International Journal of Sustainable Energy Planning and Management

Adaptable user engagement strategy for utilising energy flexibility

Iliana Ilieva[a,b*], Rose Matthews[b], Paul Tobin[b], Carmen Valor[c], Valeria Karina Moreno[c], Leonor Ruiz[d]

[a] *Institute for Energy Technology, Os Alle 5, NO-1777 Halden, Norway*
[b] *Smart Innovation Norway, Håkon Melbergs vei 16, 1783, Halden, Norway*
[c] *Institute for Research in Technology, Comillas Pontifical University, Calle de Santa Cruz de Marcenado, 26 - 28015 Madrid, Spain*
[d] *Soulsight, Calle de Castelló, 34, 1º izquierda, Salamanca, 28001 Madrid, Spain*

ABSTRACT

This paper provides a comprehensive user engagement strategy for effectively involving energy users in the utilisation of flexibility resources. The strategy is composed of a set of engagement activities and practices, guided by a methodology grounded in social science principles, including actor-network theory and a hybrid collaboration approach. These methodological foundations support the design, implementation, and evaluation of the engagement process, which is tailored to enhance user recruitment, onboarding, and retention. The engagement strategy is adaptable and suggests customisation of engagements to suit different profiles. To measure the effectiveness and overall impact of the engagement activities, the strategy includes an evaluation component with proposed metrics. By applying the most suitable for the specific target group practices, the uptake of flexible energy usage can be facilitated.

Keywords

Engagement strategy;
Energy flexibility;
Actor-network theory;
Hybrid collaboration approach;
Engagement metrics

http://doi.org/10.54337/ijsepm.8521

1. Introduction

Energy flexibility enhances the efficiency and stability of the energy system by balancing supply and demand in real-time, reducing the need for costly infrastructure upgrades, and integrating renewable energy sources more effectively [1]. Flexible energy use can bring major contributions for the energy transition [2] and various energy flexibility activities have been in the focus of recent research [3, 4]. User engagement strategies for energy flexibility services reside on knowledge about the usage and relevance of certain technological solutions, behavioural insights, community belonging, regulations and innovative business models. Despite the growing relevance of energy flexibility, a persistent challenge remains: the limited participation of energy users in flexibility services. Recruitment, onboarding, and retention of users are often hindered by a combination of emotional resistance, lack of perceived value, privacy concerns, and contextual or cultural barriers. These issues are particularly pronounced in residential and small commercial segments, where users may not see sufficient incentives or may lack trust in market actors. Without addressing these engagement challenges, the potential of flexibility services cannot be fully realized. Therefore, there is a pressing need for a structured and adaptable engagement strategy that can overcome these barriers and foster sustained user involvement.

Several key trends have been shaping the approach to strategy development in the area. The incorporation of digital and smart technologies, including smart meters, home energy management systems, and Internet of Things (IoT) devices, has become central in engaging energy consumers and prosumers by offering them real-time data and control over their energy use [5]. Approaches from citizen science, as well as nudging (a framework for directing individuals towards a desired

*Corresponding author – e-mail: iliana.ilieva@ife.no

Received 18.06.2024 | Accepted 19.05.2025 | Published 10.06.2025
©The Author(s).2025 This is an Open Access article published by Aalborg University Open Publishing under a CC-BY-NC-ND 4.0 license.

behaviour) have increasingly been employed to motivate consumers and prosumers to save energy and adopt more flexible energy usage habits [6, 7]. In relation to this, demand response programs [8] have proven essential for promoting energy flexibility, providing incentives to alter energy consumption during peak demand [9]. Further, user engagement strategies have become more personalised and tailored to individual characteristics, with segmentation enabling more targeted interventions [10, 11]. Here, merging multiple services into one engagement point, by means of integrated platforms that target the right user groups and needs, is simplifying and increasing interactions with energy flexibility [12].

In addition, other factors stemming from the social environment determine the success of user engagement strategies, such as community engagement fostering collective action towards energy flexibility [13]. Other social environment factors with major impact are policies and regulations. Here, government initiatives providing the structure and incentives necessary for both utilities and energy users (consumers/prosumers) to engage with energy flexibility services are of high importance [14].

To ensure both acceptance and impact, it is crucial that continuous implementation and evaluation of feedback mechanisms for the refinement of the engagement strategies takes place and that the strategies are adaptive to the technological, social and behavioural aspects presented above. Further, as shown by [15], advanced analytics could play a key role in assessing the impact of energy flexibility related programs. The evaluation of the engagement strategies is fundamental for several purposes: to identify the most promising engagement strategies, to track project engagement progress, to report project performance and learn how to improve the performance [16]. The evaluation will help gather evidence of the effectiveness of engagement strategies and a granular understanding of in which domains and in which stages the strategies work best [17]. This understanding will, in turn, support the development of sustainable business models and more effective resource allocation. For this work, the adoption of experimental research is recommended [18–20]. Experiments allow for rigorous causality testing and are most suitable to achieve the objectives set for this research work. The differential characteristic of experiments is the identification of a treatment or experimental cause that will be manipulated and their effects observed. In our context, the treatment may be either the content of a message, a channel, a reward or even the target of the engagement strategy.

While this paper focuses on the social and behavioural aspects of user engagement, it is important to acknowledge that the successful implementation of energy flexibility also depends on overcoming technical, institutional, and financial challenges. These include the interoperability and reliability of flexibility-enabling technologies, the clarity and consistency of regulatory frameworks, and the adequacy of financial incentives. If these aspects are not properly addressed, they may lead to user frustration or unmet expectations, ultimately resulting in disengagement. Therefore, engagement strategies must be developed with an awareness of these systemic factors, ensuring that users not only understand and are motivated to participate in flexibility initiatives, but also experience reliable and rewarding outcomes.

According to [21], with regards to how consumers participate in smart grid projects, initiatives that involve consumers have two main goals: gaining a deeper knowledge of user behaviour (observing and understanding the user) and motivating and empowering consumers to become active energy users (engaging the user). This paper gathers relevant knowledge to define engagement strategies for recruiting, onboarding, and maintaining active energy users. The Actor-Network Theory (ANT) and a hybrid collaboration approach are being utilized for the purpose. The ANT helps in developing user engagement strategies for energy flexibility by emphasizing the dynamic relationships between human and non-human actors, allowing better integration of technologies, stakeholders, and user behaviours into the energy system. A hybrid collaboration approach complements this by fostering partnerships across diverse sectors and disciplines, enabling co-creation of solutions that align technological innovation with user-centric needs and preferences, enhancing acceptance and participation. Recognising the need for adaptability, the paper refers to the need for specific, locally tailored adaptations of the strategy proposed, and considers different target groups - private consumers/prosumers, public sector, businesses or industry. Such adaptations are already under development in collaboration with pilot sites within the Horizon Europe project BeFlexible, ensuring they resonate with local conditions. Considering this, the paper contributes to the scientific field by proposing a user engagement strategy composed of

adaptable and locally tailored activities and practices, supported by a methodology for their design and evaluation. This methodology integrates Actor-Network Theory and a hybrid collaboration approach to ensure the strategy is context-sensitive and responsive to the needs of different user groups.

2. Methodology

When choosing proper methodologies for the purpose of this work, a priority has been their relevance for the collection of feedback from the demo sites within the BeFlexible project. Methodologies such as ANT and hybrid collaboration approach have been found suitable for developing best practices for user engagement strategies across different energy flexibility demo sites because they focus on mapping interactions between diverse actors, including technologies, users, and institutional frameworks, to uncover context-specific drivers and barriers. The hybrid collaboration approach, in particular, facilitates cross-sectoral, interdisciplinary partnerships that integrate local insights and diverse stakeholder perspectives, allowing adaptable and scalable practices tailored to the unique socio-technical environments of each demo site. Together, these two methodologies foster comprehensive engagement strategy that reflect both technological capabilities and user-centric priorities.

