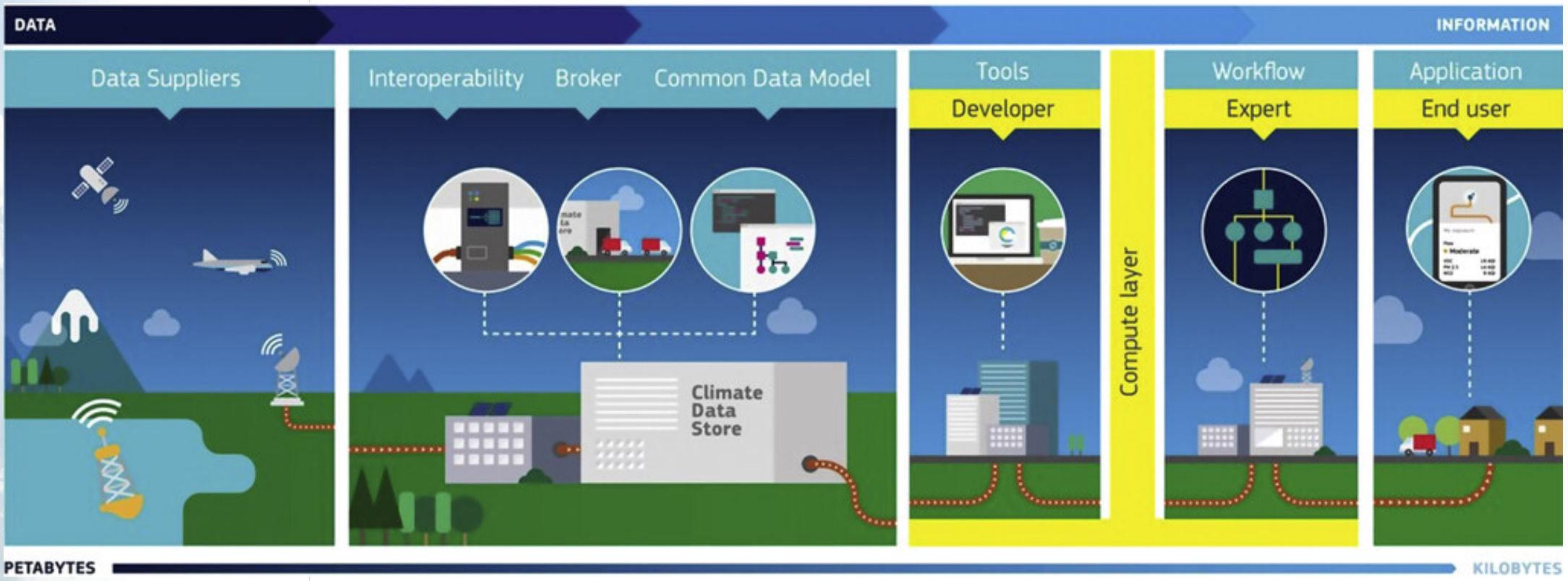
Copernicus Climate Change Service



C3S: An **operational** climate service embedded in the **Copernicus Earth** observation program

Implemented by ECMWF together with **over 300 public and private entities** from more than 40 countries in Europe and beyond

C3S provides **reliable, open, and free access** to state-of-the-art data available on the past, present, and future evolution of climate

Quality-assured data, tools, and applications to combine and transform those data into **useful information** products

https://doi.org/10.1175/BAMS-D-21-0315.1

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C3S Energy Lot 2 – Sep 2023-Aug 2025

C3S2 412 Enhanced Operational Services for the Energy Sector aka C3S Energy Lot 2

Main objective: to provide support to ENTSO-E in the preparation of the **P**an **E**uropean **C**limate **D**atabase (**PECD**)

- Delivering climate and energy variables
- Building tools to aggregate data over user relevant areas
- Delivering energy models through toolbox applications

Conversion models from climate variables to energy indicators

SPV and CSP generation

Wind power generation (onshore and offshore)

Hydro power (generation and inflow)

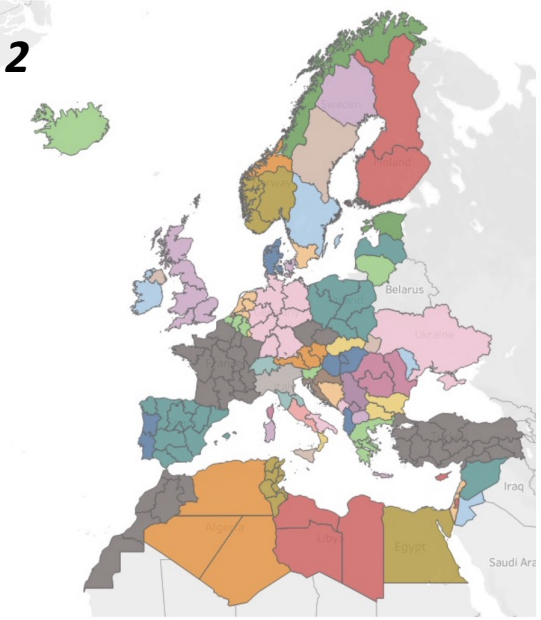
1950 — **present**

Historical stream

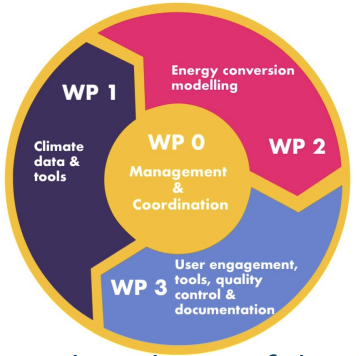
2100

Projection stream

2015



PECD domain



Work packages of the C3S Energy Lot 2 Service

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Projection models selection

Coupled Model Intercomparison Project Phase 6 (CMIP6):

- *CMCC-CM2-SR5 (**CMR5**)*
- *EC-Earth3 (**ECE3**)*
- *MPI-ESM1-2-HR (**MEHR**)*

Selection based on model components independence, max variability in Equilibrium Climate Sensitivity (ECS), availability of high temporal resolution (3h), spatial resolution (100 km)

Shared Socioeconomic Pathways (SSPs) selected: **126**, **245**, **370**, **585**

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP1-1.9	very low GHG emissions: CO_2 emissions cut to net zero around 2050	1.6 °C	1.4 °C	1.0 – 1.8
SSP1-2.6	low GHG emissions: CO_2 emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 – 2.4
SSP2-4.5	intermediate GHG emissions: CO_2 emissions around current levels until 2050, then falling but not reaching net zero by 2100	2.0 °C	2.7 °C	2.1 – 3.5
SSP3-7.0	high GHG emissions: CO_2 emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6
SSP5-8.5	very high GHG emissions: CO_2 emissions triple by 2075	2.4 °C	4.4 °C	3.3 – 5.7

Shared Socioeconomic Pathways in the IPCC Sixth Assessment Report

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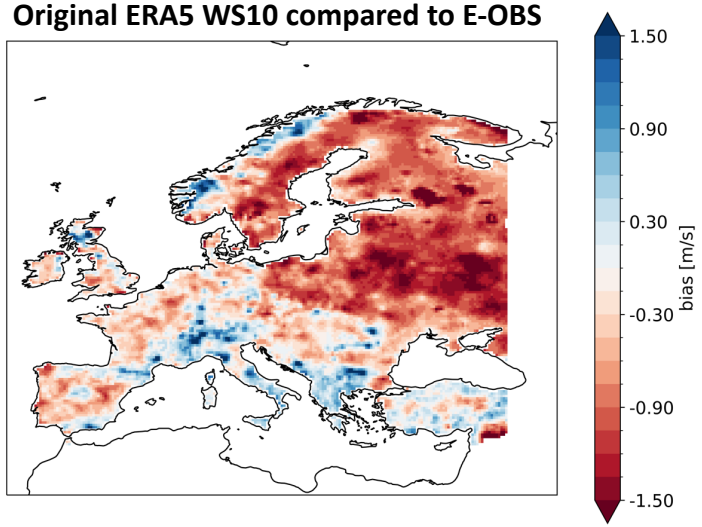
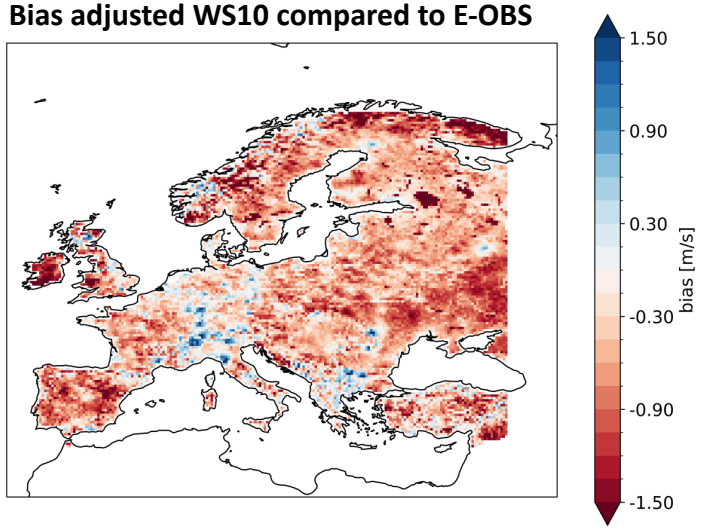
Bias adjustment

Bias adjustment: process of reducing biases in climate models at a post processing phase.

Original ERA5 WS10 compared to E-OBS



Bias adjusted WS10 compared to E-OBS



	Bias adjustment approach	
Variable	**Historical**	**Projection**
TA	-	Moving windows **Cumulative Distribution Function transform (CDFt)*** with ERA5 as reference
TP	-	**Cumulative Distribution Function transform (CDFt)*** with ERA5 as reference
GHI	-	**Delta method**** with ERA5 as reference
WS10	**Cumulative Distribution Function transform (CDFt)*** with COSMO-REA6 as reference considering ERA5 diurnal cycle	**Cumulative Distribution Function transform (CDFt)*** with bias adj. ERA5 as reference

** Michelangeli et al., 2009*

*** Navarro-Racines et al., 2020*

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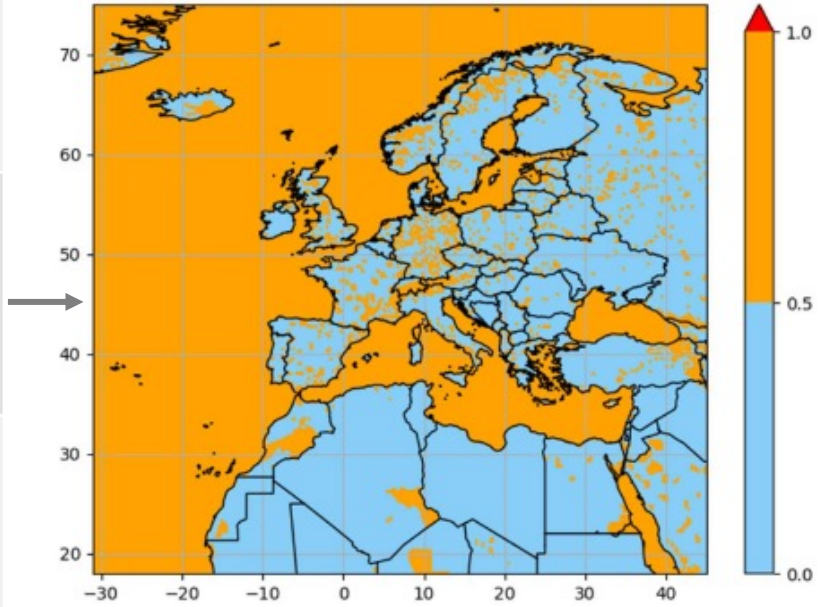
Climate Change

Tools

Tool	Purpose
Temporal interpolation	This tool has been created to interpolate the projections datasets from 3h to 1h temporal resolution. It uses a **spline** interpolation for most variables.
Wind profile – power law	It makes use of the **wind shear law** to determine the wind speed vertical profile. Firstly, the alpha coefficients are computed using ERA5 wind speed at 10 m and 100 m. Afterwards it is possible to compute the 100 m wind speed by applying the wind shear formula, taking as inputs the 10 m wind speed and the alpha coefficients. This tool is necessary since projection models often provide only the 10 m wind speed and not the 100 m wind speed.
Exclusion area composition	Its output is a **binary mask** representing the union of all the exclusion areas that the user may want to keep out of the calculations for the energy indicators. Examples of exclusion areas are *protected or restricted areas, polar regions, urban zones, water surfaces, high elevation areas* and so forth. Different combinations of exclusion areas are allowed.
Spatial aggregation	This tool takes as input shapefiles at different **aggregation levels** (country and sub-country zones), it computes gridded masks with float borders, it performs the required latitudinal adjustment, it filters out the exclusion areas if needed and finally produces the aggregated data (csv format) for the energy or climate indicators.

Combined exclusion areas for SPV generation modelling

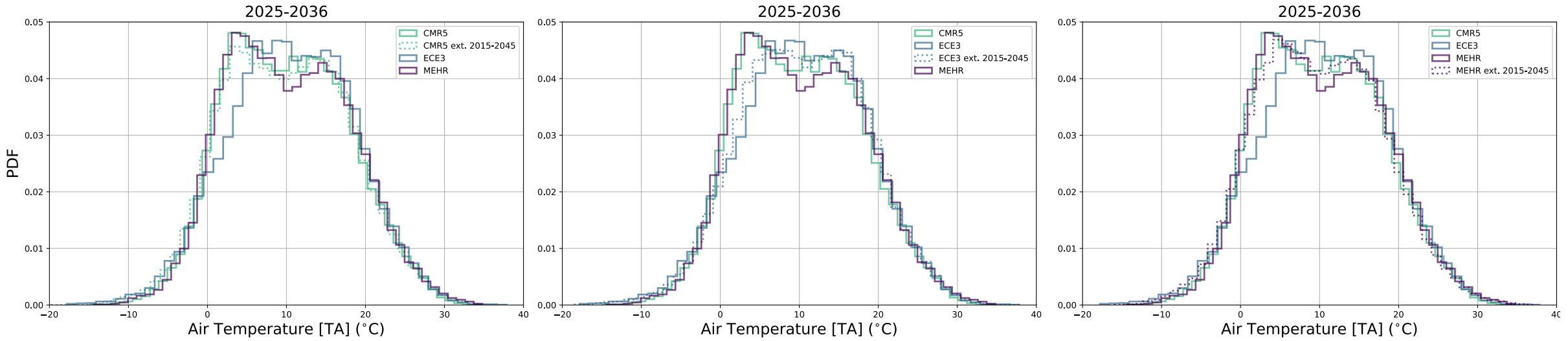


Climate Change

Change in temperature distribution with reference period

2015-2045 vs 2025-2036

Example of Germany for the three models and SSP270



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Validation plots

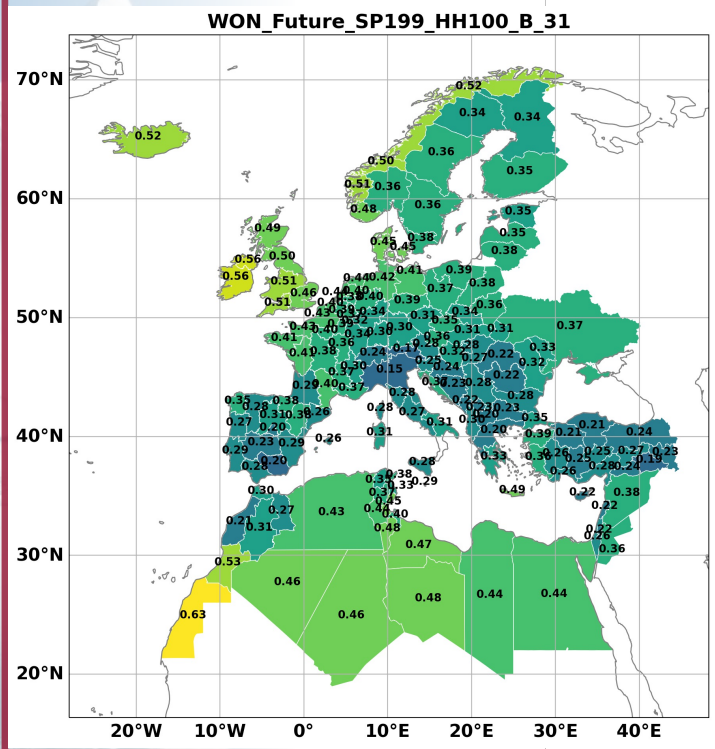
Maps		
PECDv3.1 HIST 1990-2015	PECDv4.1 HIST 1990-2015	Difference HIST PECDv4.1 - PECDv3.1
Difference PECDv4.1 PROJ (2020-2050) - PECDv4.1 HIST (1990-2020)		

