Newsletter #3 – Risk metrics to support operational planning

We are pleased to share the third newsletter in our ERA-Net project, AISOP. In this newsletter we describe a non-exhaustive list of metrics on reliability and risk which can support operational planning decisions as well as infrastructure planning processes. A summary of the activities is presented listing our activities and publications.

For more information, and to subscribe to future updates, visit www.aisopproject.com.

Who we are: an international consortium from Switzerland and Germany

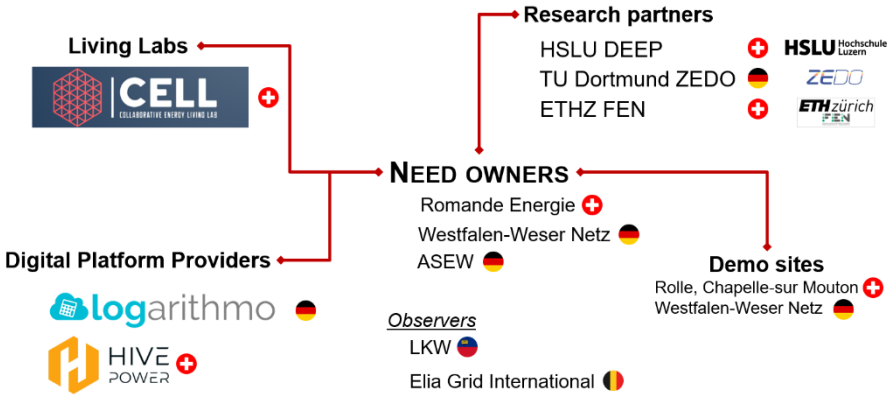

Figure 1 AISOP Consortium.

What we do: data-driven decision support system

AISOP will create an **AI-assisted decision support system for electric distribution system operators** (DSOs) to drive decarbonisation. AISOP's models are underpinned by **advanced digital technology**. The decision-support system securely and privately acquires data using state-of-the-art digital platforms. It then processes and interprets it to generate knowledge. The goal is then to use the extracted information for situational awareness and dynamic tariff setting. Overall, the objective is to use heterogeneous data for the benefit of DSO operational planning. In this way, AISOP expands data-driven techniques for improved operational planning in distribution grids with high shares of DERs by integrating AI- or ML-based solutions, enhanced situational awareness, and market incentives. We combine (i) data access and ingestion, (ii) distribution grid situational awareness, (iii) decision-support for distribution grid management, (iv) dynamic tariffs, and (v) digital platform integration with exploitation through test and training environments.

Logarithmo, as part of the consortium in Germany, is leading the activities in "securely and privately acquiring and processing the data" and establishes the connection between the data supplier and the utility partner in Germany, Westfalen Weser Netz (WWN) to ensure high-quality data to be used for knowledge extraction as part of the decision-support system. In addition to the master data (e.g., installed capacities of PV and grid capacities), historical data and live measurements from the WWN network are received and processed. For further use within the digital process twin, the confidential data by WWN is enriched with publicly available

AISOP project has received funding in the framework of the joint programming initiative **ERA-Net Smart Energy Systems**' focus initiative Digital Transformation for the Energy Transition, with support from the European Union's Horizon 2020 research and innovation program under grant agreement No 883973.

Smart Energy Systems ERA-Net

data (e.g., weather data) and brought to a "gold standard". Resulting high-quality data is then used for the decision support algorithms (e.g., anomaly detection) by ZEDO (TU Dortmund).

Topic #3: Risk metrics for decision support

Typically, assumptions on probability distributions of loads and generation are used in Monte Carlo simulations to generate scenarios for planning studies. During operation, DSOs monitor the loading of lines and transformers, as well as nodal voltage magnitudes and power quality metrics in selected nodes throughout their networks (e.g., transformers at HV-MV and MV-LV stations, MV branches). Moreover, information about ongoing or planned maintenance activities allows DSOs to maintain a high operational performance of their grids. Updated reliability metrics enable them to gain perspective on the performance over time. Recently, hosting capacity and risk metrics are receiving increased attention as valuable to support operational planning decisions, especially due to the expected increase in stochasticity in the distribution networks as a result of proliferation of distributed PVs and electrification of heating and mobility. Table 1 shows a non-exhaustive list of reliability and risk metrics.

