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Request for Proposal (RFP) – Research challenge on digitalization of system operations

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0. Executive summary

Digitalization and cutting-edge research are decisive to address current and emerging challenges of system operations in the control room of grid operators with high shares of variable, renewable energy sources.
To address these challenges, more and new software capabilities, greater automation and enhanced functionalities are required to manage and ensure stability in the systems.

Regarding research, new and agile methods of cooperation between research and grid operators are needed to enhance development cycles and increase speed of R&D to operation Therefore, we are launching a 12-month research challenge. The objective of the challenge is to provide the right environment to develop testable tools such as software and models with a concept for industrialization.

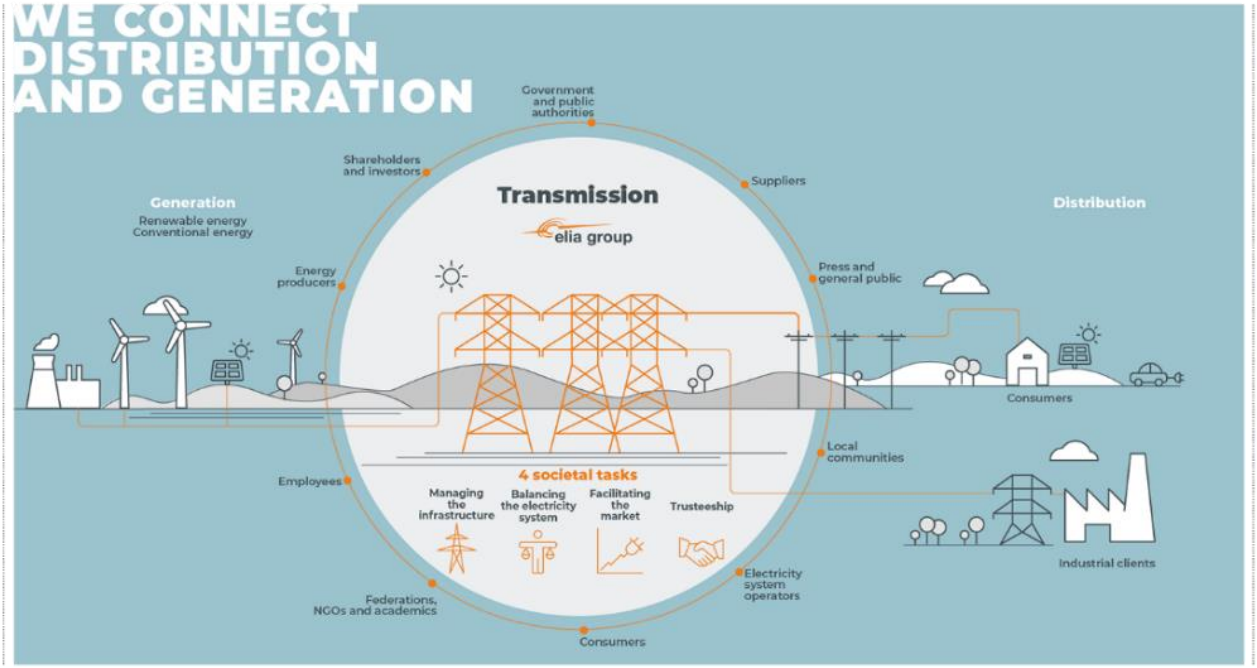
The research questions are around the topics of

1. Grid Monitoring
    a. How to design predictive analytics and ML to enable proactive alarm management?
    b. How to design a power system simulator and the corresponding communication interface to effectively test key functionalities (end-to-end) of a modular control system?
2. Grid Control
    a. How do we integrate impedance frequency scans into system operations ?
3. Grid Data
    a. How to aggregate and estimate distribution systems for dynamic security assessments ?
4. Grid Analysis
    a. How can we speed up the solution of large batches of similar loadflow computations?
    b. How can we in Modelica express and design a simplified model representation from a black box model (dll) given an interface and an accepted error tolerance?
5. Grid Forecasting:
    a. How would you create an incompressibility & adequacy risk indicator for system operations?
    b. How to use uncertainties in weather forecasts to predict uncertainties in AC load flow calculations?

