DESTINATION EARTH

USE CASE ENERGY SYSTEMS

FINAL RESULTS

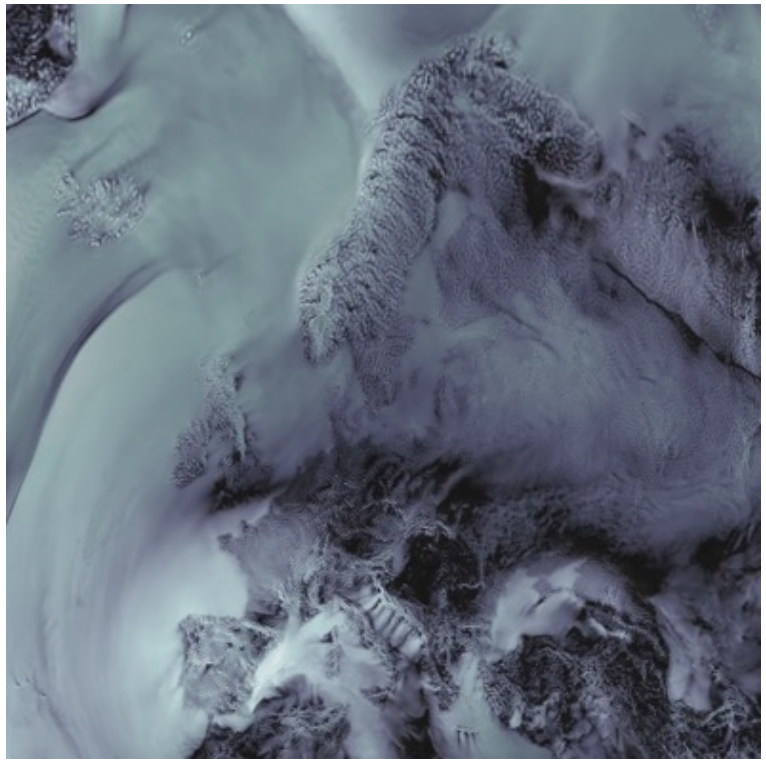
Bruno Schyska and the Use Case team

An Activity of DLR together with Aarhus University and the Renewables Grid Initiative on behalf of ECMWF

