Workshop Summary Report

Engaging users with Destination Earth's energy research
Brussels, 09 June 2026

DISCLAIMER
All statements in this document have been summarised by the Renewables Grid Initiative based on inputs collected during and after the discussions carried out at the workshop. The statements represent exchanges on the work-in-progress on the selected topics at the workshop rather than final outputs.

1. Background

Europe is the fastest warming continent and already today it faces severe impacts of climate change, including increasing frequency and intensity of extreme weather events, such as droughts, heatwaves, storms, floods and wildfires.[1] The consequences of these events are taking social, environmental, and economic tolls on European societies,[2] threatening communities, natural ecosystems and infrastructure.

Electricity grids and renewable energy sources (RES), in particular wind and solar, are also increasingly exposed to and affected by climate change and extreme weather events, including direct impacts on the physical infrastructure and impacts on the energy system at large. Extreme events can lead, for example, to collapse of pylons during storms, disruption of electrical substations during floods or damages of cables during wildfires. Changing climate and weather patterns have substantial implications on electricity generation and demand, for example, simultaneous lack of wind and solar radiation to generate electricity (Dunkelflaute),[3] or excessive electricity demand for cooling during more frequent heatwaves.[4]

The European Union (EU) attempts to address climate change risks in multiple ways, linking climate resiliency with the efforts to enhance and ensure Europe's security, stability and competitiveness. The most recent initiative in this regard – the Integrated Framework for European Climate Resilience and Risk Management – is planned to be published by the end of 2026 and deliver a clear guidance on that front.

In parallel, and from an energy system perspective, the evolving climate risks urgently require

[1] Copernicus Climate Change Service (C3S) and World Meteorological Organization (WMO), 2025: European State of the Climate 2024 (Link).
[2] European environment agency, 2025: Economic losses and fatalities from weather- and climate-related extremes (Link).
[3] Clean Energy Wire (2024): Prolonged 'Dunkelflaute' shrinks Germany's renewables output in early November (Link)
[4] Ember, 2025: Heat and power: Impacts of the 2025 heatwave in Europe (Link)

cost-efficient solutions that strengthen adaptive capacities and resilience during the planning, designing, and deploying electricity grids and RES. For that, industry, researchers, policy makers and public authorities require climate and weather information tailored to their needs.

In order to close existing knowledge gaps, the European Commission's initiative Destination Earth (DestinE) develops a highly accurate digital model of the Earth to monitor and predict interactions between natural phenomena and human activities, including two Digital Twins (DT) – Climate DT and Extremes DT. For the energy sector, several activities within DestinE have been started to demonstrate the capabilities of the DTs, including Use Cases, machine learning (ML) Demonstrators and Pilot Services. However, as these capabilities are advancing and users' needs are changing, more active user-engagement is required to better align these activities with the changing needs of energy users and changing regulatory and policy requirements, such as the abovementioned Framework.

Contributing to these efforts, Renewables Grid Initiative (RGI) and the German Aerospace Center organised a public workshop on 09 June 2026 to inform stakeholders about DestinE's energy research, enhance synergies in the context of planning a climate-resilient energy system in Europe, strengthen cooperation between stakeholders on the topic, and facilitate the expert community, including industry (e.g., grid operators, wind energy developers), public authorities, researchers and civil society in the discussions. This workshop was organised under DestinE's 5th User eXchange event (DestinE UX5) that took place on 09-10 June 2026 in Brussels.

The workshop started with a setting the scene presentation by the European Network of Transmission System Operators for Electricity (ENTSO-E) that focused on the opportunities of integrating climate resilience and adaptation in European energy system planning, reflecting upon objectives and outputs of DestinE. Involving ENTSO-E and presenting a pan-European perspective was built upon RGI's established collaboration with ENTSO-E, which in the past years (2023-2025) contributed to the improvements of the Cost-Benefit Analysis (CBA) methodology[5].

