1 Description of the use case

1.1 Name of the use case

ID	Application Domain(s)	Name of Use Case
UC1.Power Grid	Power grid	AI assistant supporting human operators' decision-making in managing power grid congestion

1.2 Version management

Version Management			
Version No.	Date	Name of Author(s)	Changes
0.1	29.01.2024	Bruno Lemetayer (RTE)	Initial document (copy from last version of short template document)

1.3 Scope and objectives of use case

Scope and Objectives of Use Case	
Scope	Power grid real-time operation and operational planning (hours-ahead)
Objective(s)	The goal of a Transmission System Operator (TSO), and thus human operators in the control room, is to control electricity transmission on the electrical infrastructure (transmission grid) while pursuing multiple objectives, firstly to keep the system state within acceptable limits, and: • keeping people and grid components safe, • meeting the production/consumption balance and avoid blackouts, • minimizing operational costs (control actions, energy losses, etc.), • facilitate energy transition (e.g., integration of renewables). In this context, this use case describes an AI assistant that provides a human operator with recommendations for action and/or strategies, considering the following objectives: <u>Functional aspects</u> 1. Aimed at safely managing overloads on the electrical lines and, more specifically, remedial action recommendations 2. Making the most of the renewable energies installed by limiting the emergency redispatching call to thermal power plants emitting greenhouse gases <u>Behavioral and social aspects</u> 3. Easing the workload of the human operator needed to fulfill his/her missions, 4. Integrate explainability, transparency, and trust considerations for the human operator. The AI assistant shall also act in a "bidirectional" manner, i.e. capitalize on the actions and the feedback from the operator with an "online" learning process running continuously.

1.4 Narrative of use case

Narrative of Use Case

Short description

The AI-assistant oversees the transmission grid, using SCADA data and available EMS tools to identify issues, categorizing them for human intervention. It monitors power flow, voltage, and balance, adhering to defined operational conditions. Anticipating problems, it sends binary alerts to the operator with confidence levels, avoiding excessive alerts to maintain operator focus (i.e., controls attention budget). Action recommendations include topological changes, storage adjustments, redispatching, and renewable energy curtailment. The human operator selects an action or seeks more information, exploring alternatives. After the operator's decision, the AI-assistant provides feedback through load flow calculations, logging decisions for continuous learning and interaction improvement.

This use cases only addresses congestion issues, even if other types of issues can arise on the Transmission Grid and are handled by the operators (e.g. voltage).

Note: Different modes of interaction are possible between AI assistant and human operator, ranging from “full human control” to “full AI control”. The selected mode depends on industry domain, and context. In this use case, an ex-ante choice is made to apply a hybrid interaction where the human operator gets the final word on AI assistant recommendations.

Complete description

1. The AI-assistant monitors the situation of the transmission grid by using the available data from SCADA (Supervisory Control And Data Acquisition) and Energy Management System (EMS) tools and categorizes issues by distinguishing the ones needing intervention by the human operator.
   The situation of the transmission grid is monitored at the appropriate horizon (e.g. few hours ahead to 30-min ahead) by using relevant forecasts (generation, consumption).
   Issues correspond to deviations from acceptable operation conditions of the electric system, mainly defined by:
   - Power flow on electric lines not exceeding thermal limits (considering, as the case may be, a tolerance for temporary overload).
   - Voltage maintained within a defined range.
   - Generation and load always balanced (frequency is maintained around 50 Hz).

   The AI assistant monitors these operating conditions and considers a predefined list of contingencies according to the operational policies of the TSO, which include:
   - The nominal grid, i.e. the “N” situation (in which all grid elements are available).
   - Cases in N situations where overload duration exceeds allowed thresholds: depending on TSO’s operational policies, it can be indeed allowed to let transit flows exceed temporary a threshold on a given line (e.g. flows can be higher than x A for 20 minutes, after which line will automatically trip).
     Note: such equipment are used on all lines of RTE’s grid
   - A list of possible “N-1” (electric system’s state after the loss of one grid element, and possibly several grid elements depending on the TSO’s policy).

2. When anticipating issues requiring intervention, the AI-assistant raises alerts for decisions at the appropriate horizon (e.g., few hours ahead down to 30-min ahead) to the human operator, in time for carrying out corresponding actions. These alerts are “binary” in the sense that either the AI assistant sends a persistent alert or not, and they are associated with a level of confidence, i.e., the level of certainty of the AI assistant that electric system won’t remain within acceptable operation conditions if no action is performed. the level of confidence is based on the uncertainty in the forecasts.
   The AI assistant should not send too many alerts to keep the human operator concentrated on his or her tasks and thus ease his or her workload.