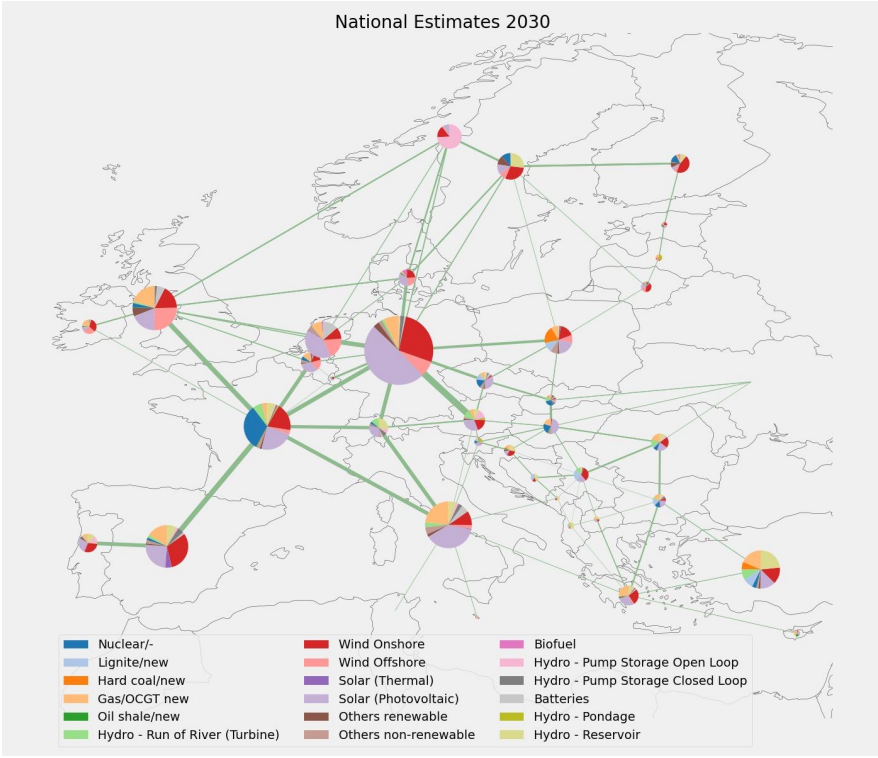
Funded by the European Union

Destination Earth implemented by ECMWF esa EUMETSAT

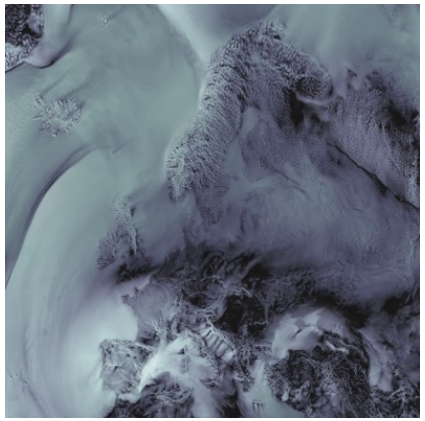
MOTIVATION: INTEGRATED CLIMATE-ENERGY MODELING

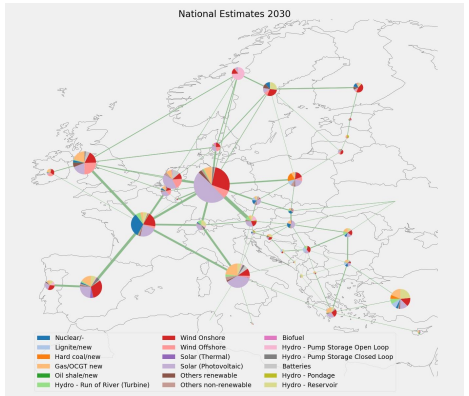