The research was conducted during 2023 and 2024 as part of the Horizon Europe BeFlexible project. The methodology was applied across three demonstration sites located in Eastern, Western, and Northern Europe. The identification of actors and mapping of relationships was carried out through a combination of semi-structured interviews, participatory workshops, and document analysis. These activities were led by a research team from one of the partnering in the project organisations, in collaboration with local partners and demo site coordinators. Stakeholders involved included energy consumers, utility representatives, municipal authorities, and technology providers.

To ensure methodological consistency, a three-step ANT-based protocol was followed: (1) actor identification through stakeholder mapping workshops, (2) relationship mapping using network diagrams and dependency matrices, and (3) co-development of engagement plans through facilitated sessions. The evaluation methodology—later described in Chapter 4—has been integrated here for clarity. It is based on experimental design principles, using both between-subjects and within-subjects approaches to assess the impact of different engagement treatments (e.g., message framing, reward types, communication channels). Evaluation metrics were defined for each stage of the engagement process (recruitment, onboarding, participation, and continuance), and data were collected through a mix of digital analytics, user surveys, and manual logs maintained by demo site leaders.

2.1 Actor-network theory

The research by [22] describes ANT as a conceptual framework within the social sciences. ANT endeavours to capture the dynamics of interaction and influence among social entities, encompassing both human and non-human actors. It refers to social networks as a constellation of actors, each being of equal significance in shaping societal phenomena. Often deployed in the realm of science and technology studies, ANT scrutinises the emergence and assimilation of novel technologies. In commercial research, ANT finds application in exploring social networks that focus on the introduction and adoption of innovative products or technologies. For instance, a corporation might employ ANT to study the various actors involved in the evolution of a software product: developers, marketers, consumers, and certain stakeholders. By identifying the social networks that underpin product development and adoption, the company gains insight into the determinants of success or failure. Within this context, ANT serves as the foundation for the engagement strategies. This involves a sequential approach that includes the identification of pertinent actors and their interrelationships and dependencies as well as the formulation of tailored strategies to engage each actor effectively. The application of ANT in this work embraces a 3-step approach: identification of actors, mapping of relationships and dependencies, and development of an actor-specific engagement plan. These specific steps are presented in the Results chapter.

2.2 Hybrid collaboration approach

The hybrid collaboration approach (Figure 1) is utilised to provide a roadmap of the engagements expected to occur throughout a flexibility-focused project. This approach consists of two major components: (1) examining the top-down perspective of the

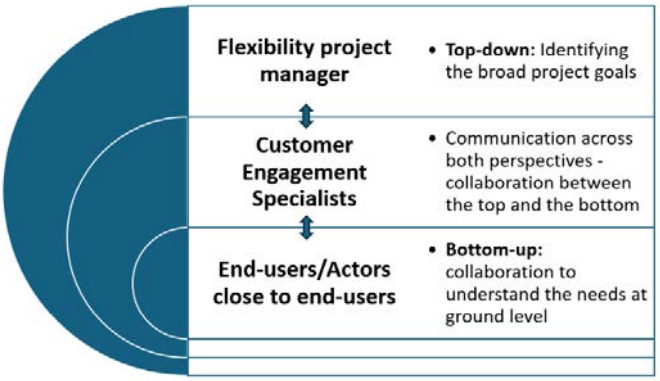

Figure 1: Key stakeholders included into the hybrid collaboration approach.

flexibility project manager; (2) gathering information from the bottom-up perspective from actors that are close to the end-users, e.g., managers of a neighbourhood. In addition to its function for planning the engagement activities, the hybrid approach fosters collaboration between the various participants to support the realisation of the flexibility initiatives, minimising the risk of working in isolation.

While the primary aim of the top-down element of the Hybrid collaboration approach is to determine the key stages at which stakeholder feedback will be required, the bottom-up aspect ensures that the perspectives and needs of stakeholders with close affiliation to the flexibility technology are considered. The hybrid collaboration approach has been applied to the 3 demo sites within the BeFlexible Project, structured by climatic areas (Eastern, Western and Northern Europe). The insights collected from the demo sites have been presented in a regionally neutral perspective, as they are considered generally valid for energy flexibility initiatives. However, reference to the locally-based conditions of importance are also provided in the Results chapter.

3. Results

To start with, the results from applying the first and second steps from the ANT are provided in sections 3.1.1 and 3.1.2. Then, in section 3.2 a detailed description of the engagement strategy proposed based on a unified application of the third step of the ANT and the hybrid collaboration approach is provided. The feedback received from the demo sites in the BeFlexibile project is considered.

3.1 Application of the ANT

ANT is particularly useful for developing user engagement strategies by identifying all relevant actors and thus ensuring comprehensive stakeholder inclusion, mapping relationships and dependencies which reveal critical interactions, and fostering more effective and targeted participation in energy flexibility initiatives.

3.1.1 Step 1: Identification of relevant actors and their roles

With reference to the research carried out within the BeFlexible project [23], key human and non-human actors involved in the flexibility piloting activities in different European regions were identified considering roles, interests, and their main focus (Table 1).

3.1.2 Step 2: Mapping actor relationships and dependencies

Once the actors and roles have been identified, a map is created to illustrate relationships and dependencies (Figure 2). It shows how actors interact with one another and how their actions influence the network. For simplicity, the actors in the map are divided into three categories: user (all types; human actors), interface (technologies and resources; non-human actors) and grid (flexibility service companies, DSOs and TSOs; both human and non-human actors). More specifically, Figure 1 shows how the different actors identified in Table 1 relate when being part of flexibility scenarios. Such mapping of relationships can be used to identify points of interaction between actors and should be considered an important reference point in relation to flexibility pilot demonstrations.

3.1.3 Step 3: Development of actor-specific engagement plan

Using the analysis from ANT's Step 1 (identification of actors) and Step 2 (mapping of relationships and dependencies) as a foundation, focus is given on the "user" profile within the actor network. Based on the understanding of roles and interests, a plan for engagement is developed. Specifically, channels, approaches and specific activities for energy users are defined. This engagement strategy benefits from using ANT by providing a holistic understanding of the energy sector, addressing power dynamics, leveraging non-human actors, and enabling adaptability. ANT challenges the traditional understanding of agency and power in social interactions. By considering both human and

Table 1: List of human and non-human actors. Inspired by [24].

Human Actors	**Role**
Energy consumers (residential, commercial, industrial, public)	Need reliable and affordable energy supply. Influence the market through their choices. Collective demand and feedback shape the energy market and can drive changes in energy policies and practices.
Energy producers	Generate and supply energy to the market while ensuring profitability. Ability to influence energy prices, production methods, and the overall energy mix through their investment decisions, technological advancements, and market strategies.
Energy suppliers (utility companies, energy retailers, aggregators)	Supply energy to end-users. Their interests involve maintaining a stable supply, competitive pricing and service. Can influence end-user prices, engagement initiatives, and the development of new services.
Regulators and policymakers	Responsible for setting policies, regulations, and standards to ensure safe, reliable, and sustainable functioning of the energy market. Cater for energy security, promoting competition, reducing environmental impact, and protecting consumer rights. Have significant influence through defining market rules, granting licenses, and enforcing compliance with regulations.
Electricity grid operators	Responsible for the operation and maintenance of power transmission and distribution infrastructure. Ensure grid reliability, manage grid congestion, integrate renewable energy sources, and promote grid resilience. Focus on grid management, connection processes, and investment decisions related to infrastructure.
Energy industry associations	Represent various stakeholders in the energy sector, advocating for their members' interests. Foster collaboration, knowledge sharing and policy advocacy. Have influence through their collective voice, lobbying efforts, and involvement in industry consultations and decision-making processes.
Energy consultants and experts	Provide specialised knowledge and advice on energy-related issues. Offer expertise in areas such as energy efficiency, renewable energy integration and regulatory compliance. Influence decision-making processes by providing insights, conducting studies and supporting project implementation.
Researchers and academics	Contribute to the energy sector through scientific inquiries, analysis and innovation. Focus on advancing knowledge, exploring new technologies and addressing challenges. Influence the sector through research findings, recommendations and collaboration with industry and policymakers.
Energy workforce (engineers, technicians, project managers, administrative staff)	Interests involve career development, job security and workplace safety. Impact the sector through their expertise, operational efficiency and implementation of projects.
Non-Human Actors	**Role**
Energy infrastructure, (electricity grids, gas pipelines)	Target reliable energy supply, facilitation of energy transmission and distribution, and minimisation of transmission losses. Importance for the overall energy system, as it determines the capacity, efficiency, and accessibility of energy.
Energy technologies (generation, smart meters, storage (batteries), heating and cooling, electric transport)	Advance energy production, efficiency, and sustainability. Enable the integration of renewable energy sources, optimising energy consumption, and enhancing the overall performance of the energy system. Shape the energy landscape by providing new possibilities for energy generation, management, and control.
Energy data and analytics (tools for data collection, tools for data analysis, utilisation of energy-related data)	Improve decision-making, optimising energy usage, and enabling predictive capabilities. Give data-driven insights, enabling energy providers and consumers to make informed choices, manage energy demand and improve operational efficiency. Crucial role in facilitating the transition to a more data-driven and intelligent energy system.
Energy policies and regulations	Designed to guide and govern the energy sector. Revolve around ensuring energy security, promoting renewable energy deployment, reducing carbon emissions and protecting consumer rights. Shape the legal and regulatory framework, defining market rules and establishing incentives and penalties to drive desired outcomes.
Energy standards and certifications	Ensure quality, efficiency, and safety in energy-related products, services and processes. Promote energy efficiency, environmental sustainability and interoperability. Set benchmarks, establish guidelines and encourage the adoption of best practices.
Financial mechanisms (e.g., subsidies, grants, carbon taxes and prices)	Incentivise sustainable energy practices, attract investments and drive the transition to a low-carbon economy. Provide financial support, shape investment decisions and influence market behaviour.