The interactive part of the workshop was designed in a "World Café" format, in which participants discussed in six groups ("Tables") about *machine learning, extreme events, dynamic line rating, energy use case for the Climate DT, climate risk assessment* and *energy system planning*. The discussions were moderated by ENTSO-E and organisations involved in energy contracts under DestinE (the German Aerospace Center; GeoSphere – the Austrian geological, geophysical, climatological, and meteorological service; AU – Aarhus University; BSC – Barcelona Supercomputing Center; RMI – the Royal Meteorological Institute of Belgium). In this way, the workshop created a shared space for stakeholders to actively engage in discussions on different aspects supporting the climate-resilience of the European energy system. The agenda of the workshop is presented in a Table below.

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[5] For more details, please see relevant information included here, here and here.

Agenda of the public workshop	
Time	**Topic**
08:50	Registration
09:15	Introduction to the workshop (RGI & the German Aerospace Center)
09:25	Setting the scene: Opportunities in energy system planning (ENTSO-E)
09:35	Brief presentations of energy themes under DestinE (RMI, the German Aerospace Center, AU, BSC, GeoSphere)
09:55	Round 1: Small groups discussions
10:25	Refreshment break
10:35	Round 2: Small groups discussions
11:05	Round 3: Small groups discussions
11:35	Briefings from the groups' discussions
11:50	Concluding remarks and announcing next steps (RGI & the German Aerospace Center)

2. Setting the scene: Opportunities in energy system planning

Moderation: Benedict Englisch and Aron Zuiker, ENTSO-E

ENTSO-E represents 40 TSOs from 36 European countries, and it provides knowledge, information and assessments for daily operation as well as long term planning of the European electricity system, in time periods spanning from a few weeks to up to 30 years. As part of these activities, ENTSO-E support the development of cost-effective, climate-resilient energy system in Europe. A joint development of a new, quantitative indicator for climate and resilience measures in electricity grids by ENTSO-E in collaboration with RGI, served for the improvement of the CBA methodology, being a part of the Ten-Year Network Development Plan (TYNDP) process.

A key climatic data source for ENTSO-E's planning is the fourth Pan-European Climate Database (PECD4), under Copernicus Climate Change service (C3S). The PECD4 provides and enables the following: combination of historical data and future climate projections with different scenarios of greenhouse gas (GHG) emissions; consistent modelling of multiple climate change pathways; estimation of future generation and demand from renewables; and advanced energy conversion models. The PECD4 can provide historical data from 1950 and climate projections until 2100, hourly timeseries data, as well as gridded and aggregated data according to different climate zones, electricity bidding zones, and countries. As such, the PECD is crucial for supporting short- and long-term energy system planning, including the European Resource Adequacy Assessment (ERAA) and the TYNDP.

However, more granular information, regional-specific weather conditions and local phenomena, as well as classification and clustering of extreme events are missing in the PECD4 and, consequently, in ENTSO-E's assessments. Hence, the workshop provided an opportunity for ENTSO-E and individual grid operators to address these knowledge gaps with innovative and advanced tools and approaches developed under the DestinE's energy research and beyond.

3. Summary of group discussions

Table 1: High Resolution forecasts for Next Generation Dynamic Line Rating computation

Moderation: Piet Termonia and Joris Van den Bergh, the Royal Meteorological Institute (RMI), Belgium

1. Background

Studies conducted within this project show that transmission line capacity along an Alpine corridor (the "Westtirol–Zell am Ziller" line, 220 kV) can vary significantly, ranging from –36% to +147%. This range points to a substantial potential for optimising transmission system operations with Dynamic Line Rating (DLR), compared to conventional static rating approaches. Accordingly, this project develops DLR solutions tailored to grid operators in all voltage levels.

Two complementary approaches are explored. First, a 6-class compound-event severity scale has been developed, providing operators with clear and actionable information on operating conditions. Second, the research advances methodologies that range from continent-wide screening down to the identification of a single critical span up to 48 hours in advance.