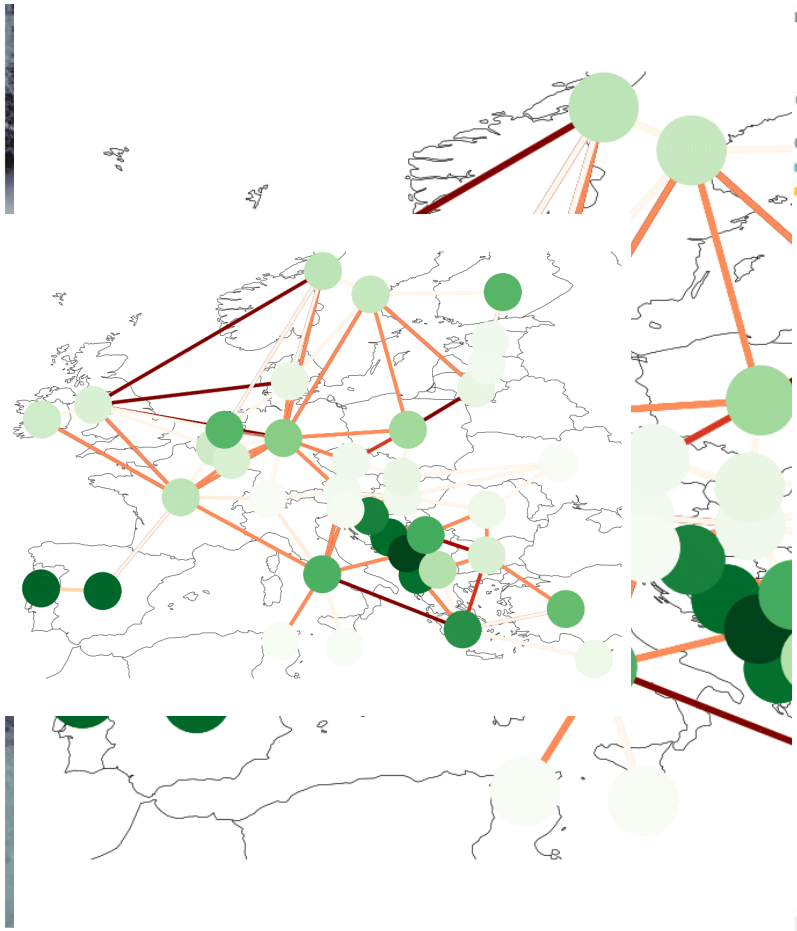
meteorological information

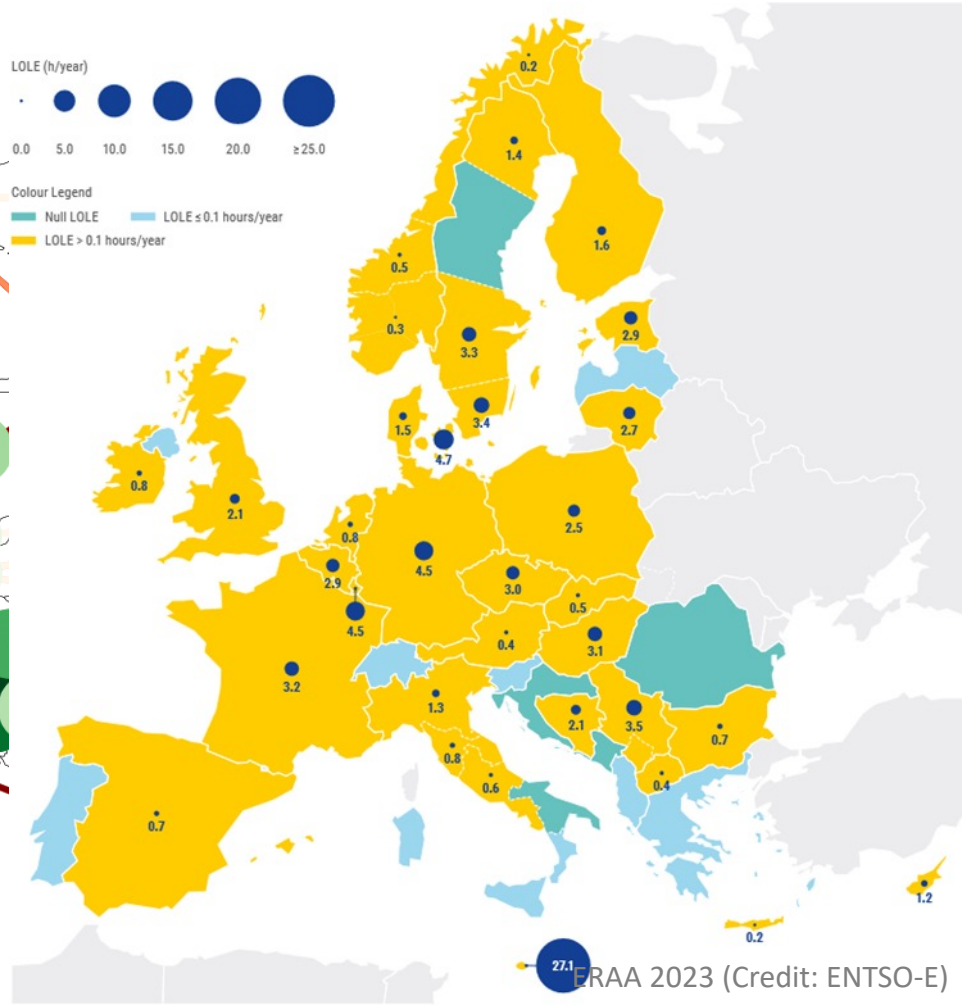


techno-economical information



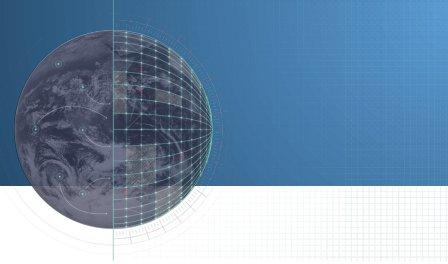






ERAA 2023 (Credit: ENTSO-E)