Contd...

Contd...

Non-Human Actors	Role
Market platforms (spot/future/ balancing markets, energy trading platforms)	Facilitate energy trading, price clearing, and market efficiency. Provide a platform for market activities, enable transparency, and foster competition and innovation.
Environmental factors (e.g., sunlight, wind)	Affect energy generation, availability and environmental impact. Determine the availability of renewable resources, driving the deployment of specific energy technologies.

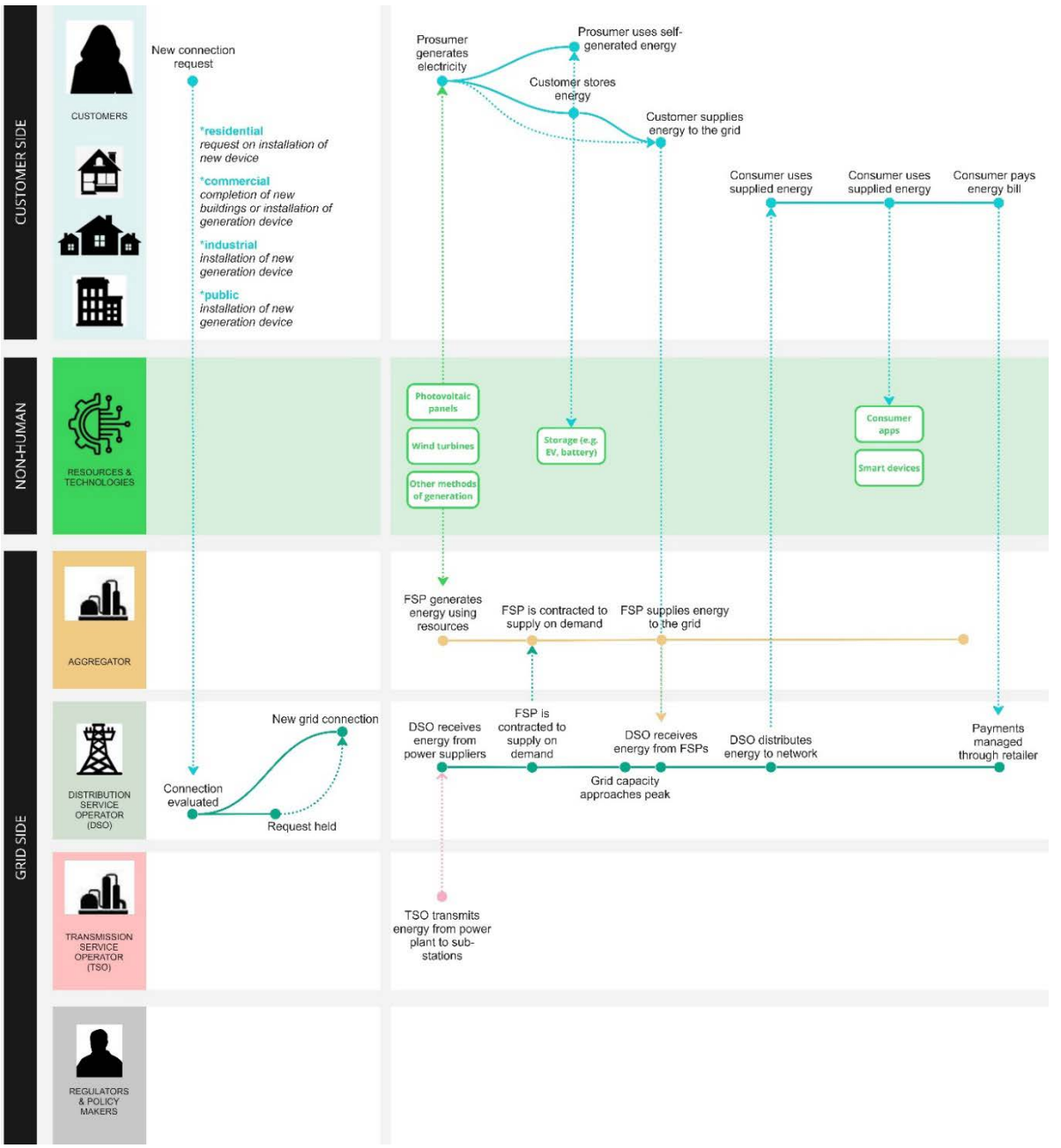

Figure 2: Illustrative map of the network actor relationships.

non-human actors as equal participants, the engagement strategy can address power dynamics and promote a more balanced distribution of influences. ANT recognises that networks are dynamic and constantly evolving. By adopting this perspective, the engagement strategy can be flexible and adaptable to changing circumstances within the energy sector. It allows for continuous monitoring, evaluation and adjustment based on emerging actors, technologies and market conditions. This iterative approach ensures that the strategy remains relevant and effective in achieving its objectives.

3.2 Engagement strategy

In this section a core engagement strategy to be applied as a starting point for conducting engagement activities is set with the help of both ANT and the hybrid collaboration approach. The strategy is adjusted to socio-cultural conditions, local energy users, and technical or regulatory requirements and tested with stakeholders in participatory workshops and individual validation sessions to refine and iterate the proposals. From the application of the hybrid collaboration process in the BeFlexible project [24], the components (representing key practices) of the engagement

Table 2: Components in the engagement process in energy flexibility-focused projects.

Component	Description
Incentives and benefits	Attractive incentives and benefits should be provided to energy users who participate in flexibility initiatives – e.g., financial incentives, access to new technologies or services, preferential energy tariffs, or other rewards that align with the energy users' interests and motivations.
Education and awareness	By means of campaigns and educational initiatives potential energy users can be informed about the initiative's objectives, benefits, and the importance of their participation. The potential positive impact on the energy transition and the environment can be emphasised to create a sense of purpose and motivation. Workshops and other communication methods can be employed at every stage of the energy user engagement timeline.
Continuous feedback and support	A feedback loop with recruited energy users can be established to address any issues or concerns they may have during the implementation phase. The provision of ongoing support, regular updates, and open channels of communication can further ensure a positive experience and maintain engagement.
Evaluation and refinement	A continuous evaluation of the effectiveness of the recruitment strategies and methodologies, refinement based on the feedback received and adaption of the approaches can help optimise user recruitment and maximise participation rates.
Timeline	The engagement strategy should be set out according to the stages of engagement, which can be flexibly implemented in line with the individual flexibility initiative needs.