This research is characterised by intensive stakeholder engagement and co-design activities with European grid operators across four countries, including:

- Austria: APG (220 kV, Alpine Tyrol) and Energienetze Steiermark (110 kV, complex terrain)
- Belgium: Elia (150/380 kV)
- France: RTE (400/225 kV, shared use case)
- Germany: TransnetBW (380 kV, quantile forecasts)

In addition, ENTSO-E's network is actively informed. Lessons learned from these collaborations were discussed during the workshop.

2. Potential Users
Two additional stakeholders participated in the discussions: the Greek TSO IPTO and the Slovenian company operaTO. Some TSOs collaborate with forecast data providers, which could become additional users of this pilot service (while DLR implementation in operational settings is progressing, it has not yet been fully deployed).

3. Data for Verification
A key challenge is access to data needed for verifying the model's output, which currently is available only to a small number of TSOs. Pilot testing is currently conducted on specific power lines. Available data sources include sensors installed on power lines (typically at heights of 30–60 meters) and ground-based weather stations. Some TSOs report using direct ampacity measurements, while others estimate ampacity based on IEEE and CIGRE methodologies. To overcome the gap in data availability, the DLR project's consortium is prepared to sign non-disclosure agreements (NDAs) where necessary to facilitate data sharing.

4. Required Service
Implementing Dynamic Line Rating in operational environments is complex and requires clear, digestible information, similar to the challenges faced by meteorologists in weather forecasting. The 6-class compound-event severity scale, proposed at the workshop, offers a potential solution by translating complex data into actionable insights for system operators.

Table 2: Energy Use Case for Climate Adaptation Digital Twin

Moderation: Francesc Roura, the Barcelona Supercomputing Center (BSC)

This research introduces open-source, high-resolution tools utilising kilometre-scale climate projections to deliver selected indicators such as energy generation and demand-side at a global scale that are relevant for project developers (especially, but not limited to, wind and solar energy). The goal is to deliver tailored insights and indicators that project developers can genuinely trust for long-term planning at both project and system levels. Key points discussed were as follows:

1. Validation and trust:
Participants in the group discussions stressed that energy indicators will only be trusted if they are benchmarked against widely used references such as the European-Reanalysis (ERA5), the PECD, and the Coupled Model Intercomparison Project (CMIP). Because the Climate DT provides global, high-resolution (~5 km) data, direct comparisons are challenging. A proposed approach is to validate against intermediate-resolution regional products (e.g., EURO-

CORDEX, ARRA, DREAM/ICON) to demonstrate the added value of higher resolution. The key requirement is to show that increase of resolution delivers meaningful improvements in the production of energy-relevant indicators, rather than simply finer spatial details, ideally through targeted case studies.

2. Demand-side indicators:
There was a strong requirement for indicators on the demand side by participants in the group discussions, which are currently underrepresented in the use case. A combined demand indicator (Heating and Cooling Degree Days) was suggested to be valuable in this context. Participants also highlighted the value of compound supply-and-demand indicators in identifying periods of severe mismatch between energy production and demand. Such indicators, together with pricing information and scenarios involving changes in the penetration of energy storage, could support more compelling "what-if" storylines.

3. New indicators and the value of resolution:
Climate DT energy indicators should match the capabilities of PECD, while differentiating itself through indicators that benefit from higher resolution, such as wind ramp events (short-term changes in wind speed) and/or atmospheric boundary layer (ABL) stability metrics. Discussions highlighted also limitations of commonly used indicators like capacity factor, which do not account for farm-level effects such as wakes and the related losses. This raises a broader question about the limits of what can and cannot be credibly delivered without any further downscaling of the climate simulations.

4. Cross-cutting priorities:
A recurring recommendation shared by the participants was to thoroughly review existing energy indicator services, particularly PECD and the Copernicus energy products, to better understand user needs and identify where 5 km resolution could provide additional value. Participants also expressed interest in access to time-series data and emphasised the need to define spatial aggregation and delivery methods.

