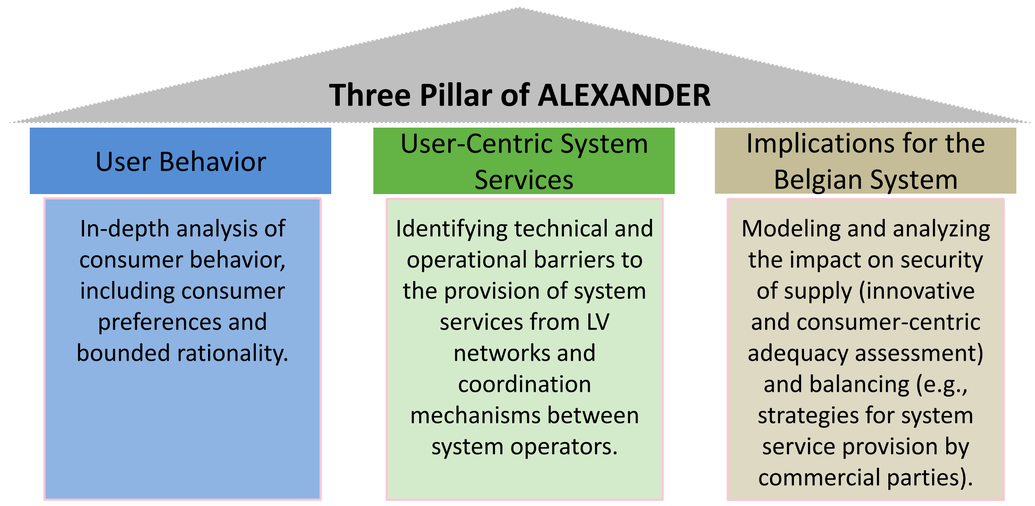
ALEXANDER – Accelerating Low Voltage Flexibility Participation in a Grid Safe Manner

Jamal Faraji, Behzad Vatandoust, Jean-François Toubeau, François Vallée, and Zacharie De Grève

* Power System & Market Research (PSMR) Group, University of Mons

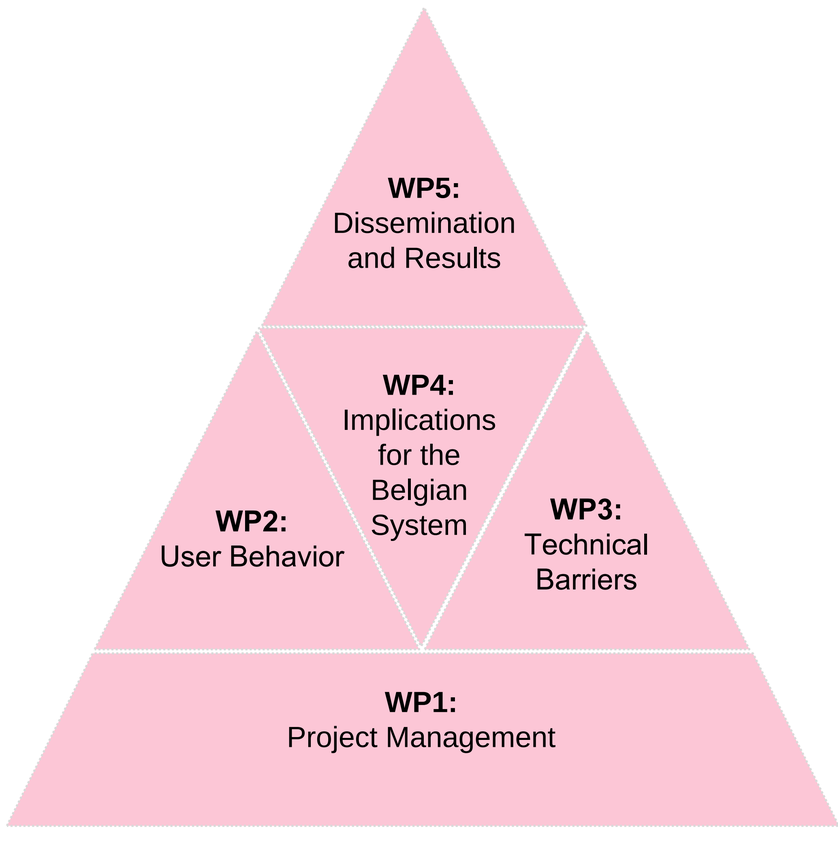
Project Overview

- ALEXANDER is an Energy Transition Funds (ETF) project that began on **November 1, 2021**, and runs until **October 31, 2025**.
- The project provides a unique opportunity for collaboration among partners from **Flanders, Brussels, and Wallonia** within a highly skilled consortium.
- ALEXANDER accelerates **innovations in concepts, models, and algorithms**, driving the adoption of **low voltage (LV) flexibility** to enable the provision of **grid-safe system services**.