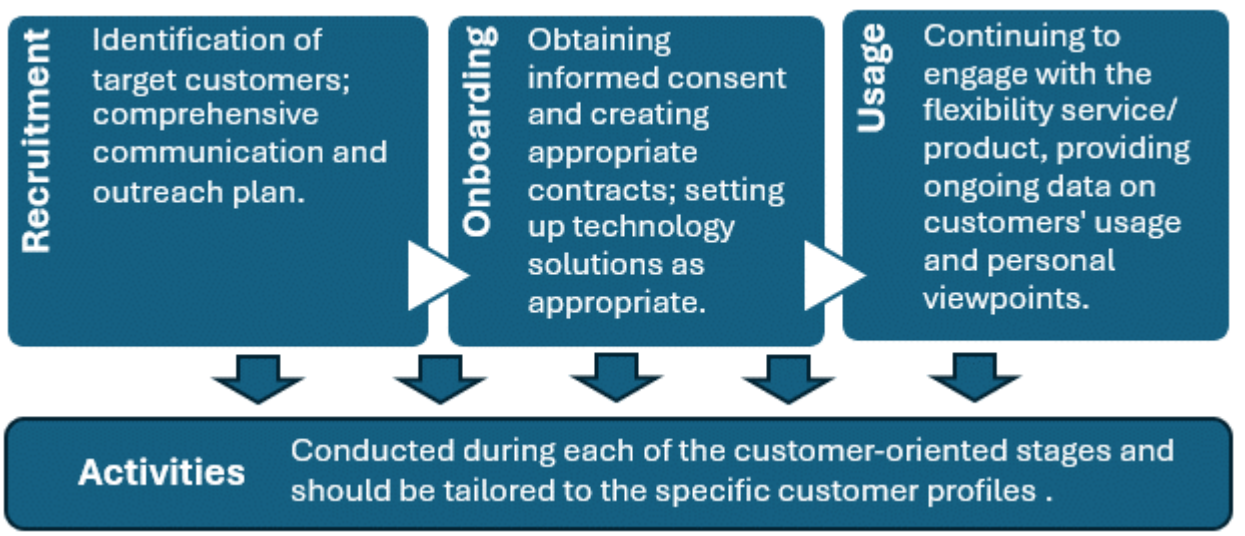

Figure 3: Stages in the engagement process, comprised of activities.

Table 3: Activities relevant for different stages in the engagement process.

Stage	Activity	Description
Recruitment	Awareness campaigns	Aim to inform and educate potential participants about the benefits and opportunities associated with engaging in energy flexibility initiatives.
	Demonstration events	Events where potential userss can experience the technologies and services firsthand. May include interactive stations (where users can explore different functionalities and ask questions), guided tours, live demonstrations, and opportunities for energy users to engage with project team members and other participants.
	Recruitment workshops	Primary aim is to ask consumers to sign up to the flexibility initiative, which can be achieved by providing appealing information.
Onboarding	Onboarding workshops	Provide comprehensive training and support to the recruited energy users. Can cover topics related to system functionalities, data monitoring, energy optimisation techniques, and platform navigation. Offer hands-on activities and demonstrations to ensure energy users are comfortable with the technologies and processes.
	Co-design workshops	Events where energy users can actively contribute to the development of new features, services, or solutions, and engage in brainstorming sessions, prototype testing, and collaborative problem-solving exercises. The participatory approach empowers energy users to shape the flexibility-related activities and fosters a sense of ownership and investment.
	Webinars and online tutorials	Activities that supplement the onboarding process. May include offering virtual training sessions and video tutorials that energy users can access at their convenience. Cover topics such as platform navigation, energy management tips, and troubleshooting. Provide opportunities for energy users to ask questions and seek clarifications.
Usage	Webinars and online tutorials	Same as above.
	User testing and feedback sessions	Include regular user testing and feedback sessions to gather insights on the onboarding process. Energy users can be invited to test the platforms, technologies, and services. Users' feedback on usability, clarity, and overall experience should be collected and used to improve and refine the onboarding process iteratively.
	Gamification challenges	Used to increase energy user engagement and motivation by means of challenges or competitions that encourage energy users to actively participate and achieve specific goals. May include rewards or incentives for reaching milestones or demonstrating exceptional energy optimisation practices.
	User support channels	This activity aims to address any questions, concerns, or technical issues that energy users may encounter during the onboarding process. It can be facilitated through multiple communication channels – e.g., email, phone, and chat support. Prompt and helpful responses to user inquiries should be ensured to enhance their overall experience.
	User feedback surveys	Used to gather insights on energy users' onboarding experience and satisfaction. Should pose targeted questions about the clarity of information, ease of platform use, training effectiveness, and overall contentment from participating in the flexibility initiative. The feedback received should be analysed, making necessary adjustments to improve the onboarding process.

process are identified and will be used in the methodology (Table 2). These components reflect the collective insights gathered from demo site partners and stakeholders during participatory planning and validation sessions.

In this strategy, we distinguish between practices and activities. Practices refer to the overarching engagement principles that guide the strategy—such as providing incentives, ensuring continuous feedback, or fostering education and awareness. Activities, on the other hand, are the specific actions or interventions that operationalise these practices, such as webinars, co-design workshops, or gamification challenges. Table 2 refers to some core practices identified through the BeFlexible project, while Table 3 outlines the corresponding activities aligned with each stage of the

engagement process. Further on, the stages of engagement can be presented through a four-part process (Figure 3):

Examples of the activities to be carried out within the engagement process stages are provided in Table 3. The activities were identified through a triangulated process. First, participatory workshops and co-design sessions conducted within the BeFlexible project provided practical insights into user preferences and engagement barriers. Second, the actor-specific engagement plans developed through the application of ANT (Section 3.1.3) informed the tailoring of activities to different user types. Finally, the hybrid collaboration approach ensured that both top-down strategic goals and bottom-up user needs were reflected in the final selection of activities.

The selection of activities that are decisive for an adaptive engagement strategy took into account the following: the participatory workshops and feedback sessions conducted across the BeFlexible demo sites highlighted which activities generated the highest levels of user interest, participation, and satisfaction; the application of ANT helped identify critical points of interaction between users and other actors in the flexibility ecosystem, where engagement interventions would be most effective. the hybrid collaboration approach ensured that both top-down strategic priorities and bottom-up user needs were considered. Through this process, awareness campaigns, gamification challenges, and co-design workshops emerged as the most versatile and impactful activities for fostering adaptive and context-sensitive engagement. Thus, these three activities are elaborated upon below.

Awareness campaigns for pilot recruitment serve the primary function of informing and educating potential participants about the benefits and opportunities associated with engaging in energy flexibility pilots. These campaigns are designed to generate interest, emphasising advantages like cost savings, enhanced energy efficiency, and environmental sustainability to attract the attention of target users. Further, such campaigns communicate the significance of the flexibility initiative in shaping the future of the energy sector and their potential positive impact on participants' energy consumption patterns. Finally, awareness campaigns serve to educate, providing potential energy users with a clear understanding of how the pilot programs operate, the benefits they offer, and the specific requirements or commitments involved in participation.

The key components of awareness campaigns refer to clear messaging, a multi-channel approach, and engaging and personalised content. The use of clear messaging brings concise and compelling information highlighting the key benefits of participation, such as reduced energy costs and contribution to sustainability. Next, the multi-channel approach means that various communication channels including online platforms, traditional media, direct mail, and collaboration with local partners to effectively reach different target user groups are exploited. Developing informative and engaging content, such as case studies, testimonials, infographics, videos, and interactive tools, to explain the flexibility programs and their potential impact is also important. The content should also be personalised, ensuring that the specific needs, interests, and motivations of different target user groups are addressed.

Based on experiences gathered within the BeFlexible project [24], the following steps are recommended for the successful realisation of awareness campaigns: 1) Conduct market research gaining insights into the preferences, motivations, and communication channels of target user groups to tailor campaign messages and content accordingly; 2) Collaborate with local partners by leveraging partnerships with local energy associations, community organisations, and industry stakeholders to effectively reach target energy users; 3) Use testimonials and success stories that demonstrate the benefits of participation in the pilot programs and build trust; 4) Provide clear call-to-action communicating the actions that potential energy users need to take to participate in flexibility programs.