Table 3: On Demand Extremes Digital Twins

Moderation: Irene Schicker, GeoSphere

1. Discussion themes
The session engaged workshop participants around four discussion themes under data integration:

- Theme A: Defining extreme events for the (European) energy system.
- Theme B: Identifying areas where high (spatial and temporal) resolution is or could be cost-efficient for users.
- Theme C: Identifying the "what-if" scenarios that matter the most to users.
- Theme D: Shifting from current extremes to future-climate impacts.

2. Findings

Seven cross-cutting messages emerged from the four mentioned discussion-themes:

- **"Extreme" is defined by impact and not meteorologically.** Across all group discussions, participants stressed that characterising extreme events will be linked to capacity, infrastructure, market signals and asset behaviour, but not as meteorological metrics *in isolation*. This validates the impact-sector framing of the project. Remaining open questions were: 1) what definitions are appropriate at climate timescales, as opposed to operational timescales? 2) should sabotage be treated as a compound-event in scenario planning?
- In relations to the previous point, **markets and regulation are part of the definition of "extreme."** Imbalance signals, negative prices and bidding-zone design serve both as early warnings of extreme events and as the operative definitions used by regulators and market operators. This opens an opportunity to collaborate with ENTSO-E and the European Commission, in terms of data-provisioning by GeoSphere.
- **Compound events are a commonly identified gap.** Temporal compounding (consecutive Dunkelflaute[6], heat and low-wind, storm and flood) and spatial compounding (multi-region wind shut-offs, continental convective outbreaks) are common identified weaknesses of the existing forecast- and planning tools.
- **Hectometric resolution (100m resolution) is or can be cost-efficient in two specific contexts:** complex orography (Alpine, coastal, mountain) and asset-level operational decisions (transmission re-routing, substation placement, maintenance dispatch). It is not obviously cost-efficient for large-area (e.g., continental Dunkelflaute), or slow-evolving phenomena. Being transparent about this blind spot contributes to trust building and increase credibility regarding the extreme events assessment and its cost-effectiveness among users.
- **Sub-hourly temporal resolution is a distinct requirement, not subsumed by spatial resolution.** Especially, fog, convection, Aerosol Optical Depth (AOD)/cloud cover and snow need temporal (not just spatial) resolution. Solar nowcasting (real time casting) and ensemble post-processing is essential and cannot be optional.
- **What-if scenarios fall naturally into two timescales, both requested by users:** (i) Operational what-ifs — alternative turbine types, wind-farm layouts, storage placement, and ramping behaviour applied to observed events — which are the current strength of the "on demand extremes" project, and (ii) Climate-conditioned what-ifs — future regime adaptation and asset sizing for changing extremes.
- **Probabilistic framing is non-negotiable.** Robustness, quantifying uncertainty, and safety margins were raised in every theme. Ensemble approaches to ensure this should be considered a requirement, not a "nice-to-have".

3. Synergies and cross-cutting opportunities

The following paragraphs identify synergies of the project with external stakeholders, impact-sectors and the other four energy themes, as well as relevant methodological pathways.

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[6] Dunkelflaute is a simultaneous lack of wind and solar radiation episodes. In contrast, Hellbrise is a simultaneous excess of wind and solar power generation.

Identifying synergies and cross-cutting opportunities will be used to explore further potential collaborations, initiatives and stakeholders such as users, policy makers and researchers.

<u>With DestinE non-energy impact sectors</u>

- Air quality: Aerosol Optical Depth (AOD), fog and convective extremes appear in both energy (PV impact, ramps) and air quality contexts. Coordinated detection / nowcasting could benefit both.
- Hydrology: flash floods and low water already surfaced from energy participants. Shared hectometric detection.
- Health / urban: heat-stress overlap with PV derating (reduced performance) and demand-side load.