1. Background, challenges and digital context

1.1 Background

As Transmission System Operators (TSOs), we provide society with a robust power grid, with a reliability level of 99.99%, which is important for socio-economic prosperity. We also aspire to be a catalyst for a successful energy transition, helping to establish a reliable, sustainable, and affordable energy system by planning, building, operating and maintaining the transmission infrastructure.



1.2 Challenges

The transformation of the energy system requires more and better integration of renewable energy sources. With the integration of these variable energy sources, the system becomes more complex and dynamic. Therefore, the control room must be able to collect, process and react to more information at a higher speed to ensure the reliability, performance, and affordability of the system.

Among other issues, the challenges entail:

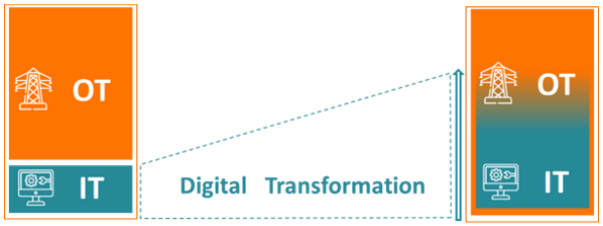
- dealing with increasingly measurable and controllable units as well as rapidly growing amounts of data;
- managing the increasing need for system and grid monitoring and control as well as support in decision-making;
- dealing with the higher volume of events and actions in the electrical system;

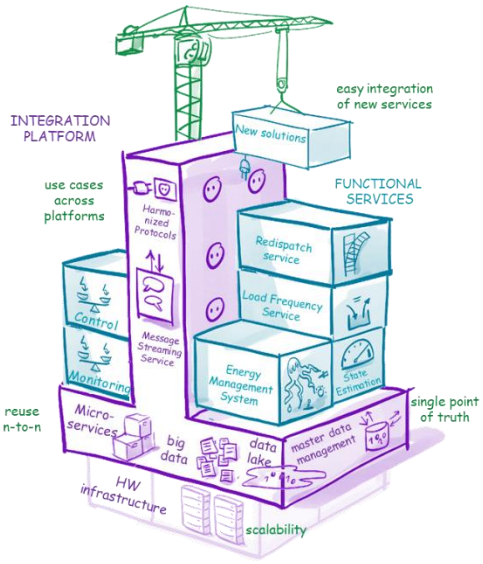
- considering the implementation of national and European regulation as well as the necessity for stronger coordination between market and grid.

1.3 Digital Context

To address the above-mentioned challenges, more and new software capabilities, greater automation and enhanced functionalities are required. In practice, a modular platform (decoupling functional modules from platforms) that enables interoperable “plug&play” of functional modules with other platforms enhances flexibility, adaptability, and scalability over time.

To achieve that, TSOs (such as Elia Group and Energinet) and other stakeholder have started to develop new systems such as the Modular Control Center System (www.mccs.com). The interoperability between these functional platforms provides a foundation to build new modular solutions (functional modules) for existing and upcoming challenges.





2. The Research Challenge

As we have entered a new and digital stage of the energy transition, we will also need a new and digital model of collaboration between researchers and grid operators.

The research challenge aims build this bridge by proposing an agile approach of cooperation between researchers and grid operators. To do so, it provides specific research questions with the goal to produce testable products such as software code or models in the timeframe of 12 months.