3. For a given alert, the human operator receives action recommendations from the AI-assistant, with information on predicted effect, and reasons for the decision. Possible actions are:
   - Topological action: topology can be changed by switching on and off power lines or reconfiguring the busbar connection within substations.
   - ~~Storage action: defines the setpoint for charging and discharging storage units such as batteries.~~
   - Redispatching action: change the flexibility’s (generator, load, battery, etc.) active setpoint value.

- Renewable energy curtailment: limits the power output of a given generation unit to a threshold, defined for example as ratio of maximal production Pmax (a value of 0.5 limits the production of this generator to 50% of its Pmax).

4. The human operator chooses a proposed recommendation, or requests new information or explanations, or looks for a different action guided by an exploration agent or via manual simulation using other specific tools (that aren't part of the AI assistant).

5. The human operator performs needed actions according to his/her decision. The AI-assistant provides feedback to the human operators on the corresponding effects: this is performed afterwards (1 hour or more after the facts) by running a load flow calculation.

The decisions made are logged with their corresponding context to continuously learn from realized actions and improve the interactions between human operator and the AI-assistant (e.g. relevance of proposed recommendations for actions).

Stakeholders

TSO: Transmission system operator in charge of maintaining and operating the electricity transmission grid, monitored by the human operator and the AI assistant.

Other TSOs: Neighboring TSOs, connected to the TSO via its transmission grid.

Regional Control centers: Control centers in charge of European operational services and TSO coordination for grid security analysis processes (e.g., TSCnet, Coreso).

Human operator: A member of TSO's team in charge of monitoring the grid and taking actions.

Transmission grid users: Any party connected to the transmission grid, in contractual relationship with the TSO. This also includes Distribution System Operators (DSOs), and other critical infrastructures like railway, airports, water treatment.

Market participants: Any party involved in a market whose physical underlying is electricity delivered to or from the electricity transmission grid, such as (but not limited to) wholesale markets, balancing markets.

Stakeholders' assets, values

TSO, Other TSOs, Regional Control Centers

- Legal and regulatory framework of action (e.g. Energy law defining role and missions of the TSO, European network codes).
- The AI system must enhance rather than hinder the TSO's operational competence. Risks involve misinterpretation of data, leading to incorrect decisions that impact the overall efficiency and reliability of the power transmission.
- Use of an AI Assistant by human operators must not lead to a progressive deskilling of human operators, who could loose (or won't acquire in case of junior operators) the knowledge needed to handle more complex situations where the AI assistant can't provide any recommendation (i.e. ability to provide feedback to the AI)
- Stakeholders (in particular grid users) must trust the AI system's capabilities. Any malfunction or lack of transparency in the AI decision-making process (e.g., excessive curtailment of a renewable energy producer) can erode trust in the TSO and its ability to manage the transmission grid effectively.
  It is therefore important to have a recurrent ex post analysis process within TSOs to analyze the outputs of AI system to improve confidence, but also detect any bias or malfunctions.
- If the AI system's deployment is not communicated effectively or if there are public concerns regarding its use, the TSO's reputation may suffer, potentially affecting public and Energy Regulator support.
  The AI system should contribute to operational efficiency and cost-effectiveness. Moreover, the AI system's recommendations should align with sustainable energy goals.

Human operator

- Procedures and operation policies that define
  - Critical boundaries, i.e. events that must be avoided (blackout or electrocution).
  - Conditions to be met by the actions, e.g., a given time must be respected between actions on a given line, and changes in generation are limited by ramp-up/down constraints.
- The human operator's decision-making authority is a significant asset. The AI system should complement human expertise.
- The integration of AI may require additional training for human operators.
- The AI system should aim to alleviate the human operator's workload rather than exacerbate it.
- The integration of AI can present opportunities for professional growth.

Transmission Grid users

- Depend on a reliable power supply, and the AI system must contribute to maintaining grid reliability.
- Sensitive to energy costs, and the AI system's impact on grid operations should aim to optimize efficiency and minimize operational costs.
- Expect transparency in grid operations.

Market Participants

The AI system's decisions should not favor specific producers unfairly, ensuring a level playing field in the energy market and promoting fair competition.