Projection models: **CMR5**, ECE3, MEHR
Scenarios (SSPs): 126, SSP245, **SSP370**, SSP585
Aggregation levels: NUT0, NUT2, **PEON,** PEOF, SZON, SZOF (when available)
Difference plots: simple differences and **percentage differences**

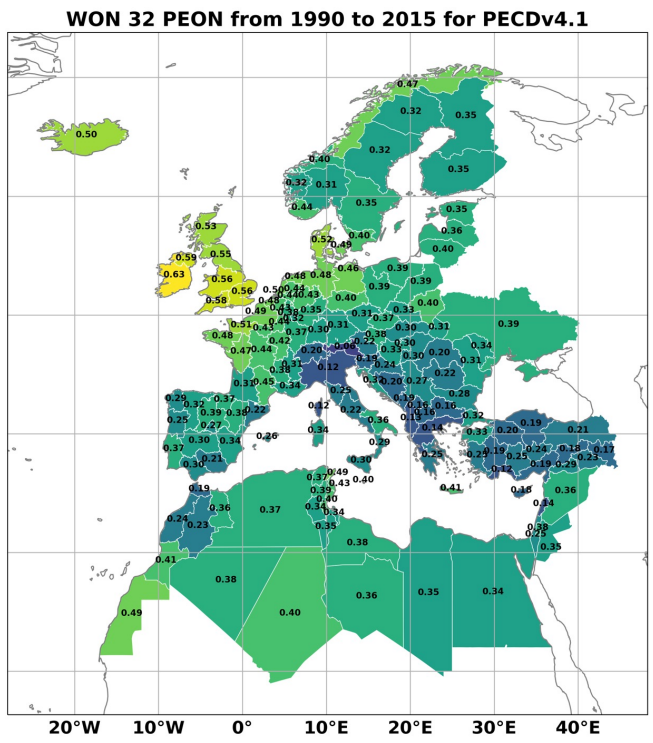
Climate Change

Wind power onshore – Capacity Factor

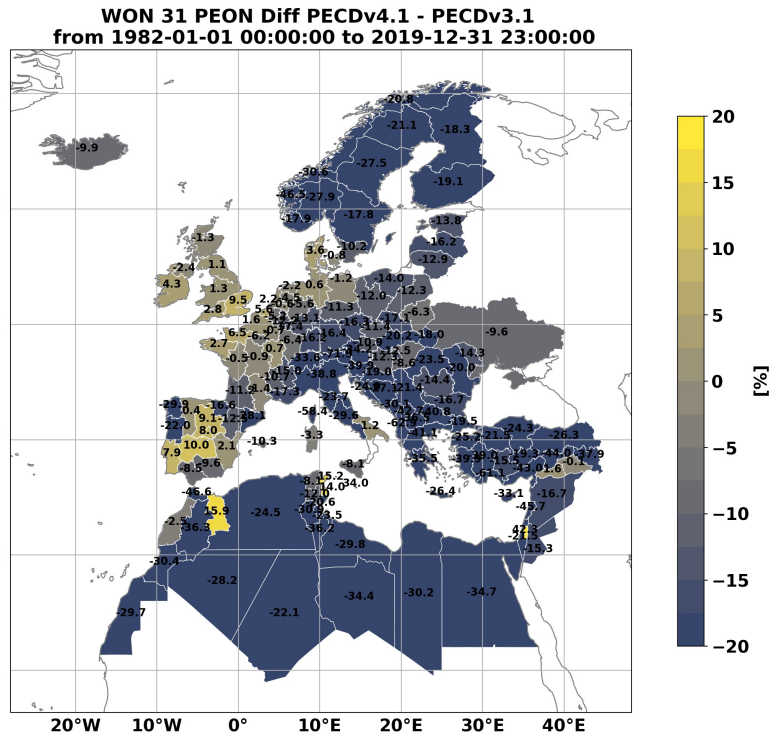
PECD v3.1 1990-2015



PECD v4.1 1990-2015



PECD v4.1 – PECD3.1 (%) 1982-2019



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Wind power offshore – Capacity Factor

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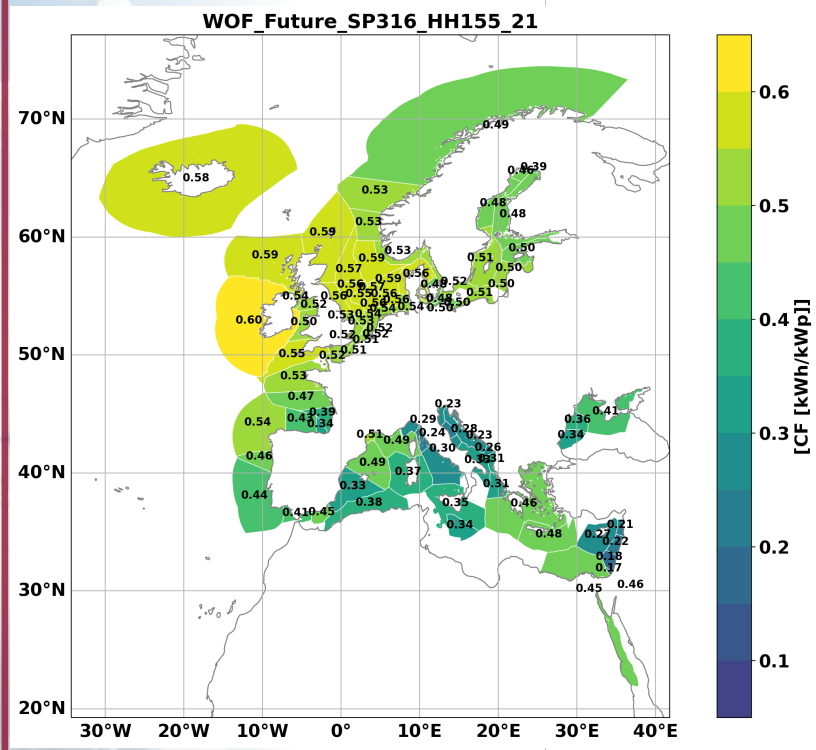
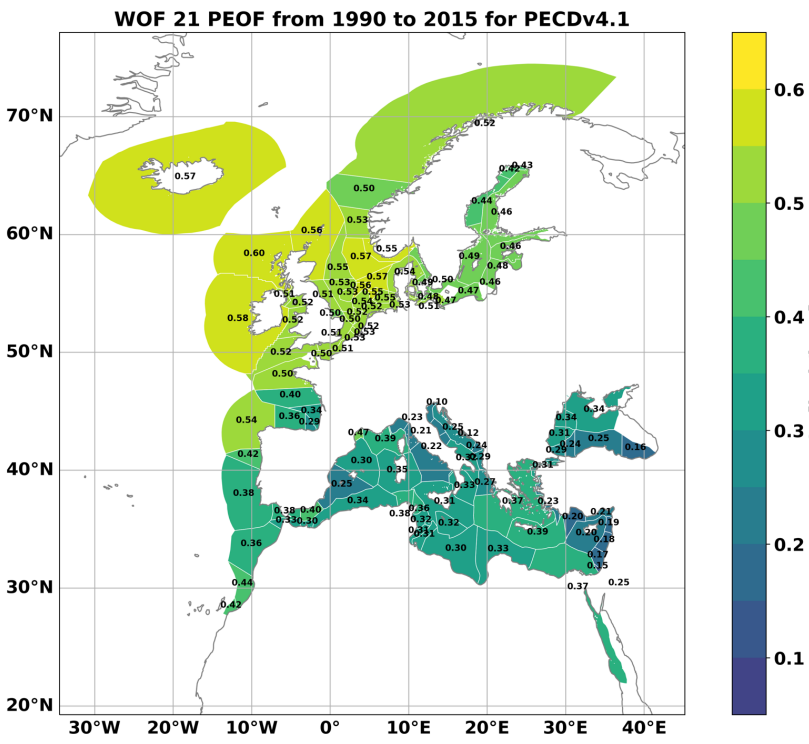
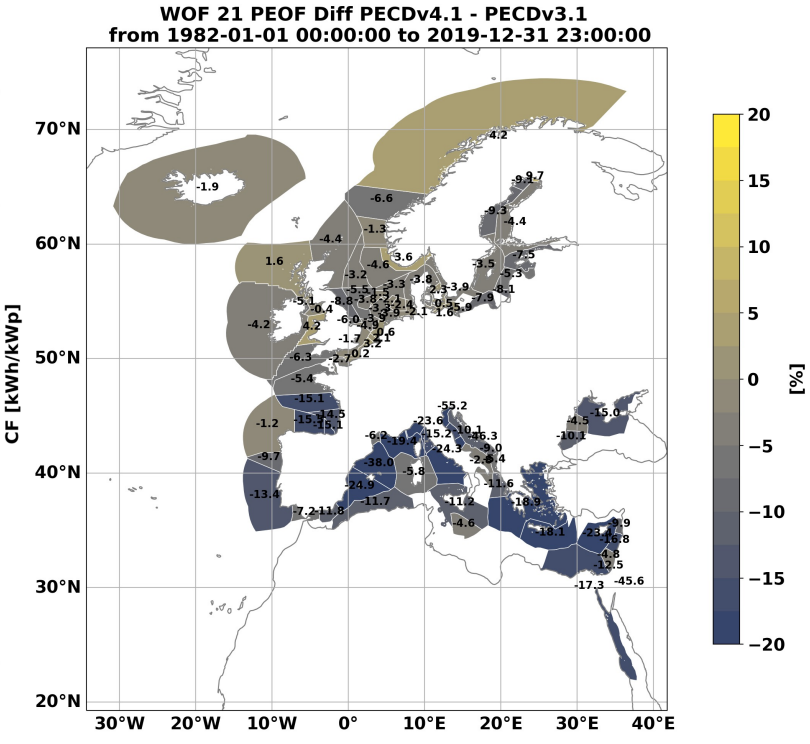
PECD v3.1 1990-2015



PECD v4.1 1990-2015



PECD v4.1 – PECD3.1 (%) 1982-2019



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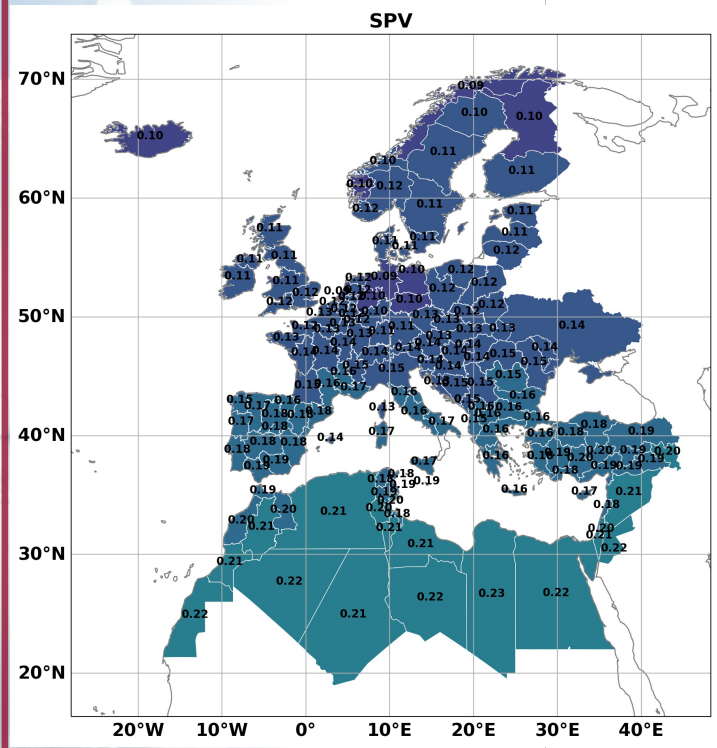
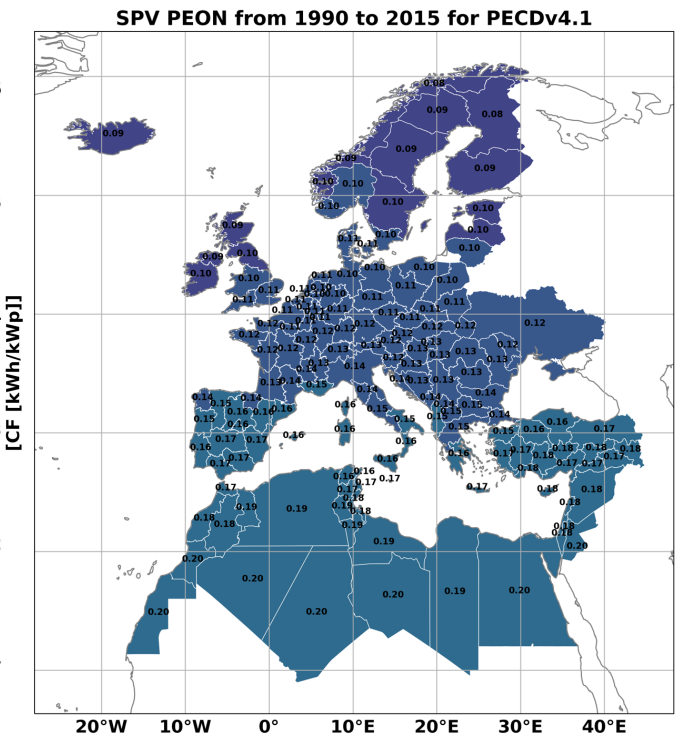
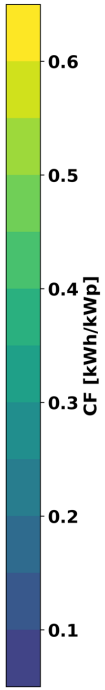
Solar photovoltaic power – Capacity Factor