2.1 The Research Questions

1. Grid Monitoring
    a. **How to design predictive analytics and ML to enable proactive alarm management?**
        i. What is the challenge for us as system operators?
            - The electrical grid is becoming more complex. This means that also the number and specificity of alarms is increasing. In case of unexpected events, operators are flooded with alarms. Even though, they need to be able to understand each single alarm, connect the dots and identify the root cause, keep calm and prioritize the steps they take to solve the situation.

        ii. What happens if it doesn't get solved?
            - We will soon reach the point where even the most experienced operators will have difficulty working with a large number of alarms, especially in unexpected events/situations. This may lead to errors.

        iii. How is currently been treated/ What has been done so far?
            - Product teams and business teams see the need to aggregate related alarm messages, to support operators with root cause identification and even go into the direction of recommended operator actions based on AI. However, none of these aspects have yet been implemented.

    b. **How to design a power system simulator and the corresponding communication interface to effectively test key functionalities (end-to-end) of a modular control system?**
        i. What is the challenge for us as system operators?
            - In system operations, we need to ensure that our control center software is highly reliable, consistent, secure and performant. It is a core component of our critical infrastructure and in any given grid situation, we have to guarantee that our software is functioning as expected.

            - Thus, we have to rely heavily not only on unit, service and integration tests, but especially on system-wide end-to-end and regression tests.

            - To perform system tests for control center applications, a real-time power system simulator (incl. IEC 104 protocol interface) is required. Such a simulator allows our test teams to perform holistic test plans that include complex relationships between functions (ie. interlocking conditions).

        ii. What happens if it doesn't get solved?
            - More challenges regarding tests of applications.

        iii. How is currently been treated/ What has been done so far?
            - Different methods of testing including system and integration tests.

2. Grid Control
    a. **How do we integrate impedance frequency scans into system operations?**
3. Grid Data
    a. **How to aggregate and estimate distribution systems for dynamic security assessments?**
4. Grid Analysis
    a. **How can we speed up the solution of large batches of similar loadflow computations?**
        i. What is the challenge for us as system operators?
            - With the increasing complexity in grid operations we need to become faster in simulating and optimizing different grid scenarios. This can then benefit various grid analysis calculations like Voltage / Topology / Redispatch Optimizations. Therefore we look into new approaches on how to speed-up AC. load flow calculations.

ii. What happens if it doesn't get solved?
    - We are already lacking speed today so we need to find alternative solutions. This could be done e.g. by using new methods, by sacrificing accuracy or using additional hardware.

iii. How is currently been treated/ What has been done so far?
    - During an innovation project we have developed a gpu-based DC load flow solver that is able to calculate on a single GPU around 1 billions loadflow/s on a Texas reference grid. Now we are looking into AC approaches to increase the accuracy of the load flow where you with this research question will come into play.

b. **How can we in Modelica express and design a simplified model representation from a black box model (dll) given an interface and an accepted error tolerance?**
    i. What is the challenge for us as system operations?
        - Dynamic simulations with large black box models are often too slow for near real-time execution.

    ii. What happens if it doesn't get solved?
        - Dynamic simulations run faster.

    iii. How is it currently treated? What has been so far?
        - We have black box models from vendor of power system components. These models are often built for detailed and off-line dynamic analysis and not for the purpose of near real-time dynamic simulations.

5. Grid Forecasting
    a. **How would you create an incompressibility & adequacy risk indicator for system operations?**
        i. What is the challenge for us as system operations?
            - Predicting incompressibility and adequacy situations is mostly based on our ability to predict generation and consumption of electricity. With the RES penetration, the uncertainty around the generation part is increasing. With the electrification we can anticipate that the uncertainty around the consumption will increase as well. The incompressibility/adequacy prediction is the ability to coherently consolidate the uncertainties of all underlying forecasts. Today this reconciliation is not done properly because it is not straightforward.

        ii. What happens if it doesn't get solved?
            - Current naive method is already able to identify risky situations but imperfectly. With the electrification and RES penetration the adequacy/incompressibility may increase if the system does not have sufficient flexibility. This is a financial risk for the market players generating those imbalances and an operational risk for the TSOs not being always able to solve the imbalance.

        iii. How is it currently treated? What has been done so far?
            - So far, Elia is publishing UMMs (Urgent Market Messages) to alert market players when such incompressibility and adequacy risk increases. The current way of identifying risky situations is pragmatic but does not reach proper statistical accuracy.

    b. **How to use uncertainties in weather forecasts to predict uncertainties in AC load flow calculations?**
        i. What is the challenge for us as system operations?