Gamification challenges can be a powerful tool to engage energy users in energy flexibility initiatives. By integrating game design elements into engagement activities, participants are incentivised to actively contribute and learn about the possibilities and impact of energy flexibility. These challenges can be tailored to various energy user segments, including residential, industrial, or municipal, aligning content and objectives with their specific needs and interests. Some examples of gamification challenges are presented in Figure 4, followed by time-scheduled guidelines (Figure 5). The timeline for carrying out the challenge spans from 1-2 months ahead in time to post-challenge activities.

Co-design workshops are a crucial engagement activity prior to onboarding stage of any energy flexibility

related initiative and are particularly important for achieving the adaptability desired. The workshops aim to actively involve energy users in the design and development process, ensuring that their preferences, needs, and expectations are considered. The purpose of these workshops is to foster collaboration, gather valuable insights, and co-create solutions that align with the energy users' requirements. By involving energy users from the early stages, the success of the flexibility initiative is enhanced, and energy user satisfaction and engagement are increased.

A co-creation workshop will normally embrace the following activities: 1) Introduction to welcome participants and provide an overview of the objectives. 2) Overview of the flexibility initiative, including its goals and objectives and explaining the importance of user engagement. 3) A group discussion to gather insights on the energy users' preferences, expectations, and requirements where interactive techniques such as brainstorming or group exercises to encourage active participation are used. 4) Co-creation and idea generation session where participants can provide ideas and potential solutions and where open discussion and

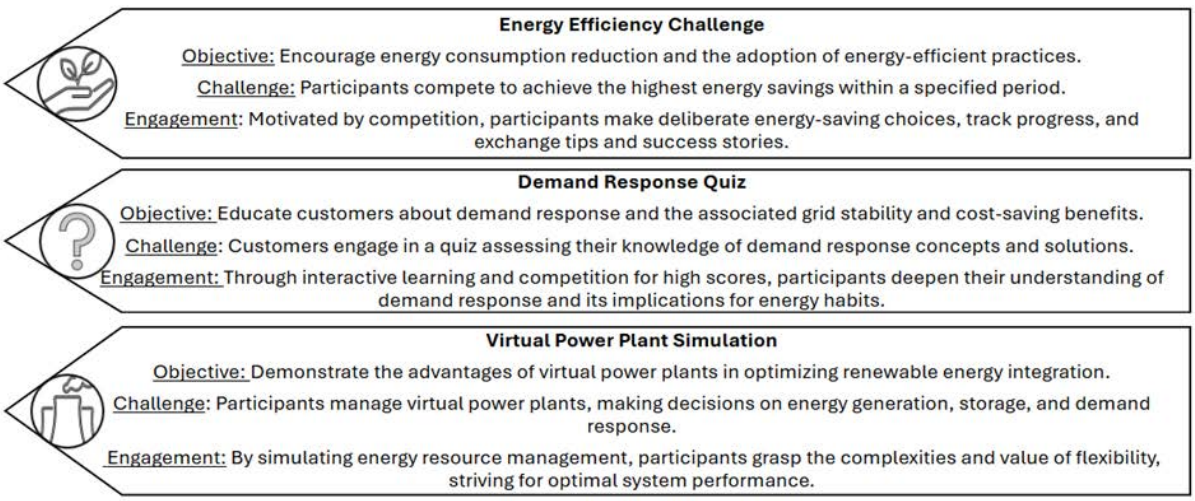

Figure 4: Illustrative examples of gamification challenges.

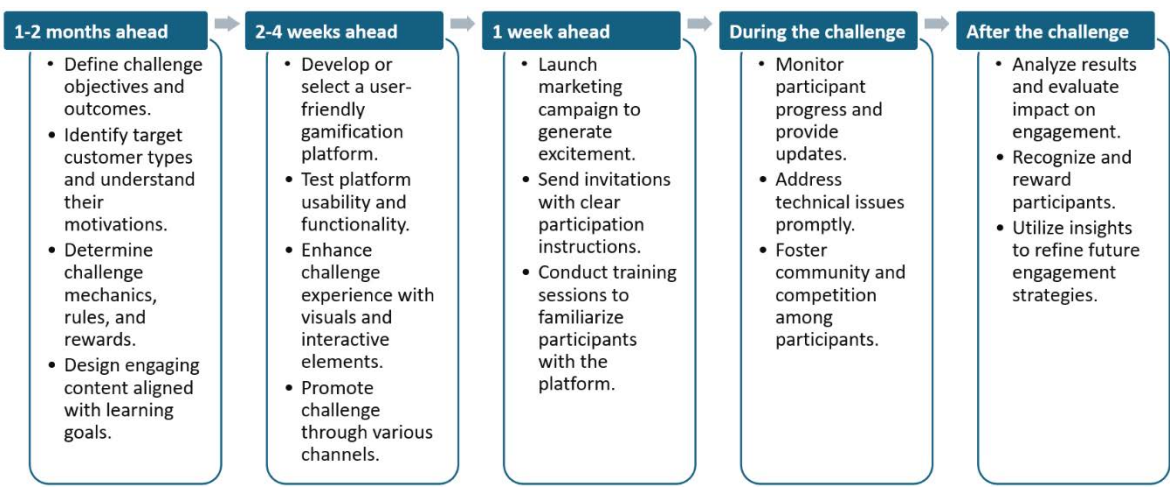

Figure 5: Timeline with guidelines for planning gamification challenges.

collaboration among participants are encouraged to foster innovative thinking. 5) Prioritisation and decision-making to help participants evaluate the generated ideas based on feasibility, impact, and alignment with project goals. Group discussions and interactive voting techniques to reach a consensus on the most promising ideas can be facilitated at this point. 6) Tailoring engagement strategies and provision of examples and guidelines on how to adapt the content and format of future workshops based on user types. 7) Summary of the workshop's outcomes and key decisions made with discussion of the next steps in the pilot process and expressing gratitude to participants for their contributions. The associated timeline with planning and facilitation guidelines is provided in Figure 6.

The core contribution of this work lies in the integration of insights from ANT and the hybrid collaboration approach into a unified, adaptable engagement strategy. While ANT provided a structured method for identifying actors and mapping their relationships, the hybrid collaboration approach ensured that engagement activities were co-developed with stakeholders and grounded in real-world constraints. By synthesising these methodologies, we developed a replicable strategy that can be tailored to diverse socio-technical contexts and evaluated through experimental methods.

4. Evaluation process

Experimental testing is essential for evaluating the effectiveness of nudging strategies in promoting behavioural change, particularly in areas such as energy and sustainability practices [25]. Research has shown that nudges can lead to significant improvements in behaviour. For example, a systematic review indicated that nudges resulted in an average 15.3% increase in healthier dietary choices among adults [26]. Experimental testing has also been utilised to assess the impact of nudges on various behaviours, including sustainable energy practices [27], providing valuable insights into the mechanisms through which nudges influence behaviour change. Furthermore, studies emphasise the importance of testing the efficacy of nudges in real-world settings. For instance, a study examined the impact of a nudge strategy on food selection by European adolescents in a real foodservice setting [28], offering practical insights into the application of nudges and their effectiveness in influencing behaviour. Moreover, experimental studies have been crucial in exploring the relationship between environmental commitment and sustainable practices, such as energy efficiency and waste management [29]. These studies aid in identifying the factors contributing to the success of sustainability initiatives and nudging interventions in promoting environmentally friendly behaviours.

