destination-earth.eu

Destination Renewable Energy (DRE) - Use Case

Destination Earth

Funded by the European Union

Implemented by ECMWF esa EUMETSAT

The team

Quest ENERGY

End user

BEYOND Centre of EO Research and Satellite Remote Sensing

Solar Energy Expertise & Project Management

Weather & Marine Engineering Technologies P.C.

Wind Energy Expertise

ENORA INNOVATION

Software Development

HYREF Software and integration on DESP

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Climate and renewable energy

- Mitigation of **climate change** → Global and international initiatives → **Renewables** will play a key role

- UN 2030 Agenda for Sustainable Development : UN Sustainable Development Goal 7
  - 7.1: ensure universal access to affordable, reliable, and modern energy services
  - 7.2: increase the share of renewable energy in the global energy mix

- UN agreements and EU Initiatives
  - The Paris Climate Agreement
  - Green Deal

Paris agreement

"Aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts: Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels"

European Green Deal

The production and use of energy account for **more than 75% of the EU's greenhouse gas emissions. Decarbonising the EU's energy system** is therefore critical to reach our 2030 climate objectives and the EU's long-term strategy of achieving carbon neutrality by 2050.

Green deal priorities

- Ensuring a **secure** and **affordable EU energy supply**
- Developing a **fully integrated, interconnected** and **digitalised EU energy market**
- Prioritising **energy efficiency** and developing a power sector based largely on **renewable sources**

https://cor.europa.eu/el/engage/Pages/green-deal.aspx

Benefits – Needs- Gaps

Societal benefits

• World-wide interdependence of conventional energy production

• Energies and uses of energies have a dramatic impact on global warming, human health and sustainable economic development

• Improved forecasting crucial to integration into electricity grids and for utility, power plant operations & the energy market

Needs

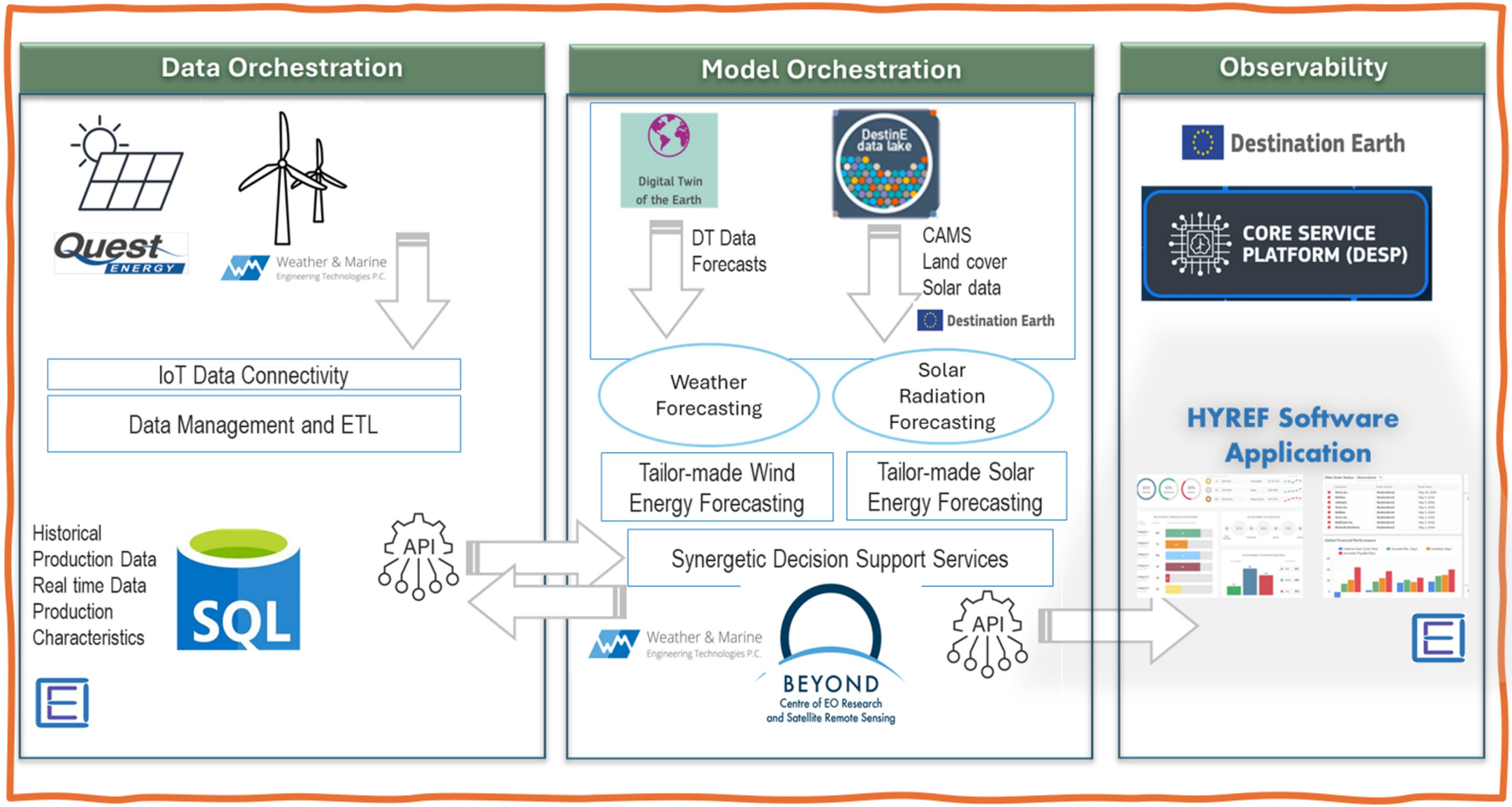
- Weather data archives for site modeling
- Weather forecasting in all timeframes
- Climate analysis and long-term variability
- Data needs: solar, wind, atmosphere, land use, surface roughness, orography, snow cover, vegetation status