- As the amount of RES, especially PV, increases we see more deviations between the load flow prediction and the actual load flow. We see the need for a much closer evaluation of weather forecasts and comparison of results to establish if different models perform differently in weather scenarios. What happens if it doesn't get solved?

ii. What happens if it doesn't get solved?
- We would like to take uncertainties into account to be able to optimize the risk margins when releasing capacity to the power markets. It will also contribute to making more reliable power forecasts for the balancing purpose.

iii. How is it currently treated? What has been done so far?
- Today the uncertainties are not taken into account.

2.2 The Application Process

Institutions can apply to multiple research questions (separate applications for each question). They can apply individually or as a consortium of maximum two research institutions per research question. Three research questions will be chosen and worked on. The decision on which research questions will be worked on depends on the quality of the application and proposals that are submitted.

To apply, each research institution is required to submit the following documentation to both email addresses: innovation@eliagroup.eu & Advisory.Cooperations@50hertz.com by 09.12.2024 at 11:59 pm latest.

1. A power point presentation with maximum 10 slides presenting:
   a. WHO:
      - Clear description of expertise (past and current work) of the institution and researcher/experts that will work on the challenge. If relevant, presence and knowledge of the Belgian, German and Danish or more general the European grid. If relevant a link to a list of references of industrial projects related to the topics of this request

   b. WHY:
      - The motivation to participate in the research challenge (max. 800 words).

   c. WHAT:
      - High level plan/roadmap with expected milestones and potential final results.
      - Organization of resources in form of a project organization structure / organigram with a project manager / team lead/ Researcher / Other
      - A financial offer: Fixed rates related to roles and estimated workload in work days.

   d. HOW:

- Proposal of how to address the research question within 12-15 months including necessary information needed from the TSO.
- Description of how work can contribute to the objectives and provide deliverables. This will include a description of the internal expertise/resources available (laboratories, spin-off, PhD, …) and external partnerships if needed.

e. OTHER

- Further relevant information

2. CV's of Team/researcher to work on the challenge

3. Optionally

- Further documentation
- A 3-minute video introduction

After reviewing and evaluating the applications, researchers/institutions may be invited to an interview to present their proposal with regard to expertise, method of research and the expected outcome. The review and evaluation is based on a rolling process, so you may receive feedback before the deadline.
If selected, the institution will be provided with a budget and assigned to a respective project manager and expert. The project team of the research institution will meet with the respective project manager and expert regularly (at least once a month) to receive feedback and report on progress, blocking points and next steps.

2.3 The Timeline

- **Phase 0: Launch of challenge**, interviews, and selection of institutions (October 2024 to January 2025)
- **Phase 1: Initial research** with monthly updates (February 2025 – April 2025)
  - Overview of methodology, literature review, approach of tackling research questions and proposed path forward
- **Phase 2: Further research and set-up of testing** [testing to be defined] (April 2025 – June 2025)
- **Phase 3: Testing 1** (June 2025 – August 2025)

  Phase 4: Testing 2 (August- November)

  Phase 5: Presentation, conclusions and potential way forward (November – January 2025)

2.4 The expected outcome

The project has following goals:

1. Undertake research and write paper (e.g. on feasibility of implementation in real world) on specific research question.
2. Develop a testable tool (software) or method to test feasibility of industrialization in given environment.
3. Propose concept for industrialization.

3.General information

Without obligation ELIA

ELIA cannot be held physically or fiscally responsible for any costs whatsoever incurred by the offer or to prepare a response to this RFP.

This RFP does not constitute an irrevocable offer by ELIA, the tender does not in any way that ELIA must conclude an agreement with one Bidder and, more generally, ELIA is not binding in any way whatsoever.

Delivery of the offer

This tender is subject to the terms and conditions of purchases ELIA (version 01.09.2015), General Purchasing conditions.

Proposals must be received latest 09.12.2024 at 11:59 pm at the following email address: innovation@eliagroup.eu & Advisory.Cooperations@50hertz.com

Validity of the offer

By submission of its offer, the Bidder agrees that the offer is irrevocable and binding for the Bidder until 90 days after the RFP.