System's threats and vulnerabilities

Planned and unexpected outage events: The planned maintenance of the power grid implies that some lines are switched off for some (fixed) duration to allow their maintenance in safe conditions. Even if these events are planned and thus known in advance, they a) degrade the transmission grid's security state and b) increase the probability of damage to the grid device (e.g., the circuit breaker used to switch back on the line). Planned events can also include regular maneuvers on grid devices to check their operating status. Grid operation can be affected by events related to equipment failures on the network (e.g., unplanned line tripping) due to aging or extreme weather events or by cyber-attacks that can disconnect the grid's equipment. Both events are external to the AI system and can increase the complexity of the solutions to solve the technical problems. The AI system will be more "exposed" to operating conditions, and the human operator will demand faster and more accurate recommendations.

Dependency of external systems

1) Forecasting system: The uncertainty of forecasts over a look-ahead horizon is intrinsically part of the base decision-making problem (or "MDP" for Markov Decision Process, which defines the environments with states and states transitions), and, therefore, part of this use case. There are several sources of uncertainty, such as weather forecast errors, interpolation errors for higher temporal resolution, or elasticity of demand to market prices. Thus, the AI-assist will make decisions under forecast uncertainty (i.e., forecast errors), which can impact its performance (e.g., generate false alarms) and require expensive corrective actions with forecast updates.

2) SCADA measurements: Reliance on SCADA data quality and availability in terms of nodal injections and current grid topology, which introduces vulnerabilities if those sources are compromised or unavailable.

Adversarial data attacks: Malicious actors might attempt to manipulate the AI system by introducing misleading data or injecting false information into the recommendation process, e.g., feeding deceptive information about the state of a particular grid node, causing it to recommend inefficient solutions or worsening congestion; or, injection of a sequence of false information to flood the human with requests during peak grid operation times.

Trust from human operators: The operational performance of the AI assistant will not be close to 100% of problems solved, which may hinder the confidence and trust of the human operator in the AI recommendations. This will introduce a negative cognitive bias in humans.

Progressive deviation of environment behavior: Not only can the system conditions evolve (production type, consumption pattern, etc.), but also the operational rules, the human operators' behavior, or other applicable regulation. This can progressively alter the efficiency of the AI assistant if it is not regularly "updated". The issue can be exacerbated by the fact that such changes happen very incrementally in time.

A mismatch between AI training and deployment: Related to UC2. Power Grid *"Sim2Real, transfer from simulation to real-world"*, where significant differences exist between the digital environment used to train the AI model and the real operating conditions. This could lead to low robustness and poor performance during execution, e.g., recommendations based on inaccurate assumptions about grid observability and controllable resources.

1.5 Key performance indicators (KPI)

Provide as much details as possible

Name	*Description*	*Reference to the mentioned use case objectives*
Total operational cost	It is based on the cost of operations of a power grid that includes the cost of a blackout[1], the cost of	Objectives: 1

[1] calculated by multiplying the remaining electricity to be supplied by the market price of electricity.

Name	Description	Reference to the mentioned use case objectives
	energy losses on the grid[2], and the cost of remedial actions[3]. In order to simplify the computation, and without hindering future improvements, it is proposed to define it as a vector, whose dimensions represent different units. At least: • Number of real time topological actions (switching actions, etc.) • Number of redispatching actions (including but not limited to storage) • Number of RES curtailment action • Immediate Financial costs • Long term financial costs (e.g. indirect costs due to lifetime decay of circuit breakers) *Nota: The cost of AI system execution is not evaluated here, see requirement E-2*	
Assistant alert accuracy	It is based on the number of times the AI assistant agent is right about its confidence ahead of time to handle some contingencies. Moreover, a confusion matrix can be calculated to show: • True positive cases: forecast alarms were raised by the AI assistant and the problem did occur on the transmission grid, • False positive cases: forecast alarms were raised by the AI assistant, but no problem occurred on the transmission grid, • False negative cases: no forecast alarm was raised by the AI assistant, but problems occurred on the transmission grid.	Objectives: 3, 4
Assistant relevance	It is based on an evaluation by the human operator of the relevance of action recommendations provided by the AI assistant and measured by the number of recommendations from AI assistant effectively used by the human operator. It ranges in [0, 100] with: • 0 meaning that no action recommendation from the AI assistant was considered useful by the human operator, • 100 that all action recommendations from the AI assistant were considered useful by the human operator. The KPI can have values different from 0 and 100 if only a part of action recommendations from the AI assistant was used by the human operator.	Objectives: 4
Assistant disturbance	It aims at measuring if the notifications raised by the AI assistant are disturbing the activity of the human operator. For each notification, the score ranges in [0, 5] with: • 0 meaning that the notification was not considered disturbing at all by the human operator, • 5 meaning that the notification was considered as fully disturbing by the human operator.	Objectives: 3

[2] determined by multiplying the energy volume lost due to the Joule effect by the market price of electricity.
[3] the sum of expenses incurred by the actions using flexibilities (e.g. balancing products, curtailment or redispatching), based on the energy volume and underlying flexibility cost.