Gaps

- Different data sources difficult to handle
- User involvement in product definition is missing
- Delays in data access especially NRT
- Handling of large data amounts
- Spatial and temporal coverage not optimized for energy needs
- Standardisation not sufficient

IRENA, 2021, EU sites.

DRE Conceptual Architecture



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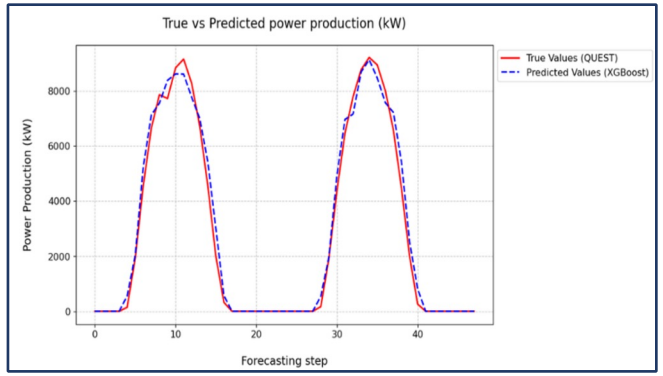
Solar power production forecasting model

Input
- **USER** data
- CAMS radiation service (**DEDL**)

Training solar model

Solar model (ML)
production = f (solar radiation, sza, T, RH, wind)

Evaluation on actual DT Data



Input
- Digital Twin (**DT**) forecasts
- CAMS global atmospheric composition forecast (**DEDL**)

solar model

Output
- **Forecast of surface radiation** [the DT output, corrected for aerosol]
- **Forecast of solar power production** [tailored to user]

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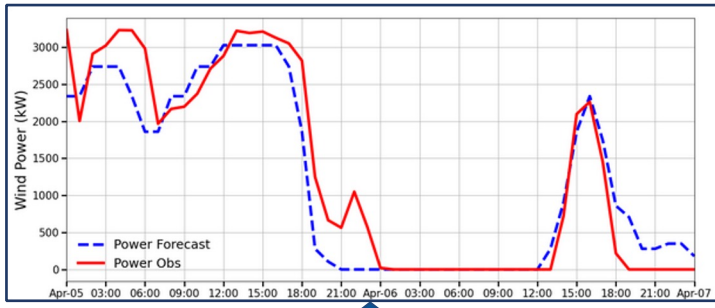
Wind power production forecasting model

Input
- **USER** data

Training wind model

Wind model (ML)
production = f (wind, power curve)

Evaluation on actual DT Data



Input
- Digital Twin (**DT**) forecasts

wind model

Output
- **Forecast of wind speed** [adjusted to hub height]
- **Forecast of wind power production** [tailored to user]

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HYREF Software solution at a glance