PECD v3.1 1990-2015

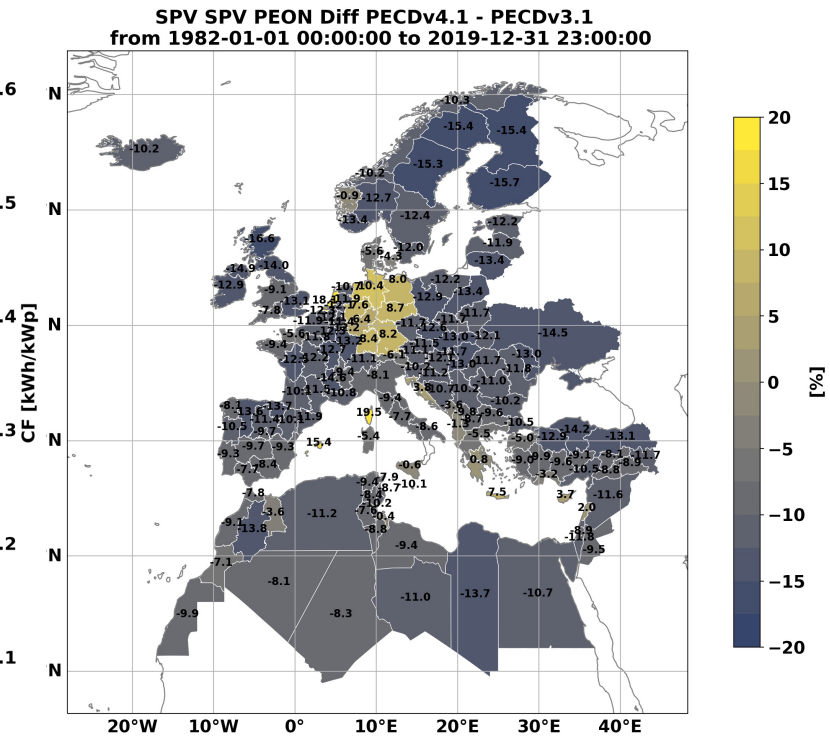


PECD v4.1 1990-2015





PECD v4.1 – PECD3.1 (%) 1982-2019



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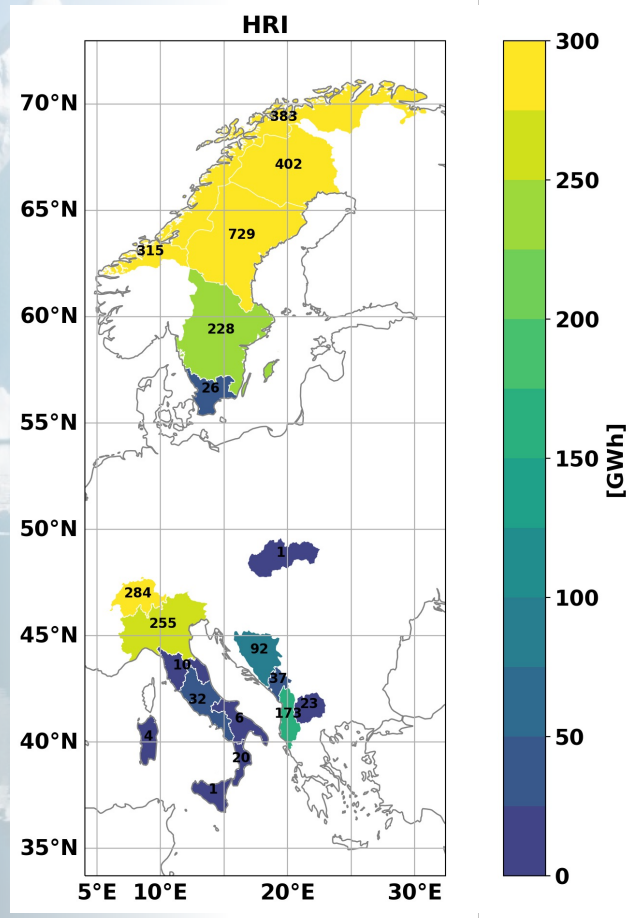
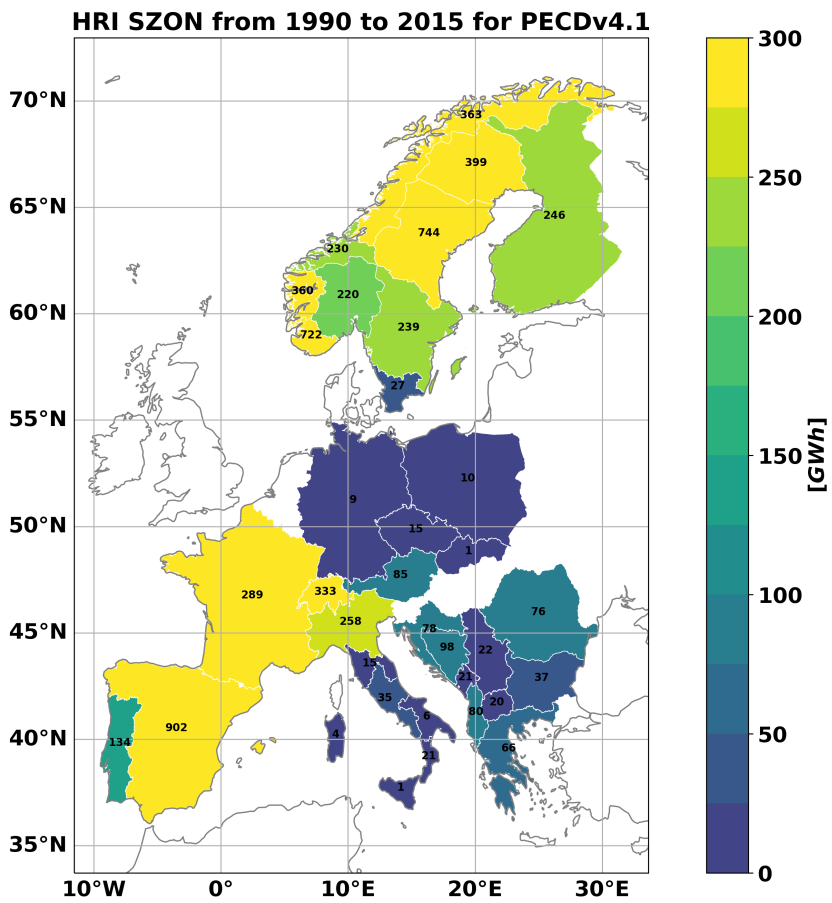
Hydro power – Inflow to Reservoir (GWh)

Climate Change

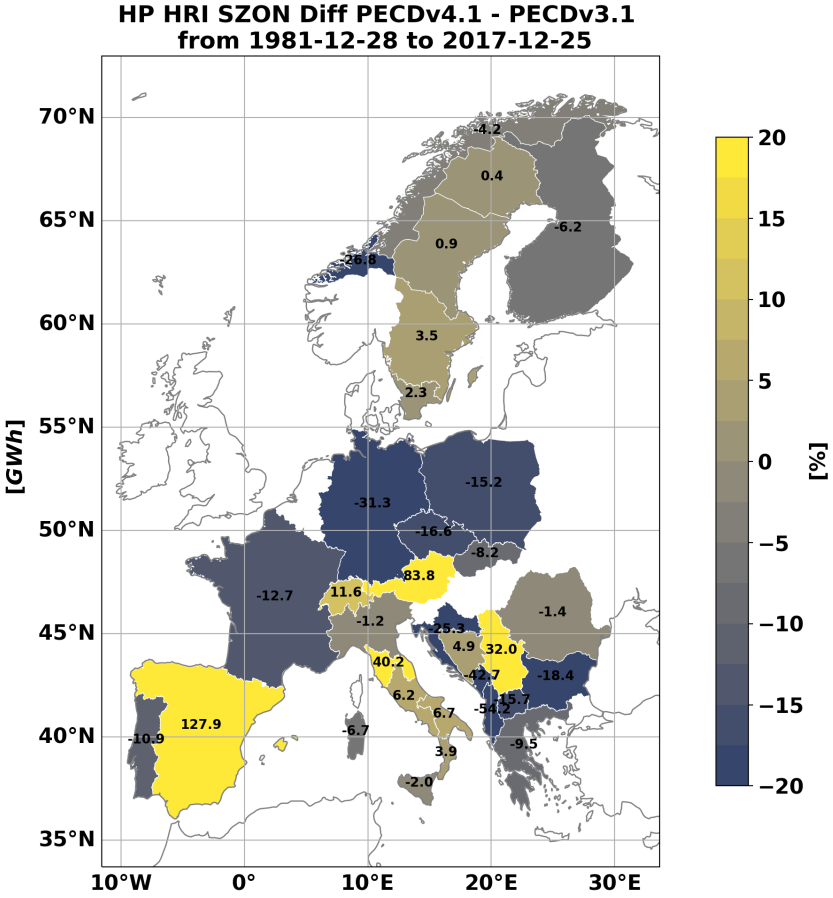
PECD v3.1 1990-2015



PECD v4.1 1990-2015



PECD v4.1 – PECD3.1 (%) 1982-2017



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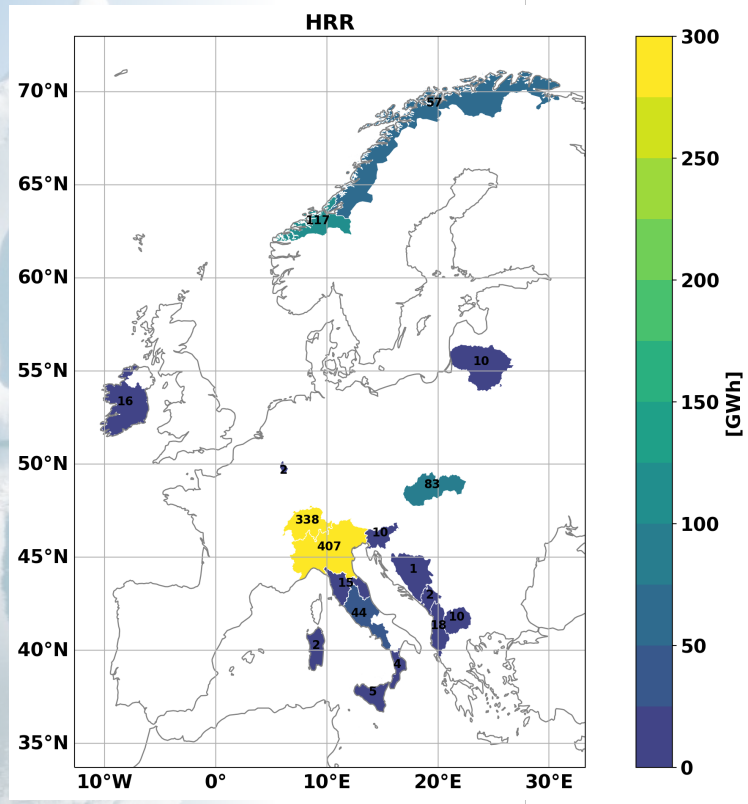
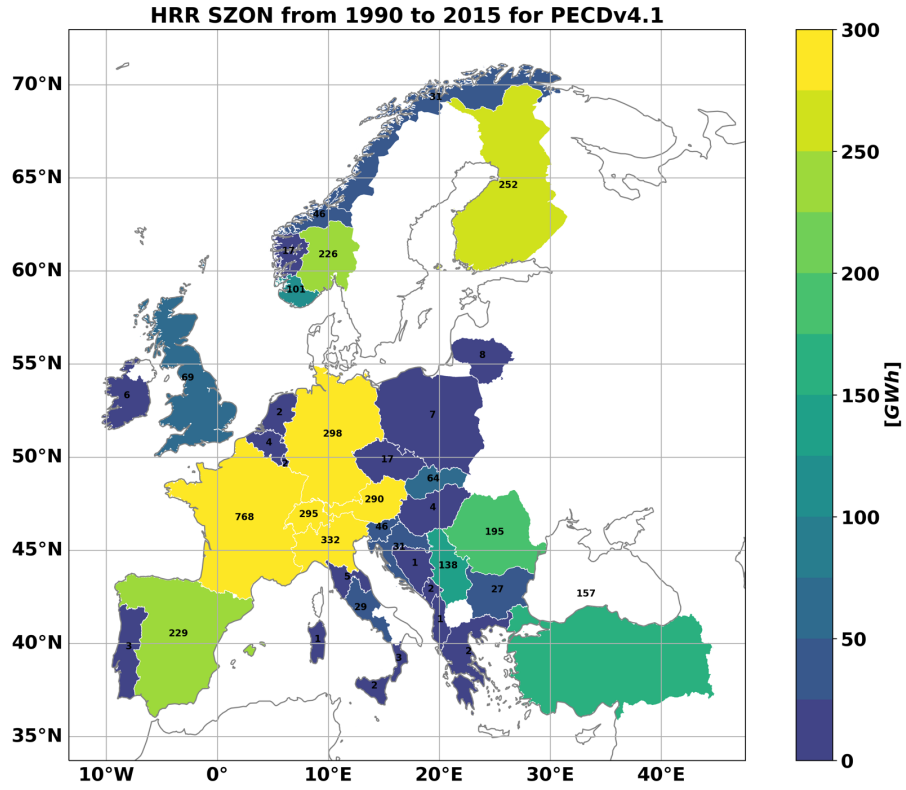
Hydro power – Inflow to Run-of-River (GWh)