4.1 Method for engagement strategy evaluation

Evaluation of the engagement strategy is important for its further implementation and development. Here, the content of a message, a channel, a reward, or the engagement strategy's target can be considered as the "treatment". Yet, it may be difficult to ensure that users are only exposed to the treatment or that the treatment was identical in all cases. To illustrate, in a case where the effectiveness of online sessions in raising energy knowledge in demo

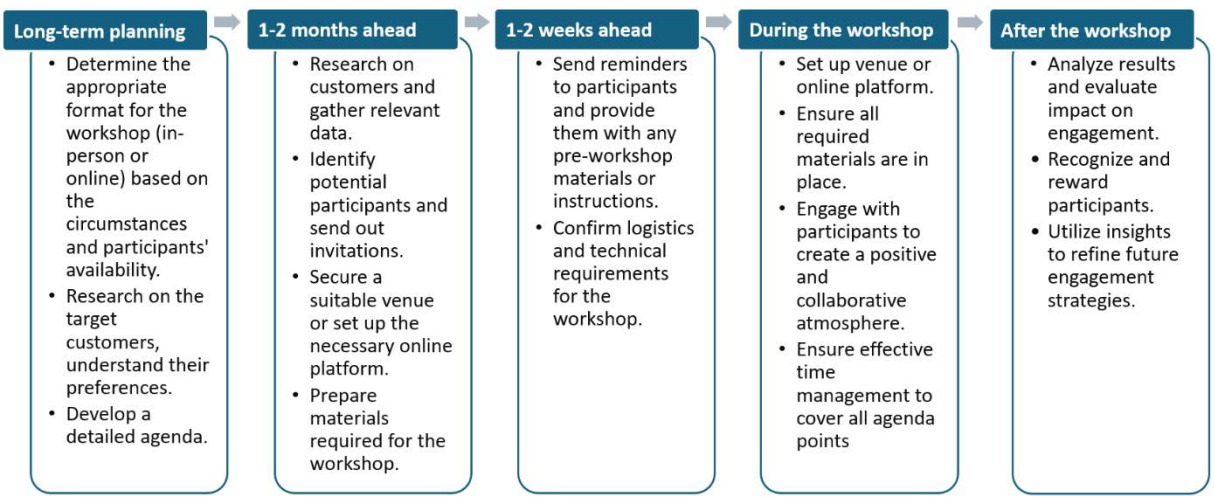

Figure 6: Timeline with guidelines for planning and facilitation of co-creation workshops.

locations is being tested, some links and extra materials may have been shared prior to the evaluation. Some users may browse the links provided to find out more about the energy transition and the functioning of smart grids. Thus, when the dependent variable "energy knowledge" is measured in the process of the evaluation, participants in the online session had greater energy knowledge. While the findings can be attributed to the location, it is in fact the confounding factor (the "homework" done by the users) that produced the effects.

Depending on how the treatment is administered, experiments can be of two types: between subjects or within subjects. Between-subjects experimental designs allow for a cross-sectional examination of causality. In this case, the treatment is manipulated across participants, so that some users will be assigned to treatment A and some to treatment B (or to no treatment – i.e., control groups). The differences between subjects in a selected metric are measured allowing for the establishment of a causal relationship. Within-subject experimental designs allow for a longitudinal examination of causality – i.e., the differences in time 1 and time 2 for the same metric are examined. In addition, the between-subject design can be of different types - for example comparing a treatment (e.g., financial reward) with no treatment, or the comparison of financial reward with symbolic reward in two locations, which in practice results in four experimental groups to compare. Also, one should be careful with assuming linear relationship between treatment and outcome during within-subjects experimental design. For instance, if participants in an experiment had great energy knowledge at time 1 it may be the case that this outcome variable does not increase in time 2.

Table 4 provides examples of treatments that can be experimentally tested. Experiments focused on engagement strategies can adopt between-subjects or within-subjects designs. Between-subjects designs manipulate treatment across participants, establishing causality by comparing differences in metrics between groups. Control groups, such as wait lists or non-accepted users, aid in this analysis. Within-subjects designs, on the other hand, measure individuals at different times to assess treatment effects longitudinally. Experimental designs may combine both approaches. For instance, assessing energy knowledge changes among participants across different demographics involves measuring metrics before and after treatment exposure. It is essential to consider the relationship between treatment and outcome, avoiding assumptions of linear effects where thresholds may exist.

Metrics for engagement evaluation can be categorised into recruitment, onboarding, participation, and continuance stages. Recruitment aims to attract potential users, measured by the number of leads and conversions and the time to generate leads. Onboarding metrics track user progression through steps, identifying pain points and time taken. Participation metrics vary by demo, focusing on key activities and user satisfaction. Continuance depends on user satisfaction and perceived value, measured alongside intentions to maintain participation post-project.

Table 4: Examples of treatments that can be experimentally tested.

Message strategy	Which attracts more leads: emphasising environmental value or episteme value?	Which brings greater lead conversion: foregrounding self-centred benefits or other-centred benefits?	What led to greater leads among commercial users (compared to residential or industrial users)?
Channel or activity	Which generated more leads: demonstration or online sessions?	Which offered the shortest path from lead to conversion?	Did online sessions generate a similar number of leads among commercial and residential users?
Rewards	Were there differences in satisfaction depending on the reward used, rebate vs. direct payment?	Did consumers offered a rebate display a greater conversation rate compared to those not offered a rebate?	Were differences in the reliability of the flexibility among residential and commercial users offered a rebate?
Target	Did online sessions elicit different leads across demo locations?	Did participants in online sessions have a better understanding of flexibility than participants in gamified approaches?	Did participants in co-creation sessions experience more empowerment than those that did not?

4.1.2 Metrics specifications

Having explained the suggested method for engagement evaluation in Section 4.1, the metrics that can be used in relation to energy flexibility are to be presented. These metrics are classified along the stages of the engagement process, as illustrated in Figure 3 - namely recruitment, onboarding, and usage, with the last being sub-categorised into participation, and continuance. One of the key onboarding steps includes the signing of terms and conditions (TACS), which formalises the user's participation in the flexibility initiative and is used as a metric for onboarding progress. Participation is the stage of the process where users will interact with the actors steering the flexibility usage and will rely upon the technological devices to provide flexibility services. Continuance is the stage that begins once the demonstration is finished. Understanding the continuance intention of users is important because the sustainability of the business models depends on the continuance of users providing flexibility services. The set of metrics for the activities presented in Table 3 are provided in Table 5.

Furthermore, descriptive metrics for the experimental approach should be considered – in particular, sociodemographic, psychographic, and motivational information about users. Such information allows for more granular analyses of outcome variables and ensures the equivalence among groups in experimental designs. Sociodemographic metrics include gender, age, education of the person signing TACS, type of user (industrial, residential, or commercial), number of inhabitants (household or organisation), energy flexibility equipment available, location (size, urban vs. rural), type of building (social housing, detached house, condominium), and recruitment. Psychographic metrics comprise, technological readiness, energy transition awareness, perceived empowerment, self-reliability assessment (reliability to activate), membership of energy communities or energy-related grassroot movements, and previous participation in other energy projects. Finally, motivational metrics should be based on value sought (e.g., self-centred or motives), number of willing activations, time period (day/hours) for flexibility activation, and willingness to pay for equipment after the project ends.

4.1.3 Challenges to metrics measurement

The metrics specified in Table 5 can be measured with self-reported or behavioural data. Self-reported data are appropriate for metrics that capture the internal states of the users, such as their awareness, knowledge, or affective engagement. Self-reported data or manually reported data

Table 5: Evaluation metrics and methods for their measurement.