HYREF is a Software Application

Supports the digitization of solar and wind production sites

Providing

- Solar radiation assessment and production and 2-day forecasts of Global Horizontal Irradiance (GHI) and solar production
- Wind power production assessment and 2-day forecasts of wind speed and power production
- Hybrid production assessment and 2-3 day forecasts products
- Customisable Production KPIs for power producers
- Plans for Free and Premium Tiers

Solar and wind resource assessment

Uses CAMS solar radiation and wind historical data to provide statistics on the performance and output of the specific power system

Solar and wind forecasts

Models require end-user data to simulate energy production output for user-tailored solar or wind parks

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HYREF Solar Prototype

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HYREF Wind Prototype

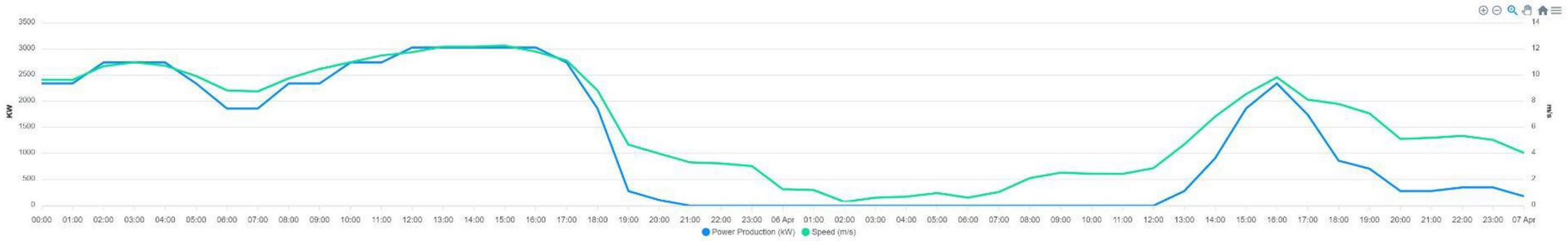
Hybrid Renewable Energet Forecasting System (HYREF)

Wind
Solar
Hybrid

Plant

VirtualWindFarm

HYREF Model Prediction



Energy Production summary

Timestamp	Direction °	Speed (m/s)	Power (kW)
05/04/2024 00:00:00	286.5133	9.6351	2339
05/04/2024 01:00:00	289.2495	9.6286	2339
05/04/2024 02:00:00	290.4497	10.6775	2739.3
05/04/2024 03:00:00	291.0689	10.9797	2739.3
05/04/2024 04:00:00	292.5767	10.7162	2739.3
05/04/2024 05:00:00	289.4813	9.9243	2339
05/04/2024 06:00:00	282.2416	8.8285	1859.8
05/04/2024 07:00:00	278.477	8.7514	1859.8
05/04/2024 08:00:00	276.9613	9.7395	2339
05/04/2024 09:00:00	277.1066	10.4631	2339

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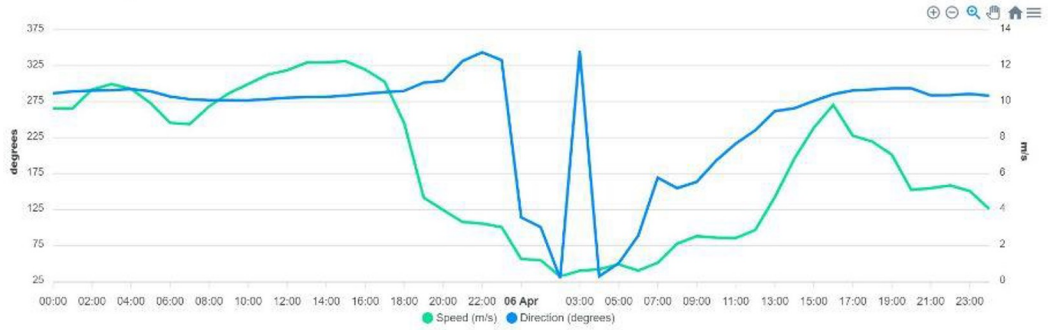
Plant Production parameters