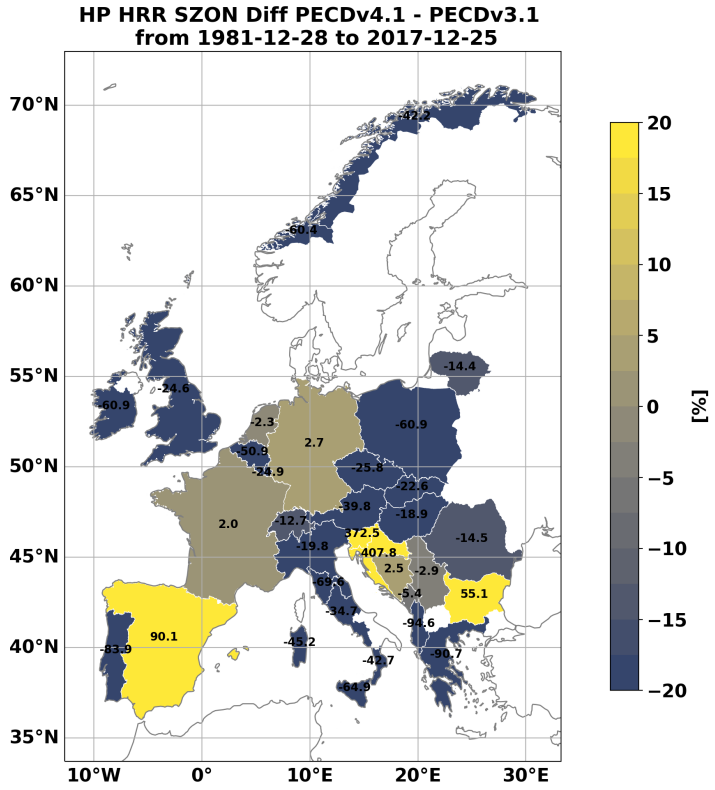
PECD v3.1 1990-2015



PECD v4.1 1990-2015



PECD v4.1 – PECD3.1 (%) 1982-2019



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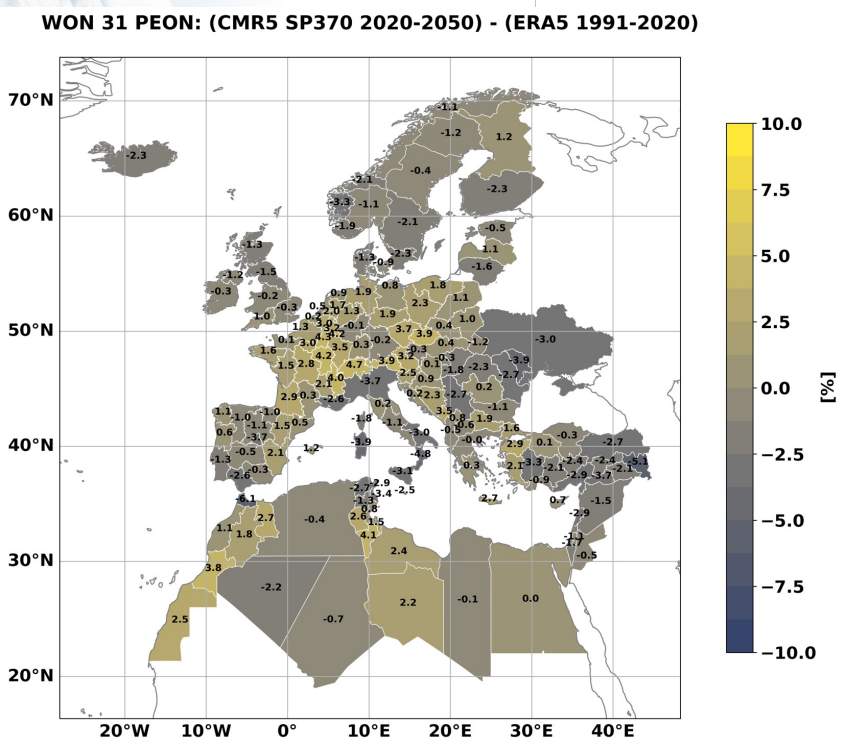
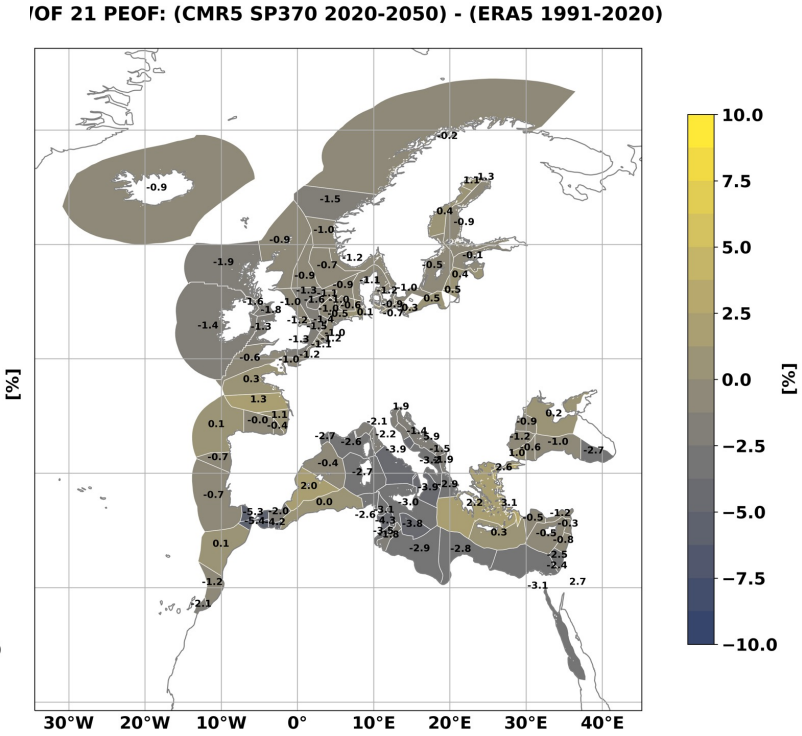
Wind power onshore, offshore and solar PV – Projections

Model: CMR5 – SSP370 Scenario – (2020-2050)-(1991-2020) (%)

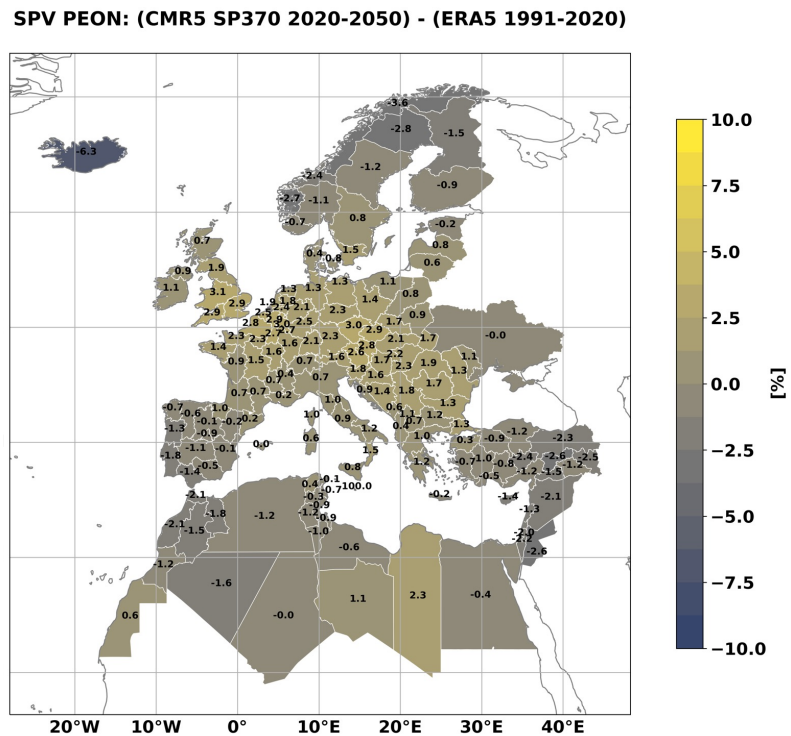
Wind Power Onshore



Wind Power Offshore



Solar PV Power



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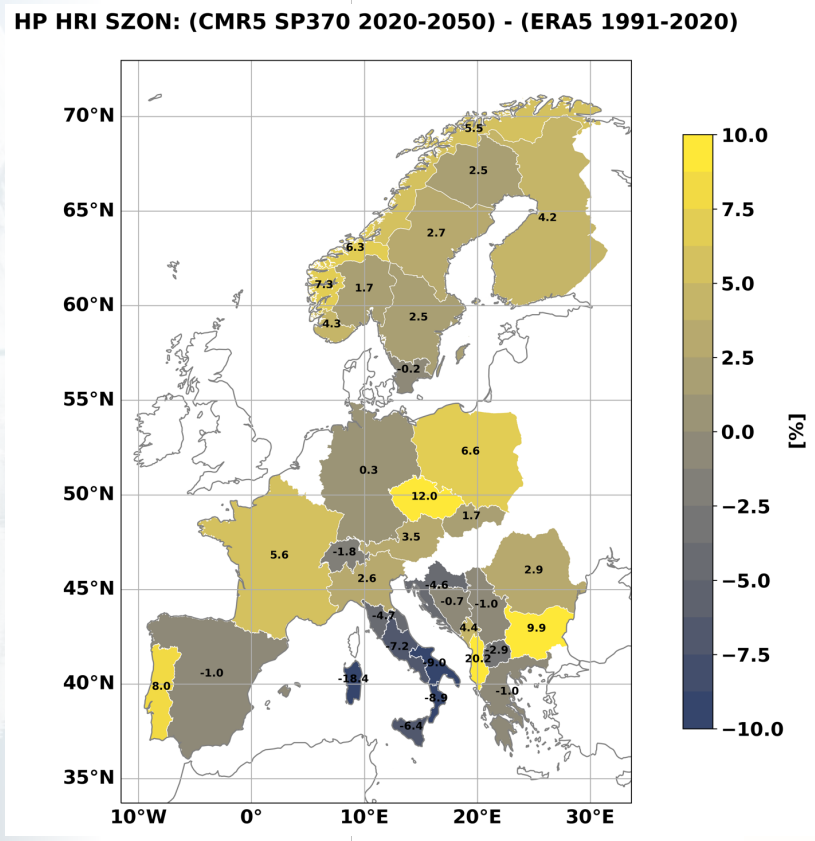
Hydro power – Projections

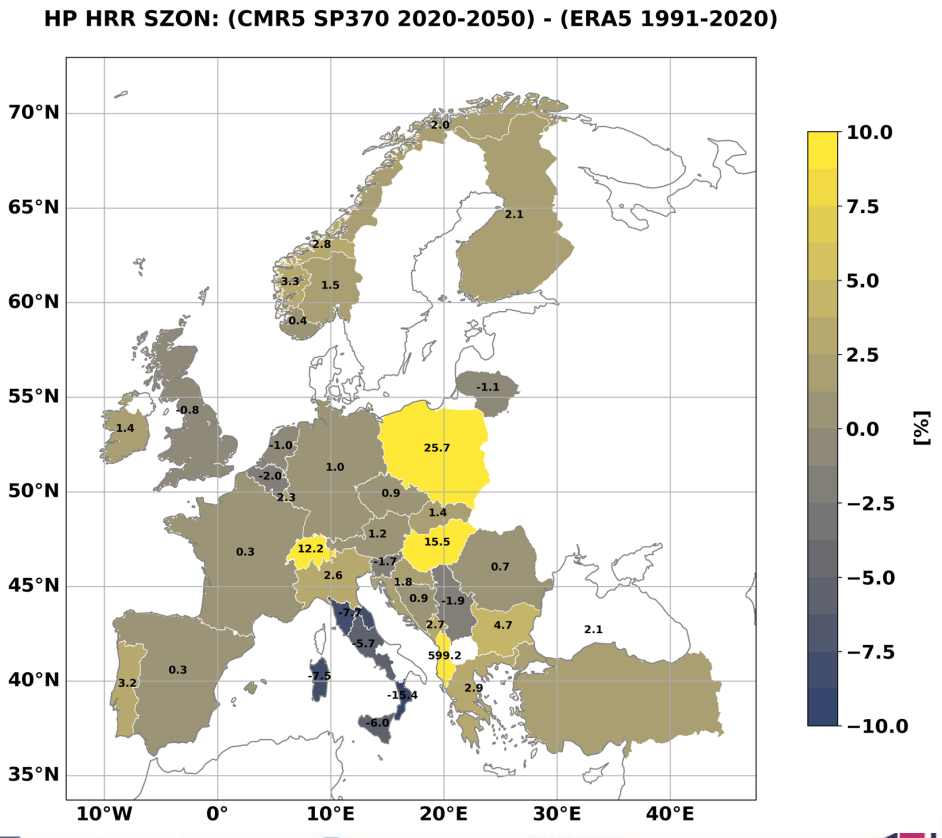
Climate Change

Model: CMR5 – SSP370 Scenario – (2020-2050)-(1991-2020) (%)

Inflow to Reservoir



Inflow to Run-of-River



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C3S Energy Lot 2 – Workflow

Climate Change

*planned future release

Historical: ERA5 data
Projections: EURO-CORDEX and CIMIP6 models

Data Retrieval

Spatial and temporal interpolation (only for projection data)

Bias Adjustment

Historical: Only for 10m wind speed
Projections: all variables, different methods

WS100 computed from WS10 with wind shear law

Variables:
TA, TP, RFL*, RT*, WS10, WD10, WS100, WD100, GHI, DNI, CC*, RH* direction, global horizontal irradiance.
Historical: 1950 – 2021
Projections: 2006 – 2069

Gridded Climate Indicators (NetCDF format)

Computing TAW

BZON / BZOF
SZON / SZOF
NUTS0 / NUTS3

Aggregated Climate Indicators (CSV format)

Installed capacity and generation data

Energy Data

Wind Power (WP) (onshore and offshore)

Solar Photo Voltaic Power (SPV)

Concentrated Solar Power (CSP)

Hydro Power (HP)

SPV only.
Historical: 1950 – 2021
Projections: 2006 – 2069

Gridded Energy Indicators (NetCDF format)

Exclusion Layers

BZON / BZOF
SZON / SZOF
NUTS0 / NUTS3

Hydro: NUTS0 at weekly resolution

Aggregated Energy Indicators (CSV format)

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On-demand C3S Application for ENTSO-E

Climate Change

Copernicus Climate Change Service (C3S) activity supporting ENTSO-E in the production of the Pan-European Climate Database **(PECD),** which includes **CLIMATE CHANGE** impacts on the power system.

PECD 3.1
Based on ERA5 climate reanalysis, Extended in time: 1981-2019

PECD3.1

2022

MoU ENTSO-e ECMWF

PECD4.1

PECD 4.1
Historical Stream: based on ERA5 1950-2021
Projections Stream: CMIP6 models Emission scenario 2015-2065

2024

European Resource Adequacy Assessment

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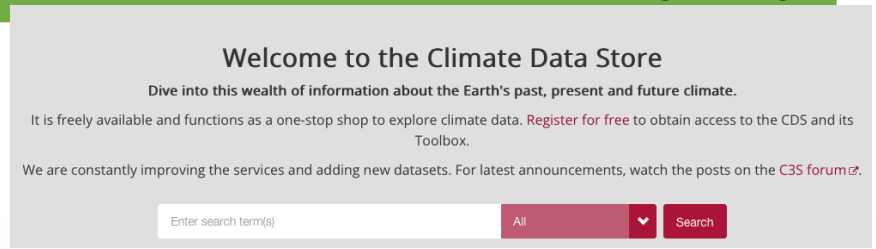
PECD4.1 dataset was developed by ECMWF, C3S and ENTSO-E under **a CC-BY-4.0 licence** and will be publicly **available** in the coming months via **Copernicus Climate Data Store (CDS)**



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C3S Energy Lot 2 – Summary and next steps

Climate Change

Summary:

- ✓ Assessment and bias adjustment of historical (ERA5) data
- ✓ Delivered PECD v4.1 – 3 projection models and 1 SSPs
- ✓ 3 projection models and 4 SSPs made available – for future PECD v4.2
- ✓ Development of scalable, configurable and user-friendly computational tools

Next Steps:

- ➢ Further assessment of ERA5 and CMIP6 climate variables
- ➢ Ongoing improvement of energy conversion models
- ➢ Publication of data and procedures,
- ➢ Ongoing engagement with ENTSO-E and its members, and training

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Insights on ERAA 2024 preliminary data