Stage	Sample metrics	Methods for measuring
Recruitment	No. of users reached: attendants/emails sent/impressions; No. of interested users/leads: users sending expression of interest, clicks on ads, responses to emails; No. of converted users: users that start the onboarding stage; Lead rate: leads/users reached; Conversion rate: users reached/leads. Time length in the process; number of contacts to convert a user; Cost per conversion.	Digital channels: behavioural data. Non-digital channels: manually recorded data by demo leaders.
Onboarding	No. of users submitting eligibility questionnaire; No. of users signing TACS; No. of users uploading TACS; No. of users with successful installations; Satisfaction with the onboarding; Perceived user support; Time length to complete the process.	Digital channels: behavioural data. Non-digital channels: manually recorded data by demo leaders.
Participation	Perceived usefulness Perceived comfort Perceived data privacy Perceived control	Self-reported data by users (collected by questionnaires)
Continuance	User experience: usefulness, ease of use, performance, and enjoyment; User satisfaction; Perceived realised value; Energy engagement; Intention to maintain provision of flex services; Willingness to pay for equipment for devices after the project ends; Willingness to adopt other services or other energy technologies.	Self-reported data by users (collected by questionnaires).

is also necessary when behavioural measurement is impossible to implement. It may be difficult to obtain self-reported data from participants. Thus, to overcome user reluctance to respond to questionnaires and other risks related to adequate metrics measurements, different actions can be implemented. Some general risks and challenges refer to the validity of self-reported data, perceptions for intrusiveness of behavioural data (could lead to pushback or reduced participation), incentive-based bias (participants may provide feedback just for the incentive, and not due to genuine engagement), data storage and privacy. Actions used to mitigate these general risks may refer to use of triangulation methods where self-reported data is combined with behavioural data and third-party reports to validate findings, opting out of behavioural tracking, gathering feedback without incentives to measure genuine response, and employment of strong encryption methods as well as regular data audit to ensure compliance with privacy laws. The specific risks encountered at each engagement stage and the respective actions to be taken are provided in Table 6.

5. Socio-cultural focus in the proposed strategy and indications from demo sites

Socio-cultural barriers and drivers of engagement of different types of consumers (residential, public, business, industrial) as well as the grid side actors (DSO, TSO and Aggregators) have been identified through the development of value propositions, as proposed in [27]. By identifying the obstacles and frustrations, whether in the context of residential energy management or industrial processes, more efficient flexibility solutions and engagement strategies can be developed. Understanding and mitigating user-related issues in energy flexibility utilisation is a key driver for flexibility adoption. According to [27] barriers to flexibility adoption can be as follows:

- Emotional – When users are expected to provide flexibility they may feel annoyance, injustice, anxiety or fear. These feelings are more intense when they think the benefits are not worth their effort.

Table 6: Risks and actions for the end-user metric calculation.

STAGE	RISKS	ACTIONS
Recruitment	*Data authenticity*: not all leads or prospects will necessarily provide accurate or genuine information); *sampling bias*: challenge to represent the broader target population, leading to skewed metrics; *survey fatigue*: questioning users too often about usefulness, informativeness, interestingness may reduce response rates or accuracy.	*Data validation checks* during the signup process (e.g., email or mobile number verification); *diversified recruitment channels* and methods to capture a wider audience; *periodical review* and adjust targeting criteria; *concise surveys* and limited frequency. Alternatively, interactive methods like quizzes or games to gather feedback.
Onboarding	*Incomplete data*: users may abandon the onboarding process without giving any feedback, making it hard to pinpoint specific issues. *Subjectivity*: perceived support and overall satisfaction are subjective metrics, and there may be variance based on personal preferences; *inconsistent feedback*: users may have varying definitions of "difficulties" during onboarding.	Introduction of *interim save points* during onboarding, allowing users to return and complete the process later; *combining qualitative feedback with quantitative metrics* (e.g., time taken to complete a step) to balance subjective data; provision of *clear guidelines or examples* with feedback forms to ensure users understand the questions.
Participation	*Tracking limitations*: if users are not consistently using digital devices or platforms, capturing behavioural data will be limited; *data privacy* concerns may affect participation rates; *interpretation challenges* related to perceived value, comfort, data insecurity, and control; *extrinsic motivators* that incentivise users skewing the genuine participation metrics.	Encourage users to use *digital platforms* through incentives or gamification; *transparent data policy* with explicit consent where needed; regularly *educate and onboard* users to standardise understanding and expectations; *diversified metrics* including both incentivised and non-incentivised activities.
Continuance	*External factors* like market trends, technological advancements, or societal shifts; *device bias*: if consumers are provided with free devices, their feedback might be influenced by the perceived value of the device rather than the actual service; interpretation of *cross-services willingness* where external factors like marketing can affect the metrics related to cross-service adoption.	Regular *market and trend analysis* to adjust and align metrics; Blind studies or control groups to measure feedback without the influence of free devices; *Regular feedback loops* to understand the factors influencing adoption, beyond just marketing efforts.

- Privacy - users may be reluctant to share detailed consumption data due to fears of misuse or inadequate data protection [30].
- Contextual and cultural - Flexibility adoption is hindered by contextual influences, specifically lifestyle factors such as the kind of family or people living in the house or working conditions.
- Technical – Flexibility provision involves a technological aspect. The installation and use of flexibility resources demand a high level of technology preparedness. For this, users need information and knowledge on what and how to install devices, and how to maximise benefits.
- Economic – As suggested by [26], users should see value in taking part in a flexibility initiative. Based on the research carried within the BeFlexible project where users' attitude in four demo locations was investigated (France, Italy, Spain and Sweden) [31], it became clear that the current economic rewards for the energy supplied to the grid did not matter to users. Users were motivated to use as much energy as they can themselves, store or share it, instead of what they perceive as "sending it to the grid" or "throwing it away". The economic benefit from selling energy was perceived as insignificant, or even worse - as unfair.

A detailed description of socio-cultural determinants and interventions is provided by [32]. In the context of this work, it is important to consider socio-cultural barriers in order to understand how different types of users utilise flexible energy resources. This can help create suitable to the target group engagement strategies. Different user categories, such as residential consumers, businesses, and industries, have different energy needs, priorities, and limitations. By taking these differences into account, it is possible to find customised solutions that can improve energy consumption patterns and increase grid stability.

For example, residential users depend a lot on how their community is organised, what kind of houses they live in, what kind of subsidies and compensation they get for providing flexibility. For them, energy is not only about lighting, but also about insulation and other non-energy topics like mobility, food and leisure. For commercial profiles, the main factor that influences their relationship with energy is economy. They are less worried about the risk than industrial consumers, but they still want to have a lot of control and simplicity. They use renewable resources as part of their business activities and invest time in them, aiming at economic benefits and sustainability. Industrial entities see flexibility provision as risky for their operations and must ensure that production lines are not jeopardised. In the case of public buildings, ambition to be seen as good examples or role models can be observed. They may also be forced by regulation to participate in the energy transition. The collective views that were gathered and shared by flexibility pilot informants in the four demo sites (referred to in [31]) suggested generally strong environmental value, limited economic value of flexibility provision and associated subsides, insufficient trust in conventional market actors, various level of community sense (from "low" in Spain, to "strong" in Italy) and strong social responsibility.

6. Conclusion

This paper proposes the development and application of a user engagement strategy to effectively involve energy users in the provision and utilisation of energy flexibility services. The strategy comprises a structured set of activities and practices, informed by a methodology based on Actor-Network Theory and a hybrid collaboration approach. These methodological tools guide the identification of relevant actors, the design of engagement activities, and the evaluation of their effectiveness. Human and non-human actors have been identified and their relationships explored as a way of understanding the social dynamics that underlie any engagement with energy users within that network. A timeline and various engagement activities have been presented, offering guidance on the implementation of the strategy as each pilot demonstrator develops its user engagement plans. Contingency planning and accessing continued implementation support have also been addressed to ensure the sustained success of the engagement strategy. Importantly, the EU-funded project BeFlexible has been used as a reference case.

The proposed engagement strategy provides a comprehensive framework for effectively involving energy users in the use of flexibility resources. By using the methodologies, insights, and activities outlined in this paper, managers of energy flexibility programs can choose the specific approach that can successfully engage energy users and drive the adoption of flexible

energy practices, creating their own engagement plans. This proposed agile approach to engagement strategy will allow for real-time changes and improvements based on the achieved results. Then, the strategies will go through a careful evaluation and possible redefinition, to further strengthen user engagement and achieve the energy flexibility initiatives' goals. The trends and practices utilised show the interdisciplinary nature of the strategies that are used to engage energy consumers and prosumers in energy flexibility.