From information ⟶ through simulation ⟶ to impact



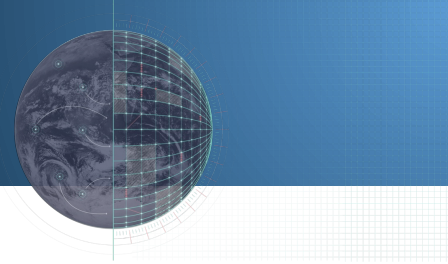
THE DATA

We combine:

- Databases used by ENTSO-E for the annual *European Adequacy Assessment* (ERAA), namely the PECD and PEMMDB, with

- Time series derived from DestinE's Climate DT,
- Alternative PECD scenarios[1] and
- Further openly available data sets (here: University Reading[2])

1) Koivisto, Matti Juhani; Murcia Leon, Juan Pablo (2022). Pan-European wind and solar generation time series (PECD 2021 update). Technical University of Denmark. Collection. https://doi.org/10.11583/DTU.c.5939581.v3
2) Bloomfield, Hannah and Brayshaw, David (2021): ERA5 derived time series of European aggregated surface weather variables, wind power, and solar power capacity factors: hourly data from 1950-2020. University of Reading. Dataset. https://doi.org/10.17864/1947.000321



THE TOOLS

1. Demonstrator showcasing the use of meteorological information in a semi-operational power system modeling workflow following the lines of the European Resources Adequacy Assessment[1]

2. Standardized assessment of model sensitivities on meteorological parameters linking results of power system simulations to meteorological conditions

3. Validating Climate DT data with high-resolution observations

4. Machine learning to replace expensive and complex linear-optimal-power-flow (LOPF) calculations

DLR

AARHUS UNIVERSITY

Renewables Grid Initiative

The DestinE Use Case Energy Systems is an activity of DLR together with Aarhus University and RGI supporting ECMWF's role in DestinE.

[1] implementations are available open-source on GitHub: https://github.com/destination-earth/DestinE_ECMWF_EnSys

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DLR AARHUS UNIVERSITY Renewables Grid Initiative

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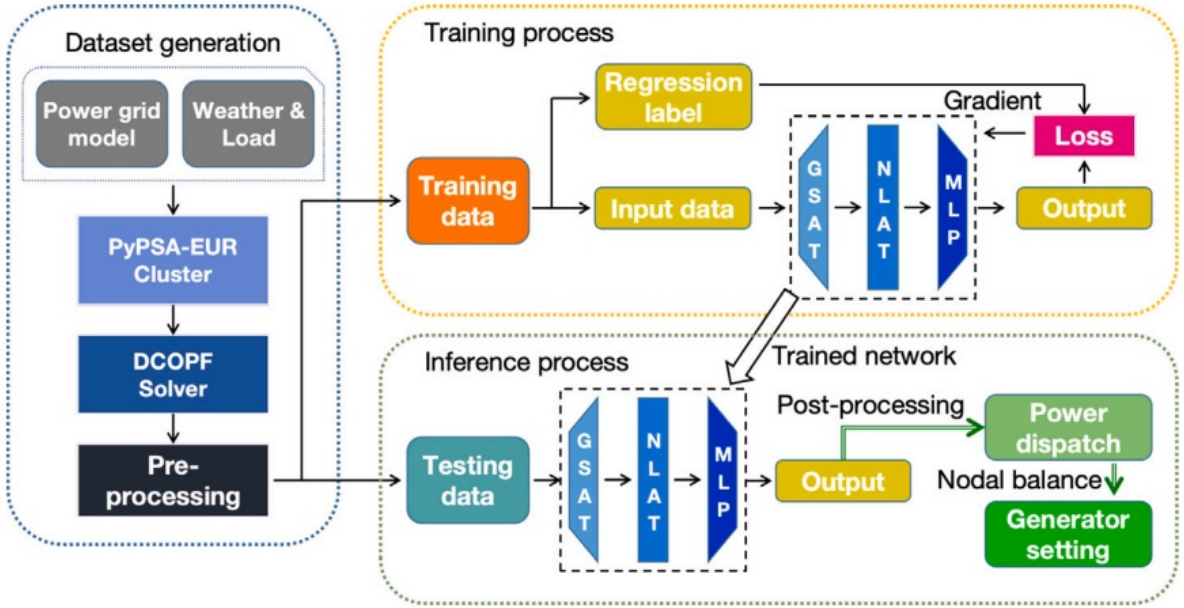
With interventions from the European Commission, ECMWF and Industry