<u>With external stakeholders</u>

- The European Commission confirmed interest in climate-conditioned what-ifs that can complement the ERAA and the TYNDP.
- ENTSO-E: market and regulatory dimension of "extremes" (Themes A and C: "Defining extreme events for the energy system" and "the 'what-if' scenarios that matter the most to users", respectively). Possible collaboration on extreme event-definition standards.
- National TSOs (APG, Elia, TenneT): hectometric resolution justifies its cost for asset-level operational decisions; clear pilot use cases identified. With RTE, market-extreme definitions (Theme A) and bidding-zone what-ifs (Theme C) correspond to TSOs/DSOs operational decision-making.

<u>With the DestinE energy contracts:</u>

- Climate DT energy indicators: concerning the regime-shift / changing-weather-pattern discussion (Theme D, "Defining extreme events for the energy system"). Proposed joint activity: co-design of indicators that bridge operational extremes and climate-regime changes, building on Climate DT energy indicators.
- ML demonstrator and climate risk assessments: concerning probabilistic compound-scenario work (Theme D). Ensemble of compound storylines for risk assessment could become a joint product.

<u>Methodological synergies</u>

- Probabilistic framing for "what-ifs" is a common methodology across all DestinE energy work, and hence a joint-paper on the topic by the contractors can be explored.
- Compound-event detection and characterisation are similarly a shared methodological challenge across impact sectors (energy, air quality, hydrology, urban). Coordinating on definitions and detecting suitable algorithms would multiply the value for each sector.

Table 4: Machine learning (ML) Demonstrator energy systems

Moderation: Alexander Kies, the Aarhus University (AU)

This research focuses on implementation of an innovative ML Demonstrator based on a sophisticated Physics-Informed Neural Network, designed to handle a complex and dynamic nature of power systems, in particular electricity grids with high share of renewable energy. The demonstrator builds on existing energy modelling tools and services (e.g., C3S and grid operators) but introduces advanced machine learning techniques to provide faster, scalable and more adaptative solutions for users. Key points discussed were as follows:

1. Validating the ML Demonstrator:

- ML models should identify situations where their accuracy may deteriorate.
- Critical and extreme cases should be detected automatically and potentially re-solved using conventional methods.
- Reliability metrics and confidence indicators are needed to support operational acceptance.
- Rigorous validation, verification, and quality assurance are more important for validation than explainability.
- Users would need evidence that predictions produced by ML can be trusted.
- A hybrid workflow was suggested for the validation process: ML screening, followed by identifying critical cases where the screening may be unreliable, and finalised with verification using classical simulations.

2. Trust building:

The ML model does not have to be trusted blindly by the users. Rather, its outputs can be checked against physical and optimisation criteria, such as power balance, generation and transmission line limits, storage constraints, operating costs, Energy Not Served (ENS), Loss of Load Probability (LOLP), feasibility of the reconstructed dispatch (i.e., whether the predicted dispatch satisfies all optimisation constraints), and, where appropriate, Karush–Kuhn–Tucker (KKT) -like optimality checks (e.g., assessing the optimality gap or residual violations of the KKT conditions to quantify how closely the ML solution approximates the true optimum).

3. Extreme events:

Extreme events are a major issue to address, as they are particularly important for grid operators, policy makers and other stakeholders. Hence, dedicated identification of critical situations would be valuable. For that, the following should be considered:

- Training specialised models focused on extreme events.
- Building benchmark datasets that represent critical cases.
- Characterising situations where model performance degrades.
- Finally, developing an *extreme event library* and targeted validation framework.

4. Uncertainty and ensembles:
Users rarely rely on a single simulation outcome. Ensemble approaches are preferred over single deterministic predictions. Hence, ML could enable exploration of many more weather years and climate scenarios than currently feasible.

5. Transparency and understanding model behaviour:
- Regional variations in model quality should be visualised (e.g., maps).
- Users would like to understand where the model performs well and where it struggles.
- Feature reduction and sensitivity analyses could reveal which inputs are most important.
- Questions remain regarding limited transparency / public availability of TSOs' datasets.

6. Operational use cases:
The most relevant applications identified during the group-discussions were:
- Resource adequacy assessments.
- Grid adequacy and network development planning.
- Sensitivity studies around baseline scenarios.
- Exploration of large numbers of weather years.