Gregorio Iotti (APG), ERAA 2024 Market Study Team convener

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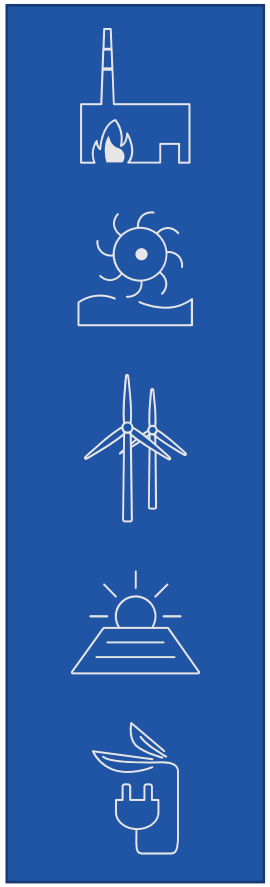
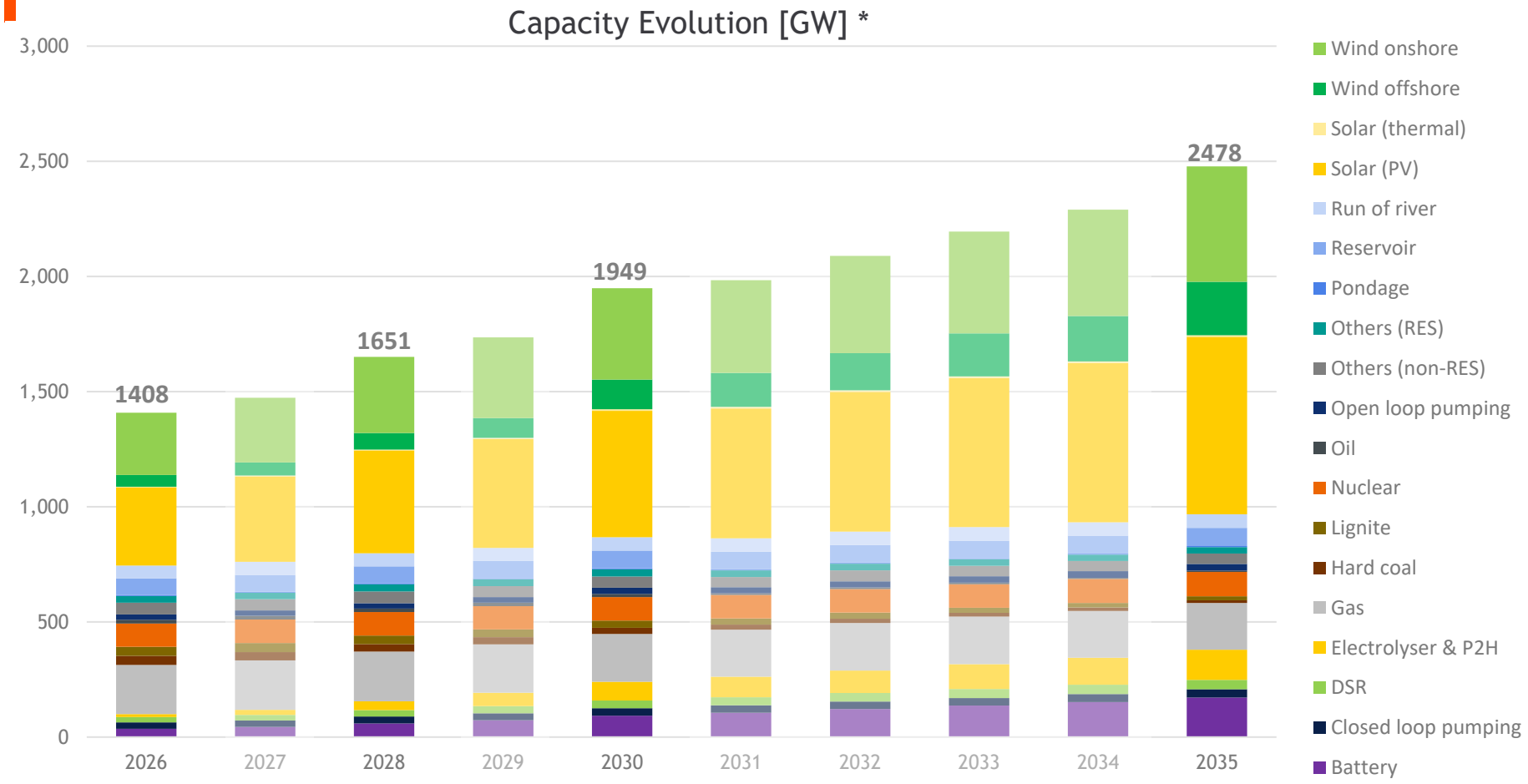
Data Assumptions and Introduction

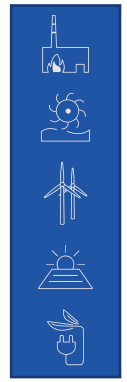
- Call for evidence on preliminary dataset, still subject to partial updates or changes
- Dataset constituted by TSOs data prior to the Economic Viability Assessment
- Data available for the pivotal years of ERAA 2024: 2026, 2028, 2030 and 2035*
- Installed capacity reported as on 1st of January. Unit- or technology-specific derating is not accounted
- Biofuels currently aggregated in corresponding thermal category
- Out-of-market thermal capacity is included
- Electrolysers, P2H, Batteries & DSR reported include only explicit capacity on the market



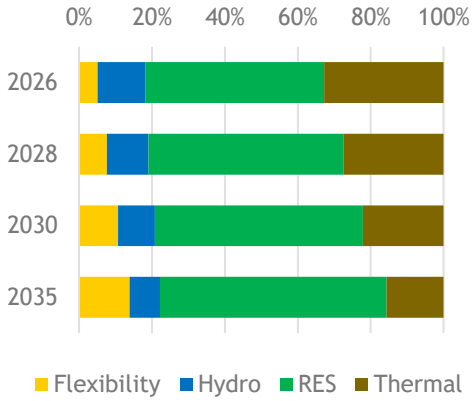
*Data for intermediate (non-target) years have been left to appreciate the complete evolution of available data, but completeness is not ensured.

ERAA 2024 Capacity evolution: overall mix





Relative Capacity Mix Evolution *



- Steady increase of generation capacity over the horizon
- Renewables increase their share in the total mix up to more than 50% in 2028
- Consistent growth of flexibility (Electrolysers, Batteries and DSR)

*Data aggregated for the whole perimeter (EU 27 + 10, excluding TR, EG, and UA)

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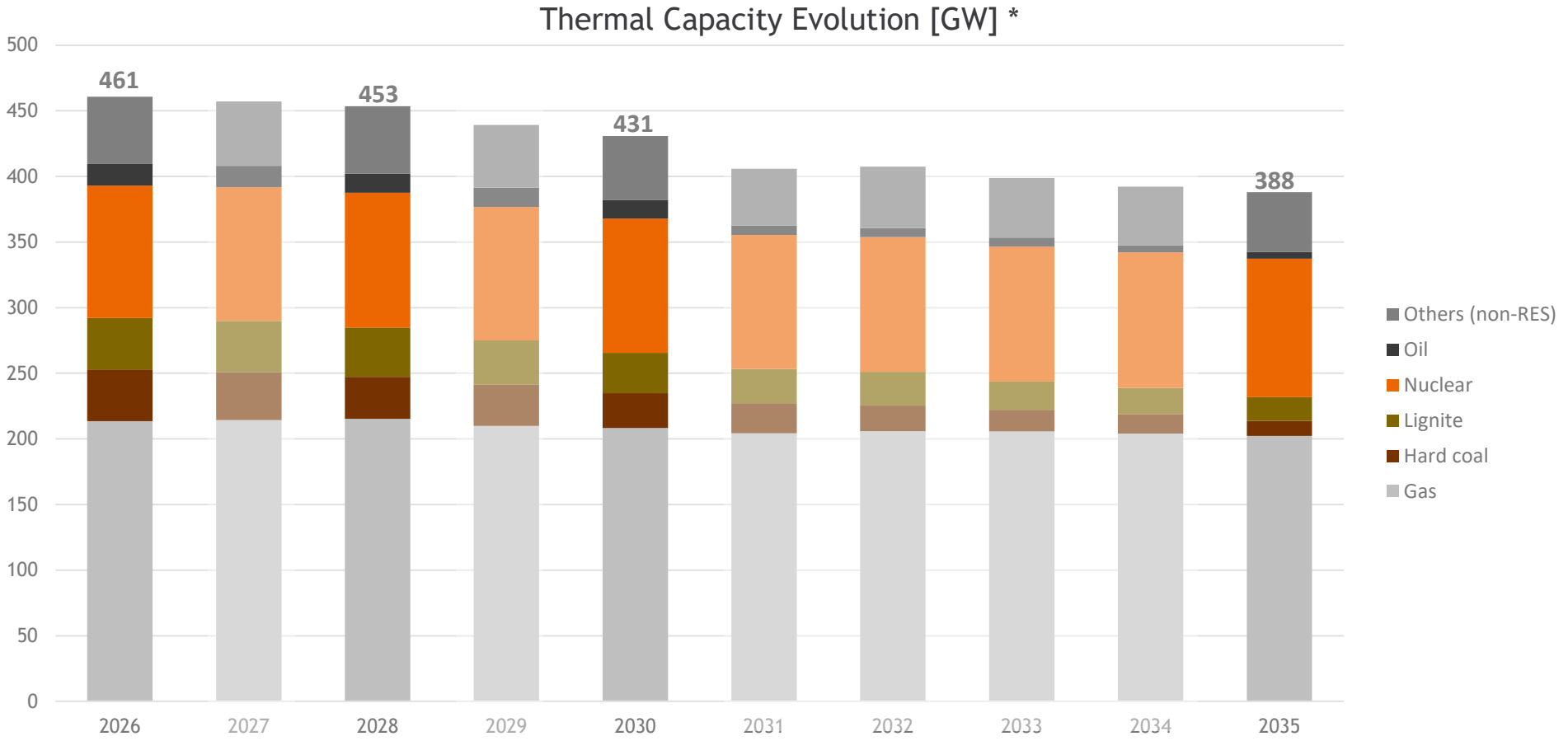
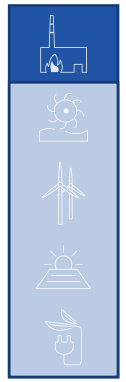
ERAA 2024 Capacity evolution: focus on Thermal capacity





- Thermal capacity is decreasing over the horizon, mainly due to lignite and coal phase-out
- Gas stays as primary fossil source with new capacity replacing old units
- New nuclear capacity in some countries compensates its phase-out in others

*Data aggregated for the whole perimeter (EU 27 + 10, excluding TR, EG, and UA)

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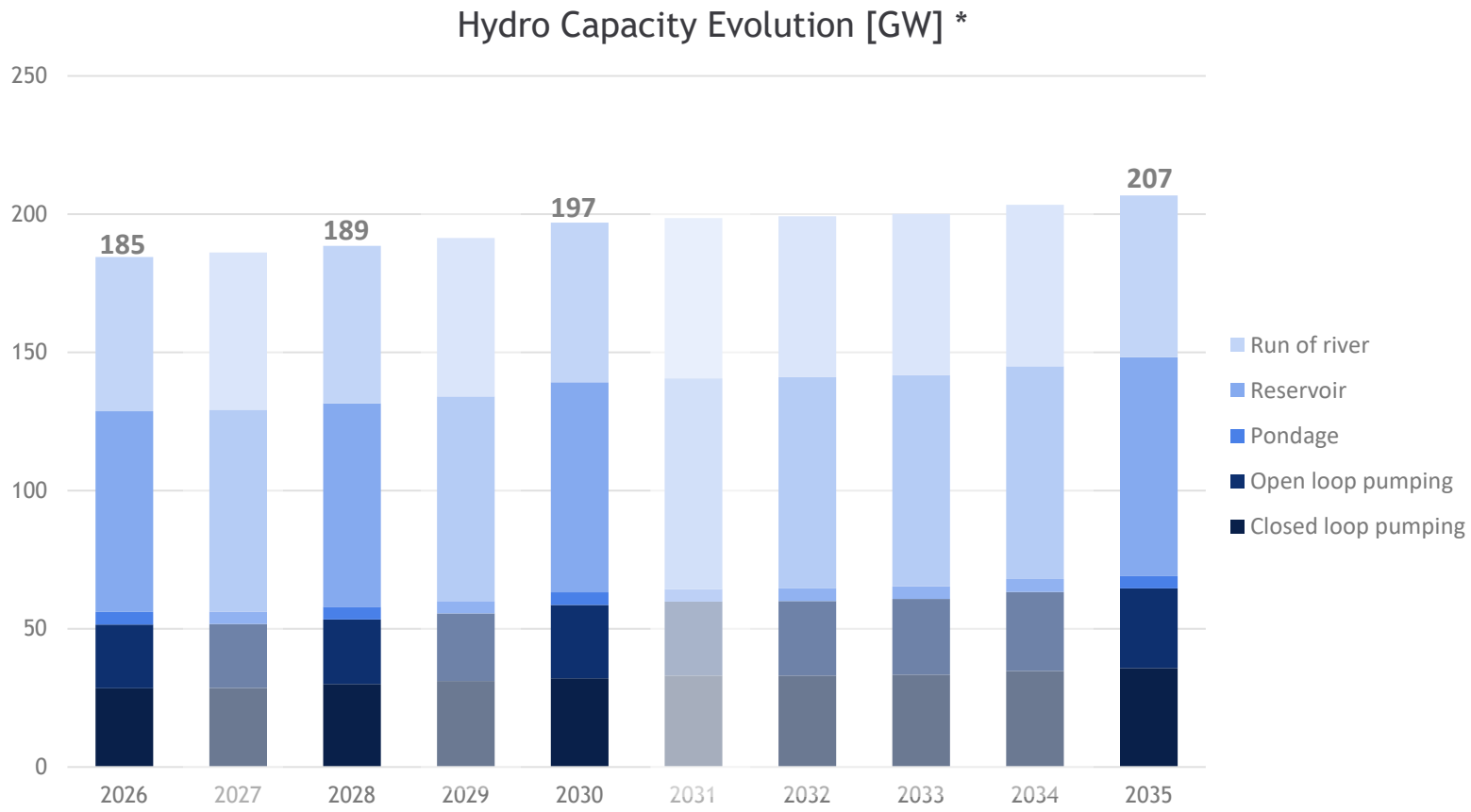
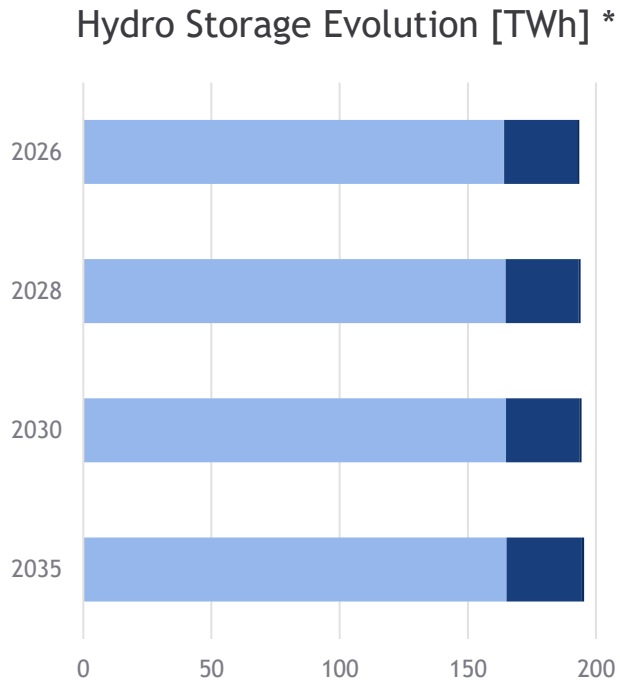
ERAA 2024 Capacity evolution: focus on Hydro





- Mild linear increase in hydro reservoir and PS capacity
- Minor increase in storage size
- Run of River and Pondage capacity stays steady after 2030 as almost full potential is exploited

*Data aggregated for the whole perimeter (EU 27 + 10, excluding TR, EG, and UA)