Name	Description	Reference to the mentioned use case objectives
Workload	It is based on a workload assessment of the AI assistant by the human operators. It shall be determined according to the NASA-TLX[4] methodology or similar[5].	Objectives: 3
Total decision time	It is based on the time needed to decide overall, thus including the respective time taken by AI assistant and human operator. This KPI can be detailed in a way that allow distinguishing specifically the time needed by the AI assistant to provide a recommendation.	Objectives: 3, 4
Carbon intensity	It is based on the overall carbon intensity of the action recommendation, calculated as follows: • The amount of energy curtailed (or decreased following redispatching action) is split according to generation type with a negative sign • The amount of additional energy yield by redispatching action is split according to generation type with a positive sign • The netted amount of energy E_i (MWh) is calculated per generation type *i* • Each amount E_i is multiplied by the corresponding emission factor (kgCO2/MWh) F_i • The score is then calculated as: $\frac{\sum_i E_i \times F_i}{\sum_i E_i}$	Objectives: 2

1.6 Standardization opportunities and requirements

Classification Information
Relation to existing standards
ISO/IEC 23894:2023, Information technology — Artificial intelligence — Guidance on risk management. Operating the power grid is a high-stakes task, and therefore, risk management specifically related to AI is fundamental. This standard describes the principles applied to AI, risk management framework, and processes. It is intended to be used in connection (i.e., provides additional guidance for AI) with *ISO 31000:2018, Risk management – Guidelines*. *ISO/IEC 38507:2022, Information technology — Governance of IT — Governance implications of the use of artificial intelligence by organizations*. This use case aims at augmenting the human operator (not only skills and knowledge, but also its role), not replacing him, by recognizing the complementary differences between humans and AI, and leveraging them for humans. This will require an analysis of governance implications on the use of AI, namely data-driven problem-solving, and adaptive AI systems (i.e., retraining during the operational phase) to new operating conditions and/or human feedback, culture, and values with respect to stakeholders, markets, and regulation. *ISO/IEC 42001:2023, Information technology – Artificial intelligence – Management system*. This standard is the world's first AI management system standard, providing valuable guidance for this rapidly changing field of technology. It addresses the unique challenges AI poses, such as ethical considerations, transparency, and continuous learning. For organizations, it sets out a structured way to manage risks and opportunities associated with AI, balancing innovation with governance. *IEEE 7000-2021, IEEE Standard Model Process for Addressing Ethical Concerns during System Design*. This standard defines a framework for organizations to embed ethical considerations in concept exploration and development. It promotes collaboration between key stakeholders and ensures ethical values are traceable throughout the design process, impacting the operational concept, value propositions, and risk management. It is applicable to all organizations, regardless of size or life cycle model.
Standardization requirements

[4] https://humansystems.arc.nasa.gov/groups/tlx/index.php
[5] See more recent works about design recommendations to create algorithms with a positive human-agent interaction and foster a pleasant user-experience: http://hdl.handle.net/1853/61232

Application ontology that leverages agent-oriented AI recommendations to aid power grid operators in solving future problems based on past observations stored in a knowledge database. The first work in this direction was initiated in the French project CAB (Cockpit and Bidirectional Assistant), reference: Amdouni, E., Khouadjia, M., Meddeb, M., Marot, A., Crochepierre, L., Achour, W. (2023, April). Grid2Onto: An application ontology for knowledge capitalisation to assist power grid operators. In International Conference On Formal Ontology in Information Systems-Ontology showcases and Demos.

In other domains of the energy sector, a good example on the use of ontologies is the Smart Applications REFerence (SAREF) ontology, a family of standards that enables interoperability between solutions from different providers and among various activity sectors on the Internet of Things and therefore contributes to the development of the global digital market.