Table 1 Reliability and risk metrics

Metric	Description
SAIDI	**S**ystem **A**verage **I**nterruption **D**uration **I**ndex: indicates the average outage duration; requires long-term outage data, used today to approximate the Expected Energy Not Served (EENS).
SAIFI	**S**ystem **A**verage **I**nterruption **F**requency **I**ndex, used today: indicates the average outage frequency, used today to approximate the Expected Energy Not Served (EENS).
EEAR	**E**xpected **E**nergy **a**t **R**isk: quantifies the risk of potential energy not served due to system constraints (statistical approach to commonly used EENS).
OVR	**O**ver-**V**oltage **R**isk: indicates the risk of nodal voltages exceeding thresholds; uses an exponential severity function.
UVR	**U**nder-**V**oltage **R**isk: indicates the risk of nodal voltages being below thresholds; uses an exponential severity function.
LOR	**L**ine **O**verload **R**isk: indicates the risk of line overloads; uses linear severity function.
LLR	**L**ine **L**oss **R**isk: indicates the risk of load loss; uses linear severity function.

Such metrics can serve decision support tools that enable Distribution System Operators (DSOs) to make up-to-date informed decisions across multiple time horizons and operational contexts. For strategic planning and investment in the long-term, the combination of reliability metrics (SAIDI, EEAR) with risk metrics (OVR, UVR, LOR) could support prioritization of grid updates. For operational planning, near-real-time or mid-term (e.g., weekly, seasonal) risk metrics may offer early warning signals that are easy to communicate and serve to trigger detailed analyses to understand root-causes and devise remedial actions such as updates in dynamic tariffs. Remedial actions can lead to adjustments of dispatch patterns of distributed energy resources or activation of demand response programs. Furthermore, risk-informed maintenance planning enabled by data-driven metrics such as LLR contribute to more efficient operational planning.

AISOP project has received funding in the framework of the joint programming initiative **ERA-Net Smart Energy Systems**' focus initiative Digital Transformation for the Energy Transition, with support from the European Union's Horizon 2020 research and innovation program under grant agreement No 883973.

Smart Energy Systems ERA-Net

AI-assisted decision support for operational planning in distribution systems

Activities & reports or publications (recent past and upcoming)

- The English version of the report on "The Digital Twin in the Network and Electricity Industry", prepared by the VDE ETG task force and led by Dr. Ulf Häger is published. The report can be found here.
- The AISOP project was presented at the ETG CIRED Workshop 2023 (DACH) in November in Munich.
- The paper titled "Measurement-based Locational Marginal Prices for Real-time Markets in Distribution Systems" is published on IEEE Transactions on Power Systems. Link in aisopproject.com/resources.
- AISOP organized the track titled "AI for Energy Utilities" at the AMLD – Applied Machine Learning Days EPFL on Tuesday, March 26th 2024. The track included a list of presentations by TSO, DSOs and a generative AI start-up. See details here. AISOP project was represented by a poster titled "A data co-pilot for electric distribution utilities to support situational awareness".
- AISOP team pre-processed part of the anonymized and aggregated data from smart meters publicly published by CKW, a distribution system operator that supplies more than 200,000 end customers in Central Switzerland, and sorted it per smart meter ID. Part of these data are accessible as described in this zenodo public record.
- The paper titled "A framework for data-driven decision support for operational planning in active distribution networks" was presented at CIRED Workshop 2024 in Vienna. Link in aisopproject.com/resources (zenodo public record).
- The M.S. thesis titled "Low Voltage Load Forecasting Using Ensemble Methods" was successfully completed by Dimitrios Papadopoulos.
- The following conference papers were presented at IEEE ISGT Europe 2024 on October 17, 2024:
    - Data-driven Approaches for Anomaly Detection in Low-Voltage Grid Net Power
    - Anomaly Detection in Low-Voltage Grids with LSTM Autoencoders: A Study on Future Scenario Impacts

To keep up to date with our progress, subscribe to our newsletter on https://www.aisopproject.com.

Future newsletters will discuss grid state forecasting, risk identification, anomaly detection in active distribution grids, dynamic tariffs, and digital twins applied to distribution systems.

Project website | LinkedIn | ERA-Net Projects

AISOP project has received funding in the framework of the joint programming initiative **ERA-Net Smart Energy Systems**' focus initiative Digital Transformation for the Energy Transition, with support from the European Union's Horizon 2020 research and innovation program under grant agreement No 883973.