Research Objectives

- **Accelerating Energy Transition:** Driving Belgium's energy system towards renewable sources (WP1-WP5).
- **Understanding User Preferences:** Analysing users' heterogeneous (economic and non-economic) preferences for energy and flexibility provision (WP2).
- **Optimizing LV Users' Flexibility:** Developing efficient methods for procuring and activating flexibility services from LV users (WP3).
- **Modeling User Behavior:** Modelling heterogeneous and bounded rational users' behavior to improve representation and exploration of the LV flexibility models (WP2, WP4).
- **Assessing Flexibility Impact:** Evaluating the effect of large-scale LV flexibility on balancing (WP4).
- **Proposing an Integrated Framework:** Developing a comprehensive framework for LV flexibility in Belgium's energy system (WP4).
- **Engaging Stakeholders:** Collaborating with relevant stakeholders (policy makers, system operators, electricity generation companies, users) to maximize project impact (WP5).



UMONS Role

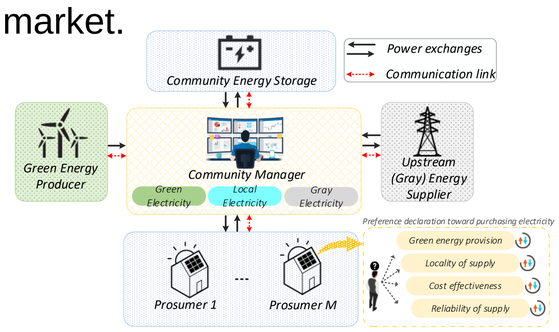
UMONS plays an important role in ALEXANDER (task leader in WP2 and leader of WP4). We are mainly focused on **unlocking the potential of energy communities in local energy and flexibility markets while considering their users' behavior**. Some key research objectives include:

I. Proposing a user-level **heterogeneous preference** measurement method and a product differentiation strategy for community energy sharing, enabling aggregators to prioritize users based on their energy supply preferences (refer to [A]).

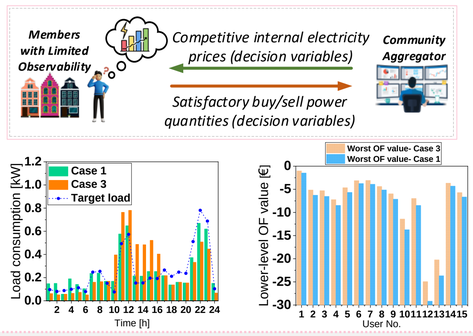
II. Modeling the **bounded rational behavior** of community users such as their limited observability into competitive internal electricity prices (refer to [B]). Additionally, we will study strategies for community aggregators to protect themselves from potential financial losses due to **near-optimal responses of community members** in real-time.

III. Investigating **how users' preferences such as comfort, financial, and environmental motives impact their flexibility provision potentials**.

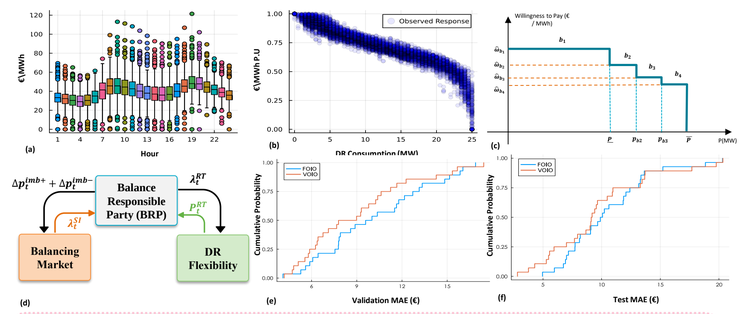
IV. Investigating the **parameterization of aggregated consumer price-response** using a value-driven Inverse Optimization framework, while accounting for uncertainties in their behavior due to **bounded rationality**. Additionally, exploring the integration of these parameters into the decision-making framework of a Balance Responsible Party (BRP) operating in the Belgian single-price imbalance market.



Respecting community users' preferences in centralized energy sharing not only promotes sustainable energy behavior by increasing the usage of green and local electricity but also increases social welfare of the community members by addressing their energy preference utilities.



Due to incomplete information, community users adopt a more conservative approach to competitive internal prices to mitigate potential real-time financial losses. This behavior results in improved social welfare, increased self-consumption, and reduced active power losses and voltage drops within the network.



Shifting parameter identification evaluation metrics from maximizing response prediction accuracy to minimizing the BRP's decision-making regret results in parameters that yield more conservative decisions on consumer incentives and balancing service activation, thereby ensuring financial viability and effective service provision.

Project Partners

Main Partners: Energy Ville, KU LEUVEN, vito (Project Leader), UMONS Université de Mons, UHASSELT, Universiteit Antwerpen, ULB

DSO Sounding Board: fluvius, ORES, Sibelga, resa

[A] J. Faraji, F. Vallée and Z. De Grève, "A Preference-Informed Energy Sharing Framework for a Renewable Energy Community," in *IEEE Transactions on Energy Markets, Policy and Regulation*, 2024.
[B] J. Faraji, J. Allard, F. Vallée and Z. De Grève, "On the Limited Observability of Energy Community Members: An Uncertainty-Aware Near-Optimal Bilevel Programming Approach," under revision in *Applied Energy*, 2024.