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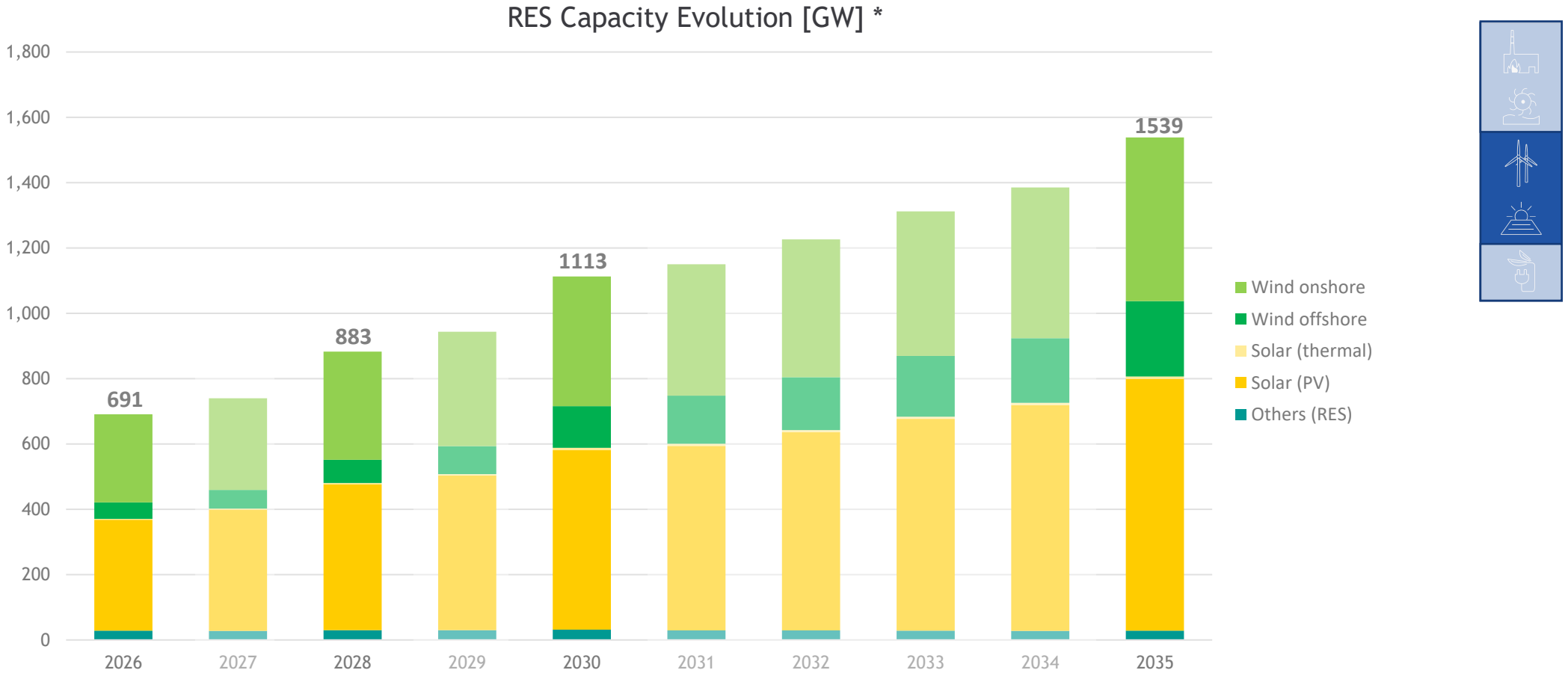
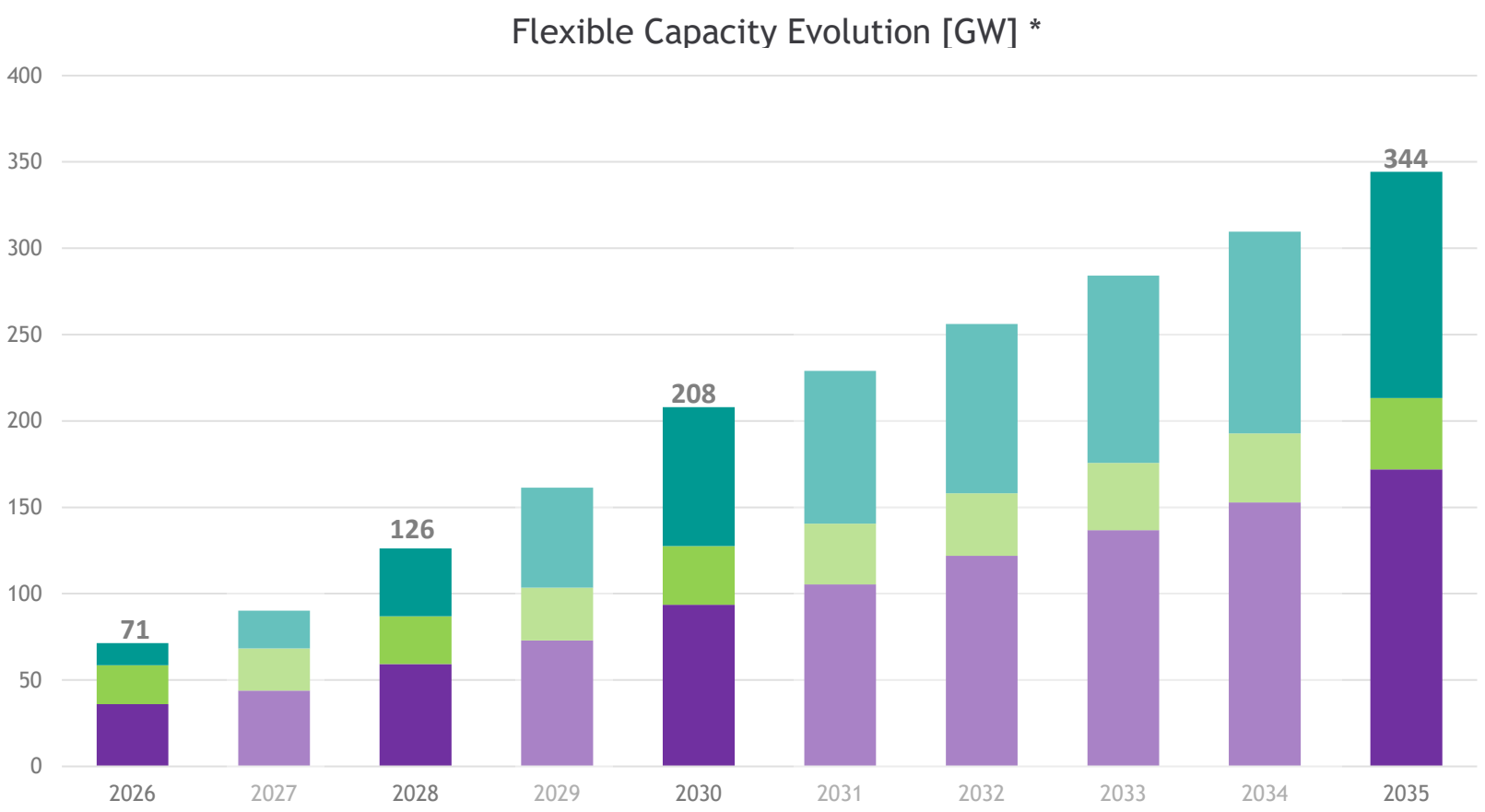
ERAA 2024 Capacity evolution: focus on Renewables

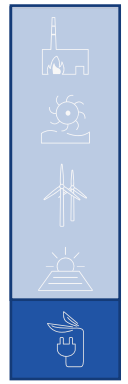


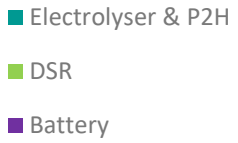
- More than doubled total RES capacity between 2026 and 2035
- High RES penetration rate often higher than 100 GW of new capacity expansion per year
- Growth driven by solar PV and onshore wind, offshore wind contributing later within the horizon

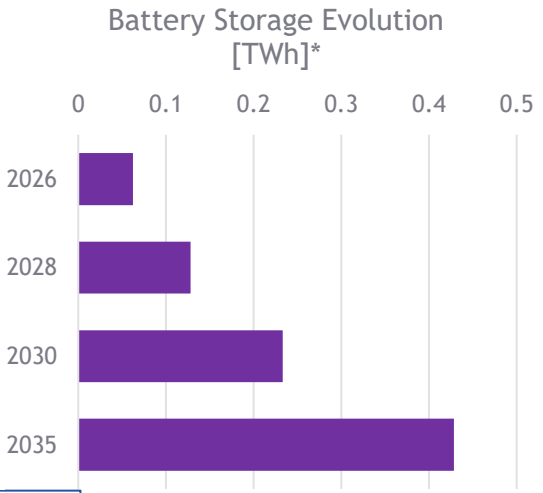
*Data aggregated for the whole perimeter (EU 27 + 10, excluding TR, EG, and UA)

ERAA 2024 Capacity evolution: focus on Flexibility





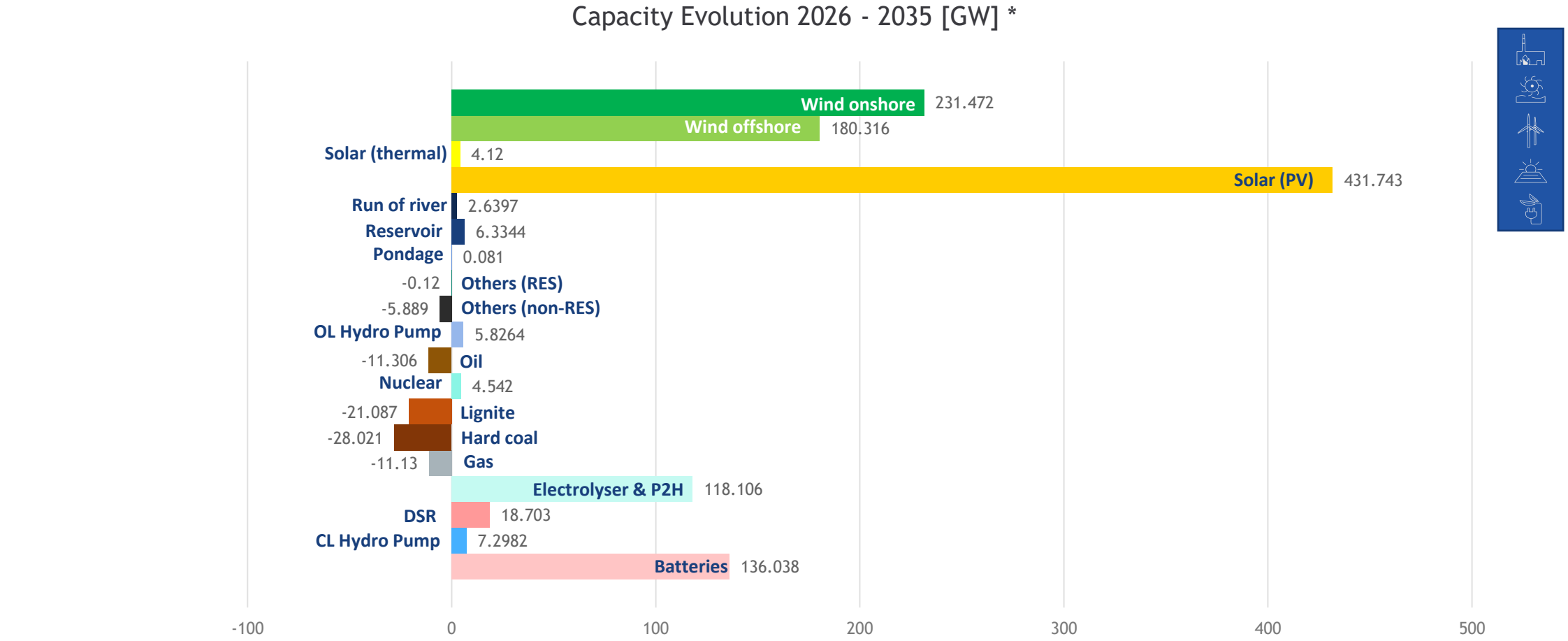




- Stable linear trend in flexible generation from 2026 to 2035
- Batteries capacity drives the growth, passing from 50% to more than 65% of flexible generation
- Electrolyser & P2H capacity mirrors the trend of batteries and DSR

*Data aggregated for the whole perimeter (EU 27 + 10, excluding TR, EG, and UA)

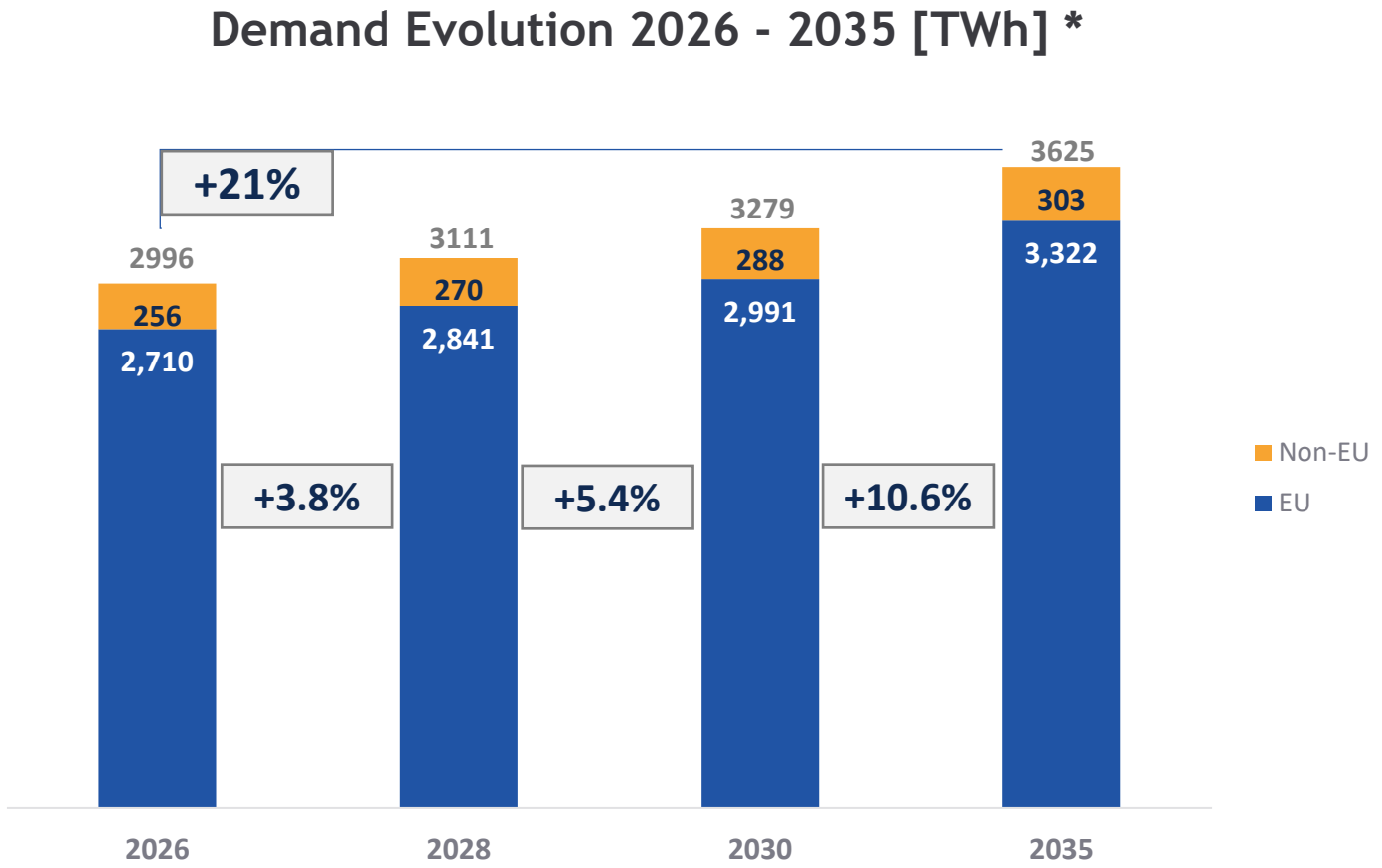
ERAA 2024 Capacity evolution: by technology