Acknowledgements

This work has been funded by the European Union's Horizon Europe program as part of the BeFlexible project (Grant Agreement 101075438). Views and opinions expressed are however those of the authors only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

References

[1] Lund P, Lindgren J, Mikkola J, Salpakari J. Review of energy system flexibility measures to enable high levels of renewable electricity integration. Renewable and Sustainable Energy Reviews 45 (2015) p 785–807. https://doi.org/10.1016/j.rser.2015.01.057

[2] IRENA. Power System Flexibility for the Energy Transition. Part 1: Overview for policy makers. 2018. International Renewable Energy Agency, Abu Dhabi. https://www.irena.org/-/media/Files/IRENA/Agency/%20%20%20%20Publication/2018/Nov/IRENA_Power_system_flexibility_1_2018.pdf

[3] Campos J, Munkácsy B. Estimating the potential of residential heat pumps to reduce surplus electricity using the flexible demand tool in EnergyPLAN. International Journal of Sustainable Energy Planning and Management 43 (2025) p 70–84. https://doi.org/10.54337/ijsepm.8394

[4] Ghionda F, Sartori A, Liu Z, Mahbub MS, Pilati F, Brunelli M, Viesi D. Optimizing the integration of renewable energy sources, energy efficiency, and flexibility solutions in a multi-network pharmaceutical industry. International Journal of Sustainable Energy Planning and Management 41 (2024) p 87–107. https://doi.org/10.54337/ijsepm.8167.

[5] Geelen D, Reinders A, Keyson D. Empowering the end-user in smart grids: Recommendations for the design of products and services. Energy Policy 61 (2013) p 151–161. https://doi.org/10.1016/j.enpol.2013.05.107

[6] Cappa F, Rosso F, Giustiniano L, Porfiri M. Nudging and citizen science: The effectiveness of feedback in energy-demand management. Journal of Environmental Management 269 (2020). https://doi.org/10.1016/j.jenvman.2020.110759

[7] Krog L, Sperling K, Svangren MK, Hvelplund F. Consumer involvement in the transition to 4th generation district heating. International Journal of Sustainable Energy Planning and Management 29 (2020) p 141–152. https://doi.org/10.5278/ijsepm.4627

[8] Tveten ÅG, Bolkesjø TF, Ilieva I. Increased demand-side flexibility: market effects and impacts on variable renewable energy integration. International Journal of Sustainable Energy Planning and Management 11 (2016) p 33–50. https://doi.org/10.5278/ijsepm.2016.11.4

[9] Palensky P, Dietrich D. Demand Side Management: Demand Response, Intelligent Energy Systems, and Smart Loads. IEEE Transactions on Industrial Informatics 7 (3) (2011). https://doi.org/10.1109/TII.2011.2158841

[10] Wen H, Liu X, Yang M, Lei B, Cheng X, Chen Z. A novel approach for identifying customer groups for personalized demand-side management services using household socio-demographic data. Energy 286 (2024). https://doi.org/10.1016/j.energy.2023.129593

[11] Papaioannou TG, Stamoulis GD, Minou M. Personalized Feedback-based Customer Incentives in Automated Demand Response. 2018 IEEE International Conference on Communications, Control, and Computing Technologies for Smart Grids (SmartGridComm), Aalborg, Denmark, 2018. https://doi.org/10.1109/SmartGridComm.2018.8587590

[12] Guthridge G. When energy hits home, will providers be left out in the cold?. Ernst & Young; 2022. https://www.ey.com/content/dam/ey-unified-site/ey-com/en-gl/insights/energy-resources/documents/ey-energy-transition-consumer-insights-final.pdf

[13] Heiskanen E, Johnson M, Robinson S, Vadovics E, Saastamoinen M. Low-carbon communities as a context for individual behaviour change. Energy Policy 38 (12) (2010) p. 7586–7595. https://doi.org/10.1016/j.enpol.2009.07.002

[14] Marra A, Colantonio E. On public policies in the energy transition: Evidence on the role of socio-technical regimes for renewable technologies. Energy Economics 128 (2023). https://doi.org/10.1016/j.eneco.2023.107126

[15] Vardakas JS, Zorba N, Verikoukis CV. A Survey on Demand Response Programs in Smart Grids: Pricing Methods and Optimization Algorithm. IEEE Communications Surveys & Tutorials 17 (1) (2015) p 152–178. https://ieeexplore.ieee.org/document/6861959

[16] Pauwels K, Ambler T, Clark BH, LaPointe P, Reibstein D, Skiera B, Wiesel T. Dashboards as a service: why, what, how, and what research is needed?. Journal of service research 12 (2) (2009) p 175–189. https://doi.org/10.1177/1094670509344213

[17] Turban E, Strauss J, Lai L, Turban E, Strauss J, Lai L. Customer engagement and metrics. In: Social Commerce: Marketing, Technology and Management. Springer International Publishing Switzerland; 2016. p 99–125. http://dx.doi.org/10.1007/978-3-319-17028-2_5

[18] Dean A, Voss D, editors. Design and analysis of experiments, New York: Springer; 1999. https://link.springer.com/book/10.1007/b97673

[19] Dean A, Morris M, Stufken J, Bingham D, editors. Handbook of design and analysis of experiments, Boca Raton, FL, USA: CRC Press; 2015. https://api.taylorfrancis.com/v4/content/books/mono/download?identifierName=isbn&identifierValue=9780429096341&type=previewpdf

[20] Jackson S, Jacobs S. Generalizing about messages: Suggestions for design and analysis of experiments. Human Communication Research 9 (2) (1983) p 169–191. https://doi.org/10.1111/j.1468-2958.1983.tb00691.x

[21] Gangale F, Mengolini A, Onyeji I. Consumer engagement: An insight from smart grid projects in Europe. Energy Policy 60 (2013) p 621-628. https://doi.org/10.1016/j.enpol.2013.05.031

[22] Law J, Hassard J. Actor network theory and after. Wiley; 1999.

[23] BeFlexible Project Official Website. https://beflexible.eu/. [Accessed 20 February 2024].

[24] BeFlexible, Deliverable 2.2: Customer Engagement Strategies. 2023. https://beflexible.eu/wp-content/uploads/2023/12/BeFlexible-D2.2-Customer-Engagement.pdf

[25] Romano S. Experimental demonstration of a smart homes network in Rome, International Journal of Sustainable Energy Planning and Management 24 (2019). https://doi.org/10.5278/ijsepm.3335

[26] Sneum DM, Sandberg E. Economic incentives for flexible district heating in the Nordic countries International Journal of Sustainable Energy Planning and Management 16 (2018) p 27–44. https://doi.org/10.5278/ijsepm.2018.16.3

[27] Unsworth K, McNeill IM. Increasing pro-environmental behaviors by increasing self-concordance: Testing an intervention. Journal of Applied Psychology 102 (1) (2017) p 88–103. https://doi.org/10.1037/apl0000155

[28] Dos Santos Q, Pérez-Cueto FJA, Rodrigues VM, Appleton K, Giboreau A, Saulais L, Monteleone, E, Dinnella C, Brugarolas M, Hartwell H. Impact of a nudging intervention and factors associated with vegetable dish choice among european adolescents. European Journal of Nutrition 59 (1) (2019) p 231–247. https://doi.org/10.1007/s00394-019-01903-y

[29] Sendawula K, Bagire V, Mbidde CI, Turyakira P. Environmental commitment and environmental sustainability practices of manufacturing small and medium enterprises in Uganda. Journal of Enterprising Communities: People and Places in the Global Economy 15 (4) (2020) p 588–607. https://doi.org/10.1108/jec-07-2020-0132

[30] Bright, Deliverable D3.1: Overview of barriers and drivers for consumer engagement in demand response. 2021. https://www.brightproject.eu/wp-content/uploads/2021/12/BRIGHT_D3.1_TNO.pdf

[31] BeFlexible, Deliverable 2.1: Value Propositions. 2023. https://beflexible.eu/wp-content/uploads/2023/10/BEFLEXIBLE-D2.1-Value-Propositions-for-market-actors.pdf

[32] Albarracin D, Fayaz-Farkhad B, Samayoa JAG. Determinants of behaviour and their efficacy as targets of behavioural change interventions. Nature Reviews Psychology 3 (2024) p 377–392. https://doi.org/10.1038/s44159-024-00305-0