1.8 Societal concerns

Societal concerns
Description
Integration of renewable energy sources (RES): Enable higher integration levels of RES and decarbonization of the economy, while maintaining (or improving) the reliability and resilience of the electric power system. **Resilience to extreme (natural or man-made) events:** Climate change is increasing the fragility of the power grid, as well as impacting the power produced by RES. Also, the digitalization of energy systems brings additional cybersecurity concerns to TSOs. These extreme events and cyber threats have not traditionally been considered in reliability standards, which typically consider reasonably probable events and neglect very improbable situations. Presently, power systems might not be sufficiently resilient to high-impact-low-probability events, which are becoming more probable. **Degree of system autonomy:** The power grid is a critical infrastructure impacting the economy, the safety of other infrastructures, and the comfort of humans. Therefore, the type of action space is relevant, in particular if AI is providing recommendations or direct action in the environment. Furthermore, the human operator's sole ability to operate the grid and associated knowledge shall not be hampered by the AI assistant and should, on the contrary, improve thanks to interaction with the AI assistant (deskilling must be avoided). **Supervision:** Presence of external supervision and regulator conformity assessment. **Explainability and transparency**: the human operator shall be able to understand the ground basis of action recommendations provided by the AI assistant.
Sustainable Development Goals (SGD) to be achieved
SGD7. Affordable and clean energy / SGD13. Climate action

2 Step-by-step analysis of use case

2.1 Overview of scenarios

Scenario conditions					
No.	**Scenario name**	**Scenario description**	**Triggering event**	**Pre-condition**	**Post-condition**
1	Preventive action to grant N or N-1 situation security	The AI assistant raises warnings by anticipation to the human operator and provides associated action recommendations. *Note: a sub-scenario could address the case where the AI assistant can't provide any relevant preventive action and makes this clear to the human operator, see UC2.Sim2Real.*	There is a chance that the system security is not ensured at the forecasted horizon in N or N-1 situation (for a specific case that could arise) if no action is performed. Thus, the AI assistant proposes actions to the operator.	The AI assistant is continuously checking that the transmission grid security is ensured at the appropriate horizons (e.g. from few hours ahead down to 30-min ahead) when considering list of contingencies defined in the operational policies of the TSO. The transmission grid state (and corresponding security assessment) is forecasted. The Grid system is in normal situation, there is no contingency (unexpected event on the grid) and N/N-1 situations are secured.	The human operator chooses one of the recommendations provided by the AI assistant. The transmission grid goes in the state as predicted by the AI-assistant, which informs the human operator about the transmission grid state following the action performed.
2	Remedial action after a permanent outage	A permanent outage has occurred and puts the transmission grid security at risk, the AI assistant provide remedial actions recommendations to the human operator.	A permanent outage has occurred.	See scenario 1.	See scenario 1.
3	Preventive action to prepare a planned outage	Maintenance operations are regularly scheduled on the grid. The AI assistant shall take this event into account and provide action to ensure grid security if needed.	Maintenance operations are regularly scheduled on the grid.	An outage is planned.	See scenario 1.

Scenario conditions					
No.	Scenario name	Scenario description	Triggering event	Pre-condition	Post-condition
4	Human operator feedback learning	The AI assistant updates its list of recommendations with actions that were performed by the human operator.at	The same triggering event with the same pre-condition as for scenarios 1, 2 or 3 are re-run.	In one of the scenarios 1, 2 or 3, the human operator has decided to go with a different action than the one(s) recommended by the AI-assistant ("overriding"). After the facts, this action is evaluated as the most efficient one in comparison to the recommendation from the AI assistant.	The AI-assistant provides one or several action recommendations to the human operator in one of the scenarios 1, 2 or 3. In this context, the AI assistant considers the different choice previously made by the human operator ("overriding").
5	AI assistant feedback learning	The AI-assistant provides feedback to the human operators on his/her actions.	The same triggering event with the same pre-condition as for scenarios 1, 2 or 3 are re-run.	The AI assistant considers that the action chosen by the human operator was not the most relevant one: • Either it was not the recommended one, • Or after the facts, this action is evaluated as less efficient in comparison to the recommendation from the AI assistant.	The human operator considers the feedback provided.