ML PROOF-OF-CONCEPT: SETUP

- Spatial Multi-Window Graph Self-Attention (GSAT):
  Encodes node features for capturing spatial correlations, especially under varying weather conditions influencing renewable energy sources.
- Node-Link Attention (NLAT): Focuses on node-to-transmission link relationships, transforming node states into latent features for links to model their interactions effectively.
- Multi-Layer Perceptron (MLP): Refines the output, ensuring the feasibility of the power dispatches and generator settings derived from the attention layers.
- Imitation Learning: utilizes historical data and optimal solutions from traditional solvers to train the model, aiming to replicate these solutions



[Chen Li et al., 2024]

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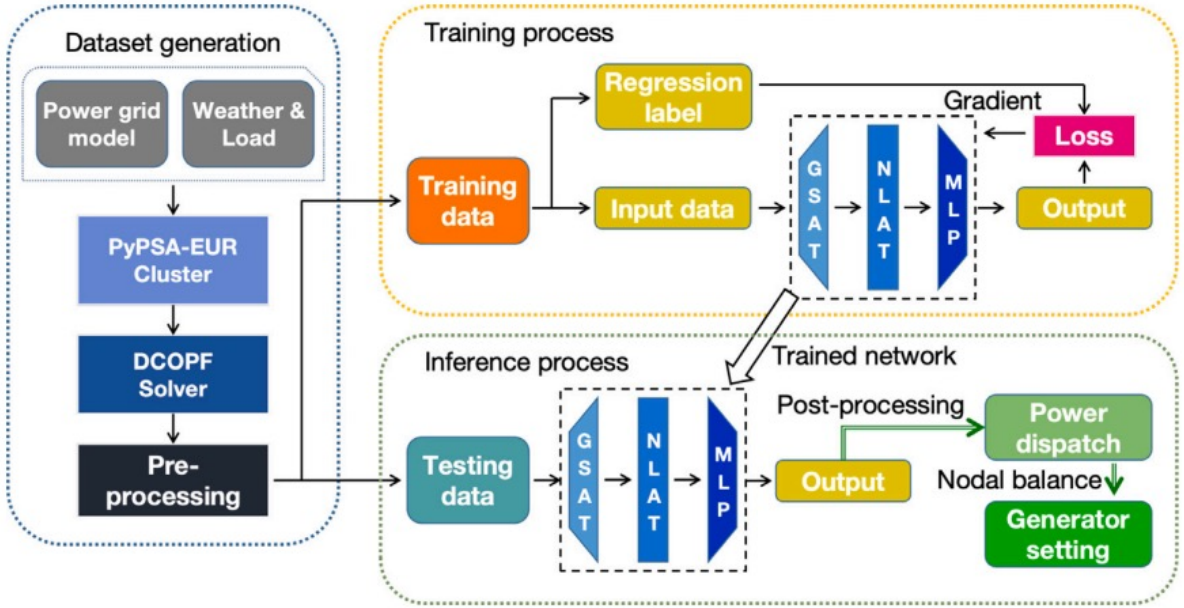