7. Key message:
While users and other stakeholders saw a strong potential in ML for accelerating large-scale adequacy and planning studies, the adoption of the ML application and its results depend on developing, applying and providing access to "trust-building" measures such as uncertainty estimates, reliability metrics, extreme-event validation, and hybrid ML–physics workflows.

8. Planned extensions and continuations based on stakeholders' feedback, indicating their implementability potential:
- Reliability indicators (implementable).
- Critical case identification (implementable).
- Hybrid ML–physics workflow (implementable).
- Regional performance visualisation (mapping) and sensitivity analysis (implementable).
- Large climate-ensemble exploration (implementation is questionable).

Table 5: Opportunities in energy system planning

Moderation: Benedict Englisch and Aron Zuiker (ENTSO-E)

1. Initial open guiding questions
ENTSO-E prepared three open questions to guide the group-discussions, focusing especially on classification of weather scenarios:
- Which set of climate variables significantly impacts power energy system operations?

- Which regional weather conditions significantly impacts power system operations?
- How could weather scenarios be classified by, e.g., regional extreme events?

2. Key insights from group discussion 1:

- Combination between historical and projection outlooks
  - Looking at historical data/ observations can provide "thresholds" of events, that can be critical for projections of future events.
  - Climate is not static: events might get less frequent, but their intensity and probability will increase (e.g., extreme colds in the winter or heatwaves in the summer).
- Preparedness of the energy system should consider how predictions are considered – as "averages" of climate change or toward increase of extreme events.
- The pan-European views on climate hazards can be significantly different than national views.
  - A national extreme event does not necessarily affect the full pan-European region (e.g., Dunkelflaute in one region).
  - Pan-European Dunkelflaute, e.g., is less likely to happen compared to regional events.

3. Key insights and open questions from group discussion 2:

- Consideration of the impact of weather conditions and how changes in weather interact with other factors (e.g., demand, infrastructure) to affect the power system is required.
- How do local seasonal effects aggregate to the European level? Can these impacts amplify each other or reduce each other's effects? What about seasonal differences (heating/cooling demand South vs. North of Europe)?
- How to account for uncertainty in the data?
  - It is hard to assess connections between meteorological situations and energy system(s); it is hardly predictable for models.
- Addressing flexibility is required.
- Optimal solution for very-near future for the energy system (the "tomorrow's forecast").

4. Key insights from group discussion 3:

- Extreme events can be regarded from two angles:
  - Already known events, in which the parameters can be looked for.
  - Investigating new events as a stress test on the energy system.
- Both angels could be combined by machine learning and data analysis, and both will have valuable insights for ENTSO-E.
- Open source is required / preferred for these purposes.
- A valuable output / supporting tool for ENTSO-E and other parties when addressing extreme events could be an "encyclopaedia" of climate-hazards, a user-driven database / registry of classified and identified weather events (e.g., in case of CMIP6 projections) to develop a knowledge base of climate events which helps users to extract relevant data for electricity infrastructure projects.

Table 6: Climate risk assessment

Moderation: Bruno Schyska, the German Aerospace Center

1. Background:

DestinE provides a powerful toolbox to support climate risk assessments for the energy sector: the Climate DT delivers highest-resolution, operational climate projections; the Extremes DT can provide detailed knowledge about extreme events for the energy system; DestinE's climate storyline simulations allow to explore how climate change is reshaping extreme events; and impact sector models and machine learning applications enable investigation of real-world problems and large numbers of what-if scenarios. Through combining these capabilities, DestinE can contribute to improving the data and model-driven evidence-base for climate risk assessments by:

- Defining advanced sets of high-resolution, stakeholder-informed climate impact indicators for consecutive, compound and cascading risks for the energy system,
- Integrating DestinE's Climate DT simulations with energy systems models at different spatial scales,
- Performing multi-scale climate risk analysis with ML-enhanced numerical models of the energy system, user-validated risk storylines and stress-testing.