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HYREF Hybrid production

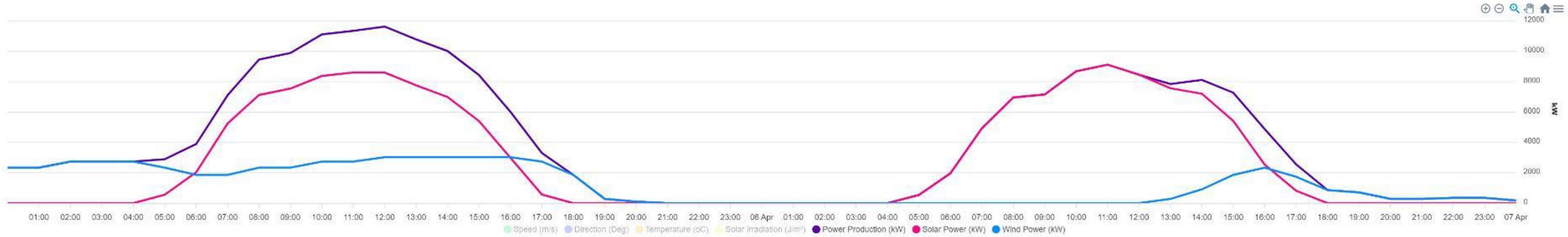
Hybrid Renewable Energet Forecasting System (HYREF)

Wind
Solar
Hybrid

Plant

Kinigos Lamia

HYREF Model Prediction



Energy Production summary

Timestamp	Direction °	Speed (m/s)	Wind Power (kW)	Temperature	J/m²	Solar Power (kW)	Total Power (kW)
05/04/2024 00:00:00	286.5133	9.6351	2339	14.03576682	0	0	2339
05/04/2024 01:00:00	289.2495	9.6286	2339	14.03576682	0	0	2339
05/04/2024 02:00:00	290.4497	10.6775	2739.3	14.15196369	0	0	2739.3
05/04/2024 03:00:00	291.0689	10.9797	2739.3	14.23379896	0	0	2739.3
05/04/2024 04:00:00	292.5767	10.7162	2739.3	14.84553132	0	0	2739.3
05/04/2024 05:00:00	289.4813	9.9243	2339	16.76235125	95816.89063	553.848	2892.848
05/04/2024 06:00:00	282.2416	8.8285	1859.8	18.33056686	643455.8672	2033.8785	3893.6785
05/04/2024 07:00:00	278.477	8.7514	1859.8	19.38256047	1377833.672	5247.6963	7107.4963
05/04/2024 08:00:00	276.9613	9.7395	2339	19.91670201	2071351.766	7123.243	9462.243
05/04/2024 09:00:00	277.1066	10.4631	2339	19.39580534	2626737.742	7550.5093	9889.5093

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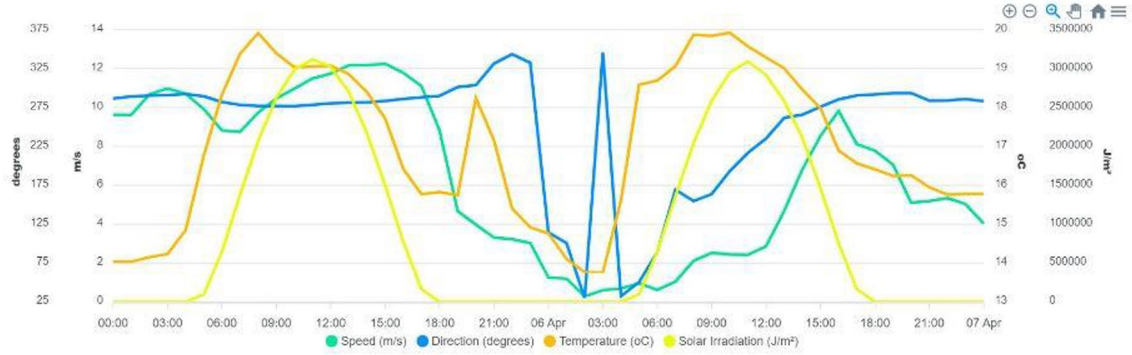
Plant Production parameters



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Next Steps

- HYREF Integration with DestinE (in progress)
  - DESP service registry integration
  - Source code security assessment (Guidelines from Serco SonarQube)
  - DevSecOps operations at test environment
  - Jira issue-tracking system in place to manage issues or dependencies during this phase