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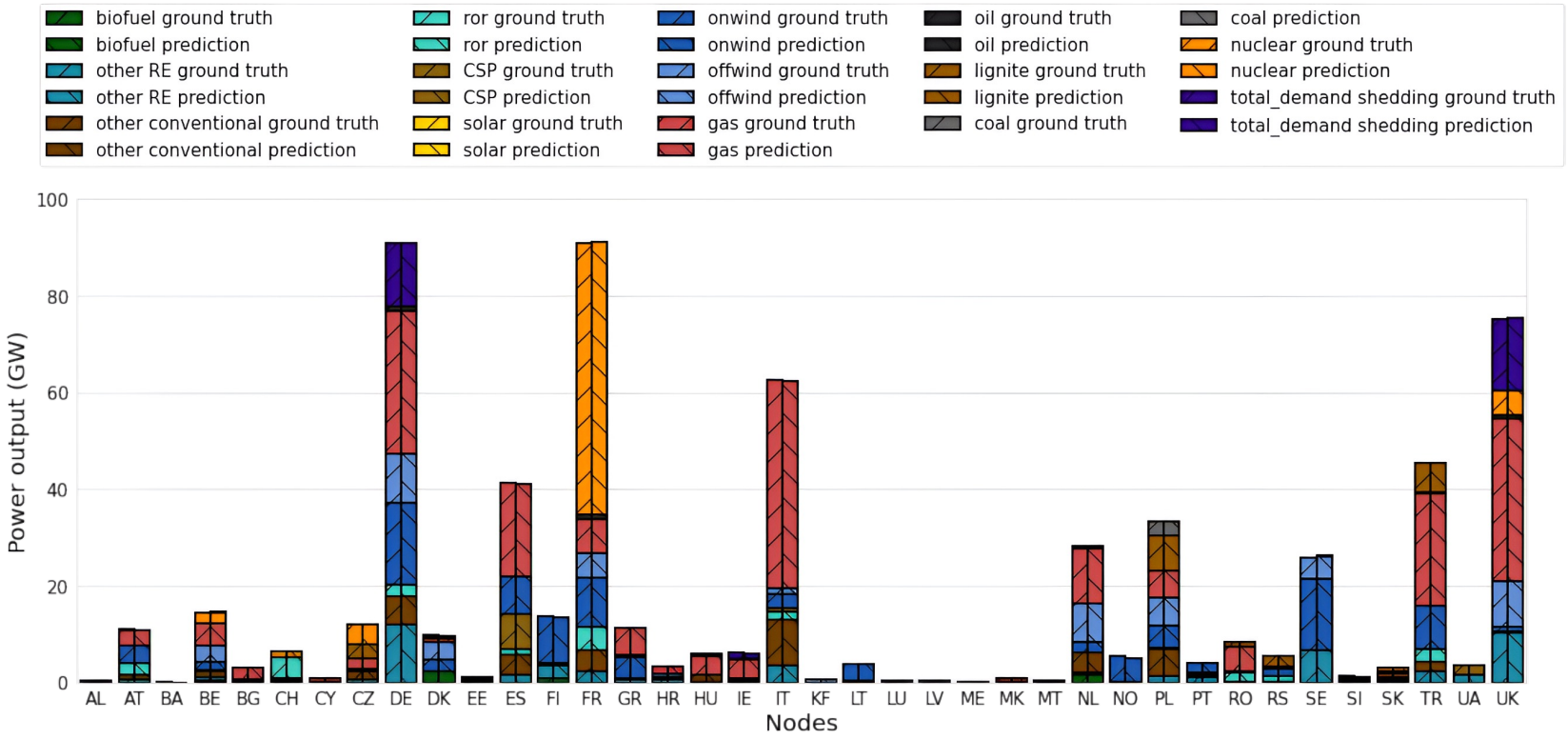
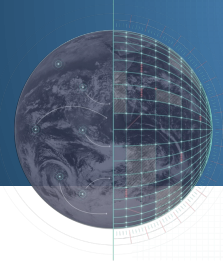
ML PROOF-OF-CONCEPT: RESULTS

- ML model is able to accurately predict the cost-optimal power dispatch in critical situations (occurrence of *lossed load*).
- No expensive optimization is required, computational cost are reduced.





SOME REMARKS

DestinE provides

- ✓5-10 km resolution
- ✓Global information with local granularity
- ✓Regular operational production

important

- ✓Bringing earth system models and impact sector models within the same workflow.

exciting

- ✓Platform for bringing together research + industry + policy to turn data and knowledge into action

Most important

[adopted from Irina Sandu]

Thanks for listening!

bruno.schyska@dlr.de

https://destine.ecmwf.int/use-case/use-case-energy-systems/

With interventions from the European Commission, ECMWF and Industry