Hence, the aim of the climate risk assessment table was to discuss this approach via collecting information about existing/ongoing climate risk assessment exercises, their shortcomings and knowledge-gap, and DestinE's potential contributions to overcome them.

2. Results:

Using climate risk assessments as an exemplary key application of the DestinE infrastructure, some key challenges for the use of the Climate DT have been discussed. The discussion followed two major lines:

1) "What are the benefits of the very high resolution of the climate DT?",

2) "How can DestinE contribute to overcoming the observed gap between the scientific progress made under DestinE and the users' capabilities to deal with climate information?".

Addressing these two points, the following recommendations have been formulated:

- Local-scale demo cases, which make explicit use of the high resolution of the Climate DT output through coupling them with downstream applications, such as flood and/or wildfire models, are important for developing assessments.
- It is crucial to continue and strengthen the role of social sciences in DestinE's co-design activities, building interfaces between climate scientists and the envisaged users of DestinE's services and datasets.

4. Key takeaways from the workshop and the next steps

While all 6 tables represented different capabilities and different users' needs in energy system planning, several direct and indirect links can be drawn between them, which are relevant to stakeholders from the *energy and climate communities*:

- From the users' perspective and, especially, grid operators and ENTSO-E, the discussions showed the **potential of integrating data and methodologies** from DestinE's energy research into assessment tools and dataset such as the PECD, Network Development Plans (NDPs) and the TYNDP, and other grid management tools at European and national levels.
- In strong relation to the point above, there is a need to **enhance collaborations with stakeholders**, from energy industry to policy makers and researchers. A notable example was ENTSO-E's interest in the ML applications to improve the accuracy and scope of scenario-building in energy system planning.
- Continuing this line, **defining extreme events** is an underlying requirement to allow the development of more accurate and synchronised assessments, according to users' needs. These definitions are *highly contextual* and depend much on the *perception* of the impact by stakeholders. Adding to this, **historical thresholds** can inform these definitions only partially. Hence, the industry, public authorities and regulators, supported by civil society and researchers, should be involved in defining and understanding hazards and the risk they pose.
- **Compound and consecutive events** emerged as a major challenge for forecasting and risk assessments. While technical solutions such as ML (Table 4) could provide a concrete technical response by training specialised models and building benchmark datasets for extreme events, involvement of other impact-sectors (e.g., air quality, hydrology) should be considered in framing and assessing compound-event as well – for example, in jointly developing assessment methodologies.
- **High-resolution (hectometric resolution) data** that can be available from DestinE outputs would likely be more cost-efficient for complexed mountain-areas and for asset-specific decisions such as grid-rerouting, but not for slow-evolving phenomena such as steady increase of temperatures. This should be well communicated to energy system planners to increase trust and improve efficiency of planning procedures.
- **Lack of data availability and accessibility** requires further discussion. Grid operators are bound from providing certain information due to security and other reasons, while the private sector restrict information sharing to keep the competitive edge. However, lack of information affects the scope, type and quality of the tools that are developed to assist these stakeholders. Raising awareness about these conflicting elements and discussing this openly with decision makers could lead to adequate solutions.
- Addressing **processes and tools in long-term energy system planning** in Europe (TYNDP, ERAA, PECD), larger number of weather-years, and suggesting broader "what-ifs" scenarios than those available now would increase the ability of planners to provide more accurate and relevant scenarios to support decision making. Existing

datasets such as the PECD will benefit from complementary data and analyses, ensuring more accurate outputs that could be translated into more efficient measures.

Ensuring the European energy system is prepared for climate-impacts is crucial to enable a secured, stable and reliable electricity supply. Contributing to this goal, this workshop has been part of RGI's continuous efforts to enhance, share and promote climate-resilience in electricity grids in Europe. More information on RGI's activities on the topic of climate adaptation and resilience can be found here.

Please do not hesitate to reach out to Ira Shefer (ira@renewables-grid.eu) and Andrzej Ceglarz (andrzej@renewables-grid.eu) with interest or opportunities to further collaborate.