- Solar PV is the highest contributor, followed by onshore wind and offshore wind
- Important increase of flexibility, especially batteries (injection/offtake) and electrolysers/P2H
- Decrease of carbon-intensive thermal capacity, driven by hard coal and lignite

*Data aggregated for the whole perimeter (EU 27 + 10, excluding TR, EG, and UA)

ERAA 2024 demand evolution

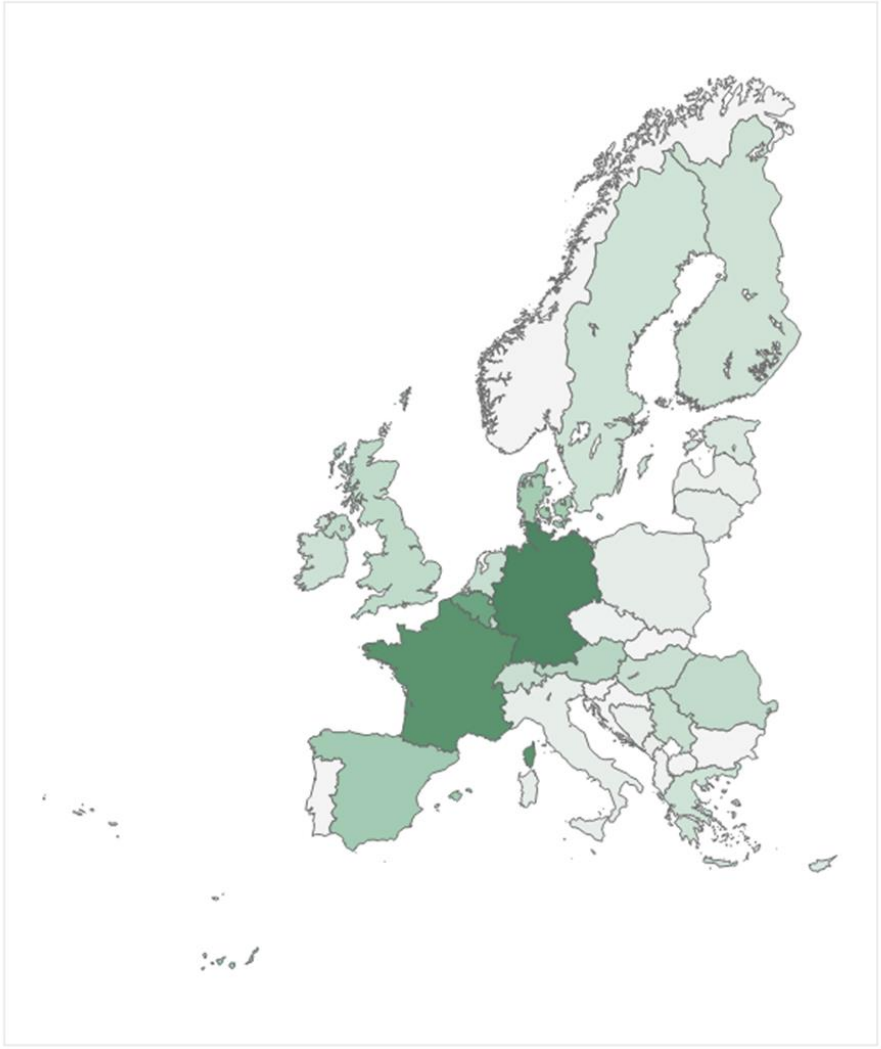


- Electricity demand will continue to increase in the coming decade (+ 21%)
- Foreseen increase in both EU and non-EU countries
- Growth rate increases in the long-term horizon

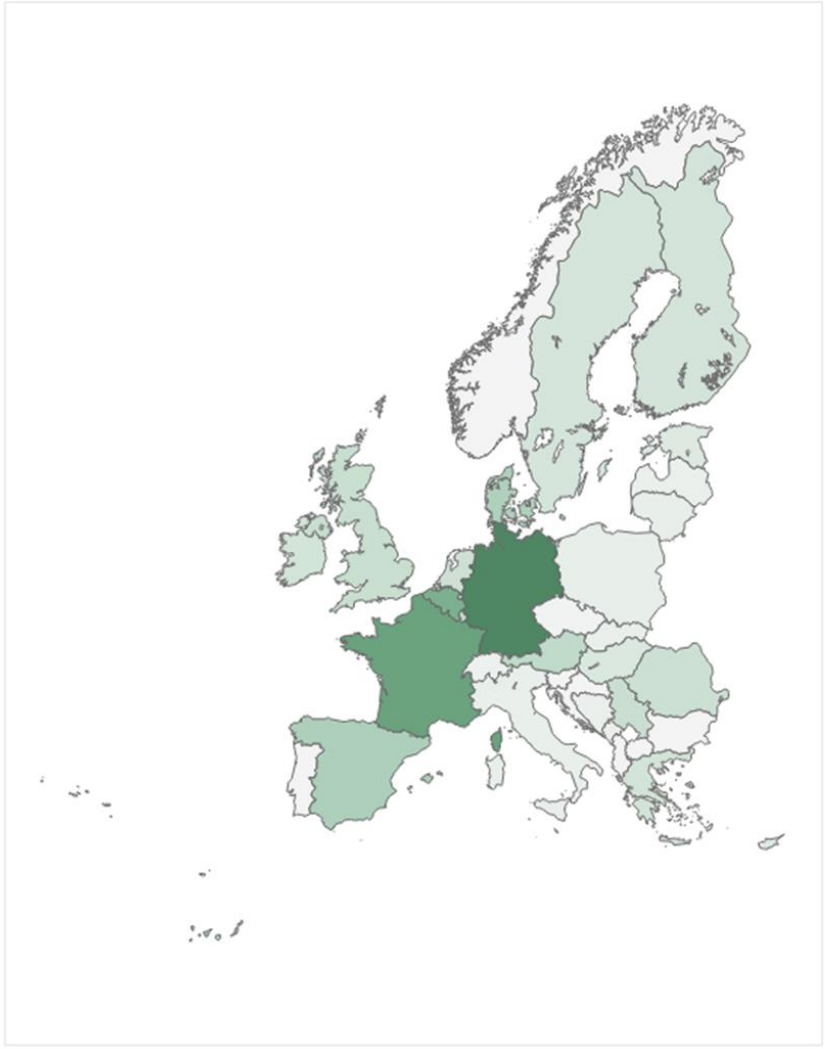
*Data aggregated for the whole perimeter (EU 27 + 10, excluding TR, EG, and UA)

ERAA 2024 NTC evolution: import-export (explicit)

Import



Export



NTC difference [MW]

-25 9,700

Start Year

2026

End Year

2035

- Increase in max NTC imports and exports in most countries
- CWE region shows highest absolute values
- Ireland to double expected max NTC over the horizon
- Steady increase also in Baltic, Nordic and Eastern regions

ERAA 2024 proposal of commodity prices for call for evidence

Fuel	Unit	Source	Assumptions	2025	2026	2028	2030	2035	2040	2050
Nuclear	2023 €/GJ	IEA 2022[1] (same as ERAA 2023)	Constant over the horizon.		1.95	1.95	1.95	1.95		
Lignite G1 (BG - MK - CZ)	2023 €/GJ	Booze&co (same as ERAA 2023)	Constant over the horizon.		1.63	1.63	1.63	1.63		
Lignite G2 (SK - DE - RS - PL - ME - UKNI - BA - IE)	2023 €/GJ	Booze&co (same as ERAA 2023)	Constant over the horizon.		2.09	2.09	2.09	2.09		
Lignite G3 (SL - RO - HU)	2023 €/GJ	Booze&co (same as ERAA 2023)	Constant over the horizon.		2.75	2.75	2.75	2.75		
Lignite G4 (GR - TR)	2023 €/GJ	Booze&co (same as ERAA 2023)	Constant over the horizon		3.60	3.60	3.60	3.60		
Hard coal	2023 €/GJ	API2 Coal Future price, Bloomberg (2025)[2] and IEA WEO 2023 (APS[3]) (2030, 2050)	Interpolation between 2025 and 2030 for 2026 and 2028; interpolation between 2030 and 2050 for 2035.	2.97	2.84	2.59	2.34	2.21		1.83
Natural Gas	2023 €/GJ	TTF Future Price Bloomberg (2025)2 and IEA WEO 2023 (APS[3]) (2030, 2050)	Interpolation between 2025 and 2030 for 2026 and 2028; interpolation between 2030 and 2050 for 2035.	7.60	7.32	6.77	6.22	5.96		5.17
Biomethane	2023 €/GJ	Danish Technology catalogue (same as ERAA 2023)	Interpolated between 2030 and 2050 values.				21.13	20.76		19.63
Synthetic Methane	2023 €/GJ	IEA WEO 2023 (APS[3]) (2030,2035)					38.96	32.75		
Gas Blend	2023 €/GJ	TYNDP 2024 data[4]	100% NG until 2028; 9% Biometh. in 2030; 20% Biometh., 4% Syn. Meth. in 2040.[3] 2035 Interpolated.		7.32	6.77	7.68	8.75		
Crude oil	2023 €/GJ	Brent Future Price Bloomberg (2025)[2] and IEA WEO 2023 (APS[3]) (2030, 2050)	Interpolation between 2025 and 2030 for 2026 and 2028; interpolation between 2030 and 2050 for 2035.	11.58	11.82	12.29	12.76	12.15		10.34
Light oil	2023 €/GJ	Crude oil price (+28%)	Interpolation between 2025 and 2030 for 2026 and 2028; interpolation between 2030 and 2050 for 2035.	14.83	15.13	15.73	16.33	15.55		13.24
Heavy oil	2023 €/GJ	Crude oil price (+5%)	Interpolation between 2025 and 2030 for 2026 and 2028; interpolation between 2030 and 2050 for 2035.	12.16	12.41	12.90	13.39	12.76		10.86
Shale oil	2023 €/GJ	ENTSO-E TYNDP 2022 (same as ERAA 2023)	Interpolation between 2025 and 2030 for 2026 and 2028; interpolation between 2030 and 2040 for 2035.	1.81	1.88	2.02	2.16	2.65	3.15	
Hydrogen (blue)	2023 €/GJ	IEA WEO 2023 (APS[3])SMR w CCUS[5] (2030,2035)	Derived from gas blend price - SMR with CCUS[5] with natural gas and CO2 prices for 2026 and 2028		22.74	22.18	23.47	21.69		
CO2 price	2023 €/ton	Bloomberg (2025)[2] and IEA WEO 2023 (APS[3]) (2030, 2050)	Interpolation between 2025 and 2030 for 2026 and 2028; interpolation between 2030 and 2040 for 2035.	56.76	72.68	104.52	136.36	156.56	176.76	202.02

Pivotal Year Data for Interpolation

Pivotal Years of ERAA 2024

Interpolated Values

1: EIA (2022) - https://www.eia.gov/electricity/annual/html/epa_08_04.html
2: Obtained on 27 February 2024
3: APS stands for Announced Pledges Scenario from IEA
4: Aligned with TYNDP 2024 as of June 2023 over the horizon
5: SMR: Steam Methane Reforming; CCUS: Carbon Capture Utilization and Storage
6: IEA 2023; World Energy Outlook 2023, https://www.iea.org/reports/world-energy-outlook-2023, License: CC BY 4.0