- Development roadmap of HYREF Software
  - Hybrid subsystem is already implemented, will continue to improve to all services
  - Under completion of API input/output for solar/wind forecasts. Onboarding and validate/integrate the services
  - Fully Integrated Software: Deliver a complete, validated software solution
  - Integrate HYREF system with solar, wind models, and user feedback, focusing on performance and reliability
  - Spatial Upscaling
  - Final UI/UX, finalize a seamless, user-friendly interface
  - Testing & Documentation, to complete system testing, validation, and provide documentation with training materials

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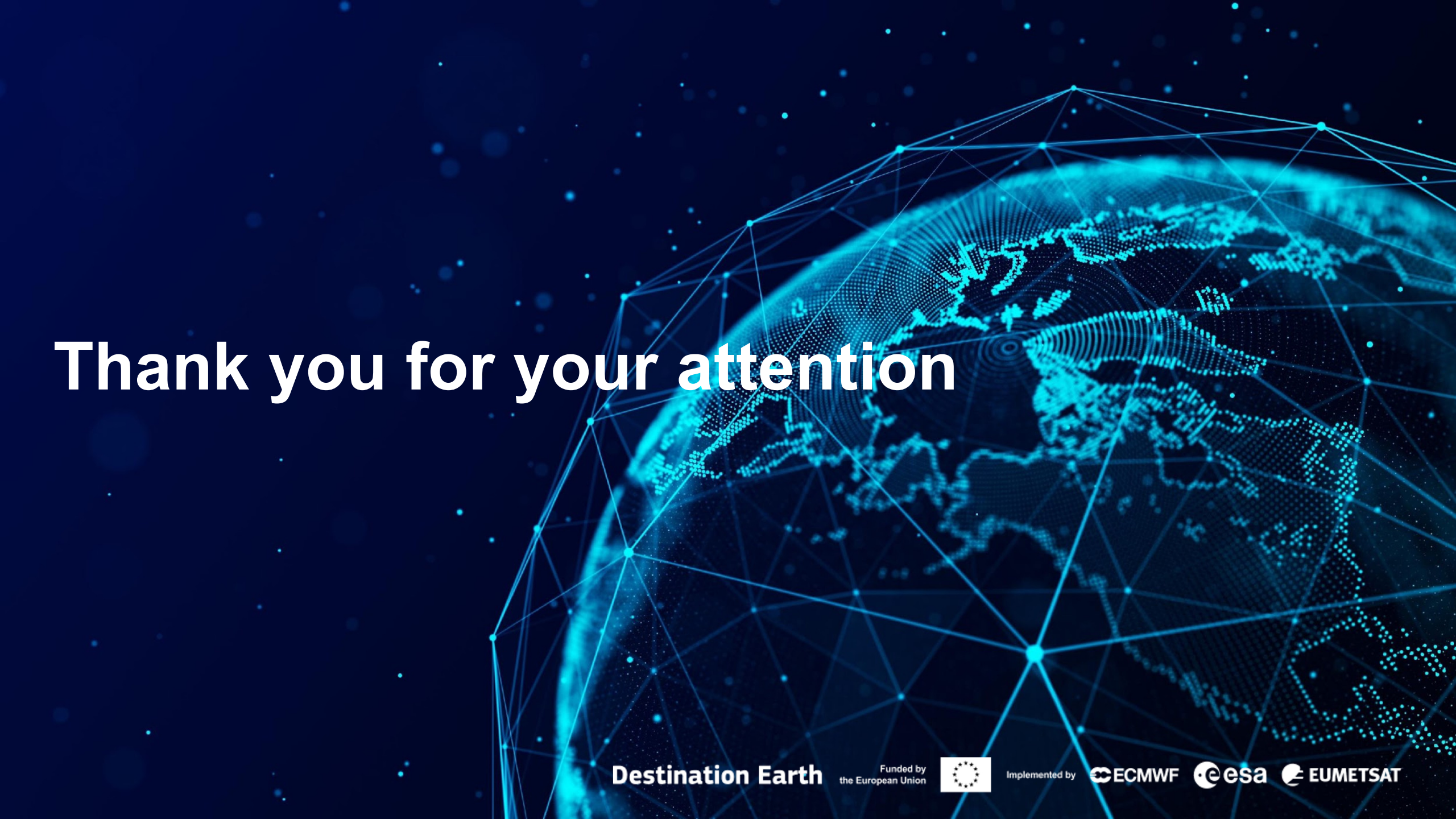
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