3 Requirements

Requirements		
Categories ID	**Category name for requirements**	**Category description**
Ro	Robustness	Encompasses both its technical robustness (ability of a system to maintain its level of performance under a variety of circumstances) as well as its robustness from a social perspective (ensuring that the AI system duly takes into account the context and environment in which the system operates). This is crucial to ensure that, even with good intentions, no unintentional harm can occur. *Source: EU-U.S. Terminology and Taxonomy for Artificial Intelligence. First Edition*
E	Efficiency	Ability of an AI system to achieve its goals or perform its tasks with optimal use of resources, including time, computational power, and data.
I	Interpretability	Make the behavior and predictions of AI systems understandable to humans, i.e., degree to which a human can understand the cause of a decision. *Source: Molnar, Christoph. Interpretable machine learning. Lulu. com, 2020.*
Re	Regulatory and legal	The AI system's capacity to meet its objectives while complying with relevant laws, regulations, and ethical standards.
Requirement R-ID	**Requirement name**	**Requirement description**
Ro-1	Grid security	The AI assistant monitors all the contingency list and recommends valid actions only taking into account all relevant operational constraints.
Ro-2	Confidence	Confidence of the recommendation is given by the AI assistant: Is the event really “well known” by the model thanks to its training? or is it out of distribution, and then few or no relevant recommendation can be given. The AI assistant shall indicate its confidence in the effectiveness and robustness of its recommendations, with clear information, such as green, orange, or red indicators.
Ro-3	Fault tolerance	The system must not impair grid operation even in the instance of failures and malfunctions of the AI system. This entails having well-defined, tested, and efficient fallback scenarios in place.
Ro-4	Reproducibility	All recommendations made by the AI system must be reproducible at a later point, given the same input. While the actions recommended by the system do not need to be identical in a strict mathematical sense - acknowledging the variability inherent in distributed computing environments - they should be closely aligned and functionally equivalent, ensuring reliable and predictable outcomes under similar conditions.
Ro-5	Adaptability	The system should be able to adapt to different scenarios or operational conditions without significant degradation in performance. The scenarios considered are related to the training examples, but particularly challenging.
RO-6	Cybersecurity	The AI assistant shouldn’t increase overall cybersecurity risk level for system. It must be closed to adversarial attacks coming from external parties so that no control is taken on information provided to the human operator. It must also be designed in a way that prevents any communication with commands of grid components (e.g. opening of circuit breakers).
E-1	Relevance	The AI assistant becomes confident most of the time in its ability to propose relevant recommendations to solve situations and limits its number of warnings towards the human operator to help him focus its attention.

E-2	Computational efficiency	The AI system must be designed to ensure efficient training and inference capabilities on a range of computer hardware, from small-scale development setups with limited processing power to configurations involving multiple servers and multiple GPUs.
E-3	Scalability	The AI system's training and inference methodology and algorithms must be designed to scale up for applications in large networks.
I-1	Action rating (Traceability)	Frame recommendations into different scenarios/strategies, and rate these scenarios based on their consequences, e.g. identify a "robust" strategy that could work in all cases, or a "no regret" strategy.
I-2	Transparency	The AI system must exhibit a high level of transparency in its decision-making processes. This necessitates that documentation on the system's training data, training methods and scenarios is available and understandable to relevant stakeholders.
I-3	Explainability	The assistant, recognizing the current limitations in direct explainability of reinforcement learning decisions, must be capable of providing comprehensive analysis to support its recommendations. This could be achieved by leveraging the simulator to demonstrate and compare the outcomes of various strategies and evaluate the proposed recommendations against predefined criteria (KPIs, or other criteria corresponding to human operator's needs).
I-1	Level of interaction	Each operator has its own preferences (e.g. one operator can be more risk averse than others): ideally, the AI assistant interacting with a given operator could provide decision support that fits the preferences of this operator, but not necessary of another, especially given the type of situation that can require more attention. So the AI system shall be able to interact more or less with the human operator according to his/her preferences : • Fully manual • Get notified every time an overload is detected • Only get notified when AI assistant is not confident enough
Re-1	Compliance	Recommendations from the AI assistant is compliant with operational policies.
Re-2	European AI Act	The AI system must be prepared for compliance with the regulations and standards stipulated in the European AI Act. This compliance involves adhering to the defined requirements for transparency, safety, data governance, and accountability.

4 Common Terms and Definitions

Common Terms and Definitions	
Term	**Definition**
TSO – Transmission System Operator	A natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity. Source: Directive 2009/72/EC and ENTSOE glossary
SCADA - Supervisory Control And Data Acquisition	System of different hardware and software elements that come together to enable a power grid operator to monitor and control various components of a power system in real-time, such as generators, transformers, and transmission lines.
EMS – Energy Management System	Optimal control center solution to enable secure, efficient, and optimized operation of the electric power system.
Nominal grid ("N" situation)	Network operating condition where all grid elements are available
Contingency ("N-1" situation)	Electric system's state after the loss of one grid element, and possibly several grid elements depending on the TSO's policy

Load (or power) flow calculation	Calculations used to determine the voltage, current, and real and reactive power at various points in a power system under steady-state conditions.