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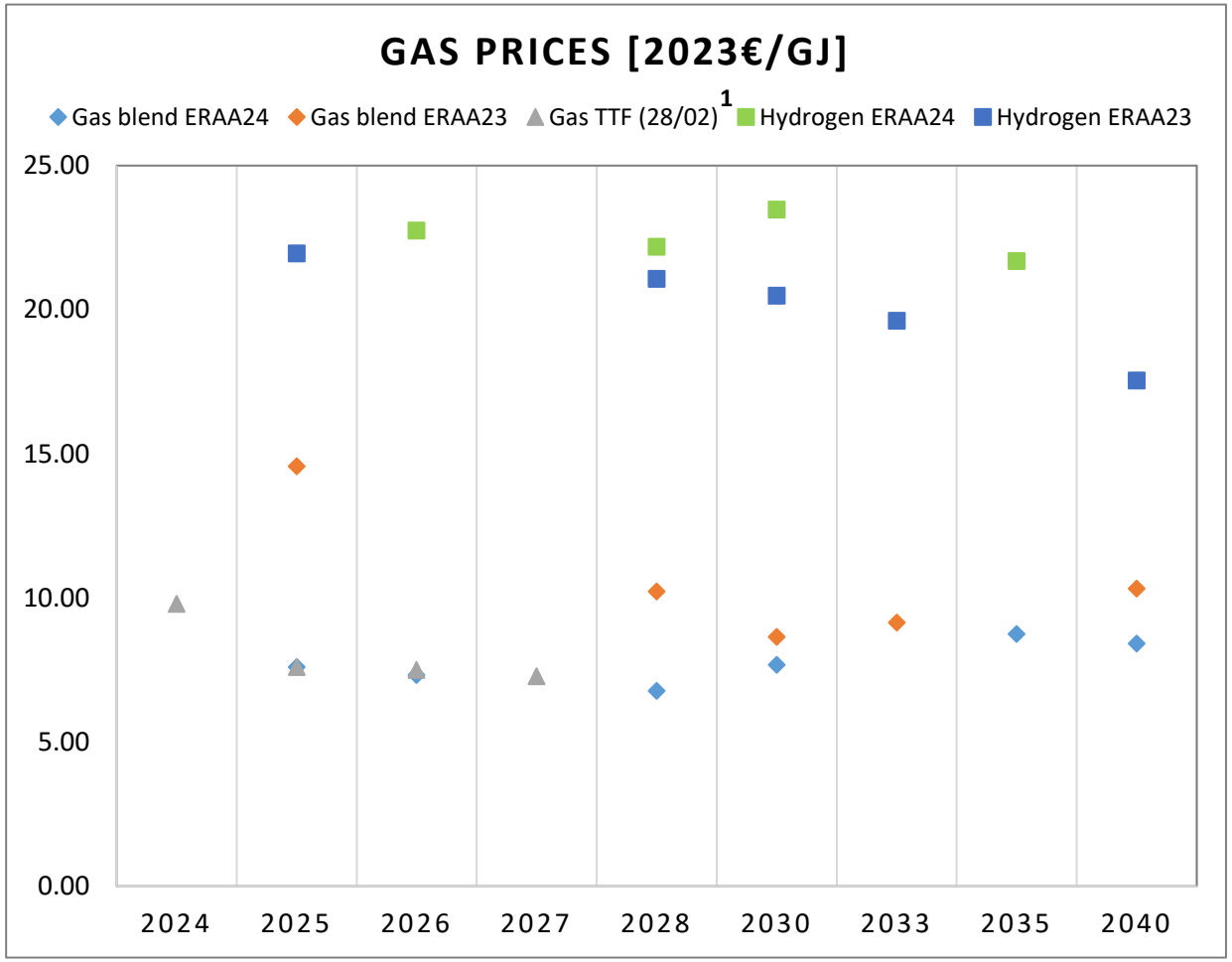
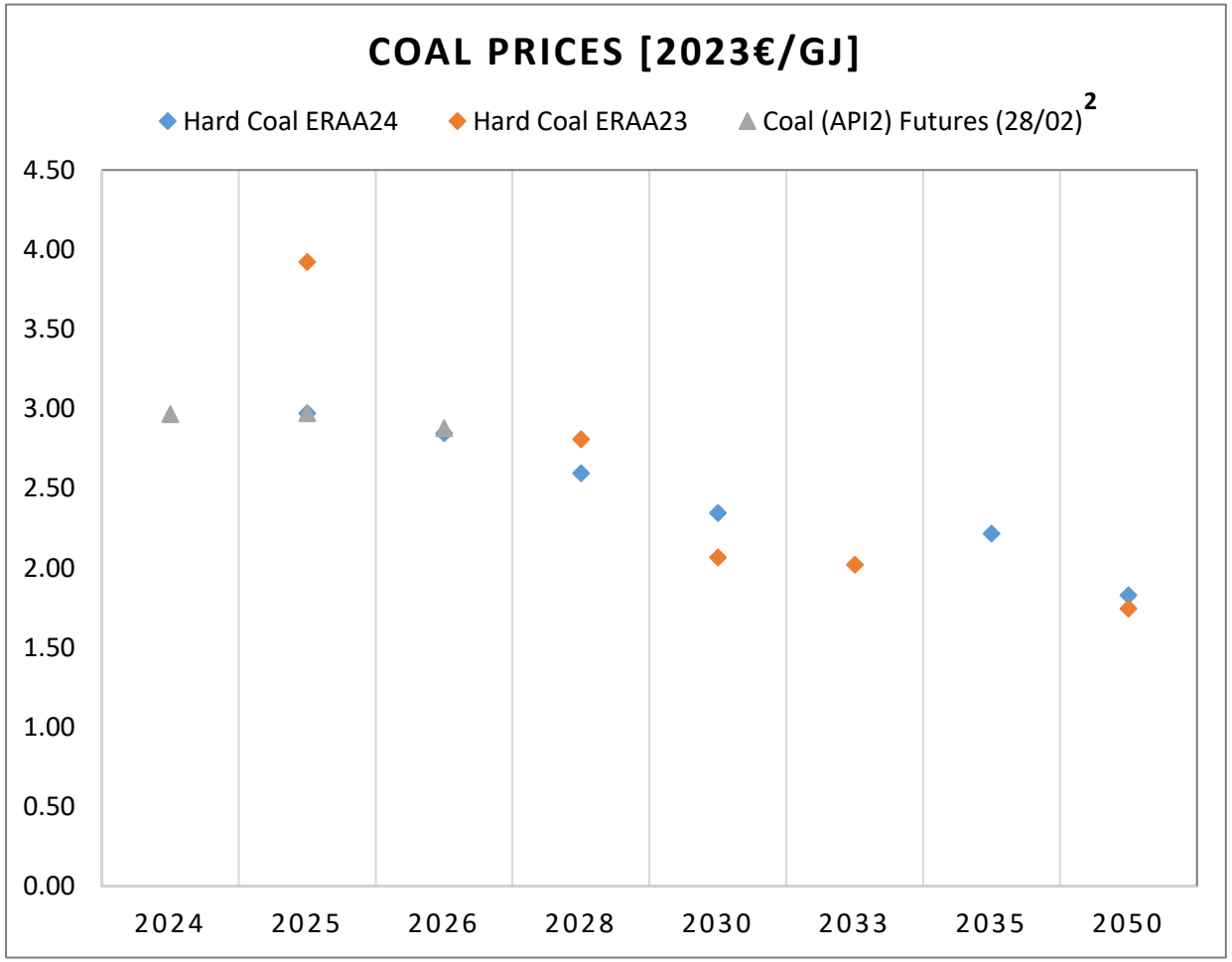
Overview on commodity price points evolution





1: Gas TTF prices as of 28/02/2024. Source: Bloomberg.
2: Coal API2 Futures as of 28/02/2024. Source: Bloomberg.

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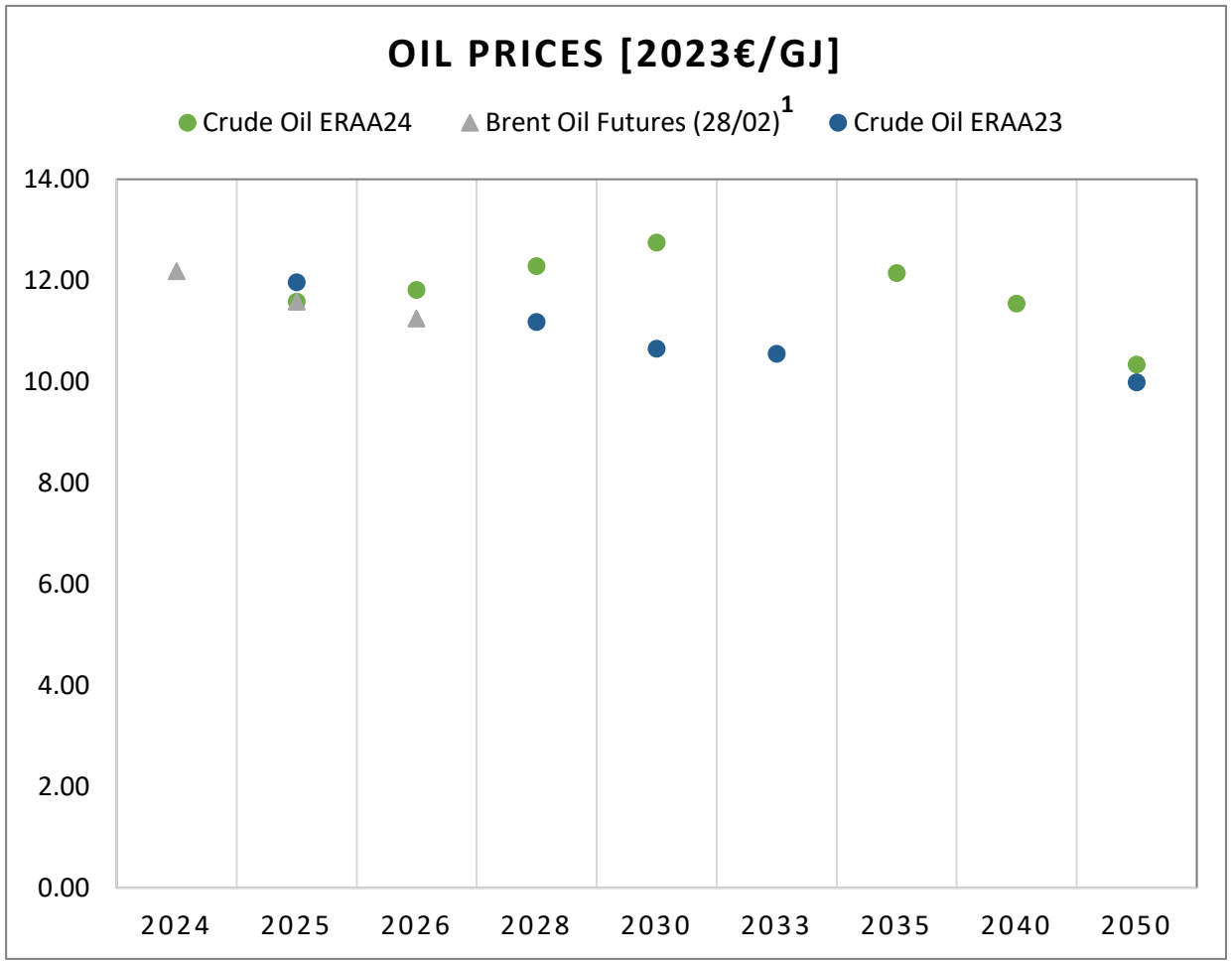
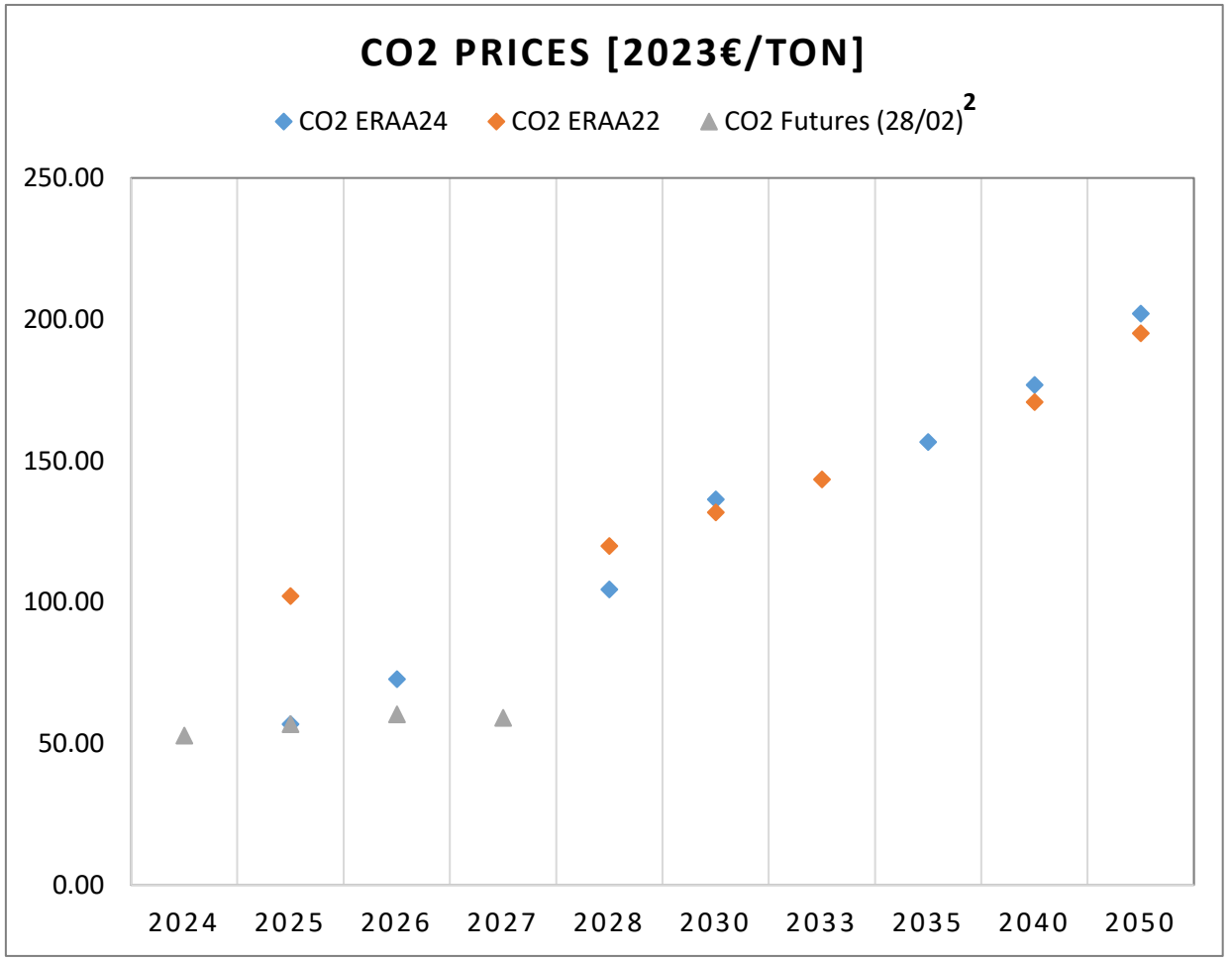
Overview on commodity price points evolution





1: Brent Oil Futures as of 28/02/2024. Source: Bloomberg.
2: EU CO2 Futures as of 28/02/2024. Source: Bloomberg.

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Audience Q&A Session

ⓘ Start presenting to display the audience questions on this slide.

Conclusion and next steps

Lukas Galdikas (ENTSO-E),
ERAA Project Manager

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Call for Evidence on the ENTSO-E consultation hub

Give us your views

Online Survey ›

Related

- Preliminary ERAA 2024 PEMMDB National Estimates & Commodity Prices
- Preliminary ERAA 2024 PECD - RES
- Preliminary ERAA 2024 PECD - Weather
- Preliminary ERAA 2024 Demand Data
- Preliminary ERAA 2024 list of CNECs
- Webinar on Preliminary Input Data - 14 March 2024

Call for Evidence by 28 March 2024

Provide your feedback

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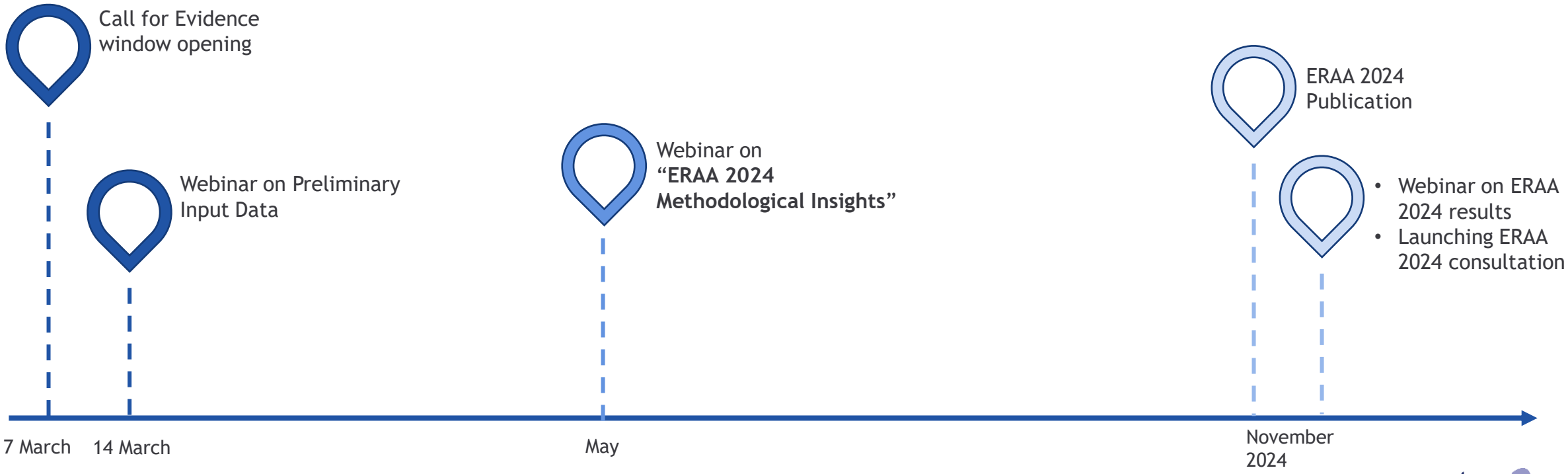
Don’t forget to join us for the next public webinars & workshops



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Thank you for your attention

Cooperation

Planning, cooperation and targeted measures are key for a secure electricity system.

Coordination

Adequacy issues deeply interlinked; regional coordination is crucial.

Visit www.entsoe.eu/outlooks/eraa for more information on the ERAAs, the interactive data visuals, past and future stakeholder interactions

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