ReDREAM
change your energy

D1.1.

Report on social requirements, use cases and functionalities for ecosystem layers and social KPIs

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1 PU = Public

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Summary

This deliverable represents the outcome of task 1.1 (of the WP1). First, the deliverable summarizes the core tenets of service-dominant logic, the meta-theory on which this project is based upon. This review is necessary to identify the way consumers and energy could relate, by going deeper into the study and practice of customer relationships. As explained further through five over-arching axioms, this SDL theory has been applied to study value creation and service systems in different contexts enriching our understanding of the micro process underpinning value creation, ecosystems and networks, or customer engagement. This framework was complemented with a thorough review (to be reported in Deliverable 1.5.) of past studies on adoption, engagement and satisfaction with flexibility and demand-response strategies including smart thermostats. The review was later expanded to also examine the best practices in energy-savings feedback, prosumption and gamification strategies. By taking stock of past studies, we were able to unveil evidence-based building blocks of the methodology.

Second, it explains the method followed to gather the user's value forms in the energy services and their requirements for effective engagement. Only by understanding in-depth user's current practices regarding energy management and their views on ideal energy services this project will make progress on the ultimate goal of enabling the energy transition. More specifically, a qualitative study was held in four countries (Spain, the UK, Croatia, and Italy). In-depth interviews were held in each country with different profiles such as households, NGOs and commercial organizations. Also, workshops and focus groups were conducted to explore differences in energy views both intra-country and inter-country. Interviews with managers of the cooperatives were also held to triangulate findings.

Third, findings regarding the social requirements are reported structured into three main themes: value forms sought in energy services, available resources and missing resources that need integrating to co-produce value and requirements for the ecosystem, namely, the socio-technical context developed in the pilot projects through which engagement is expected to occur. Technically, this ecosystem will be delivered to users via an app-based device.

The findings were then synthesized according to primary motivators, levers and barriers that users had in their relationship and use of energy services, showing differences across countries and across profiles where it was appropriate. This synthesis sets the ground for the identification of user's archetypes. These archetypes were based on two dimensions: energy awareness and energy involvement and technology appreciation or innovativeness. energy, b) per tech appreciation. The first dimension reflects the "reason why" users would be willing to participate (main value sought), and the second dimension reflects "the how" (their willingness to relate within and through their experience in the ecosystem, be it as individuals or as a group or community). The structure of the archetypes was the same for each country, although the prevalence of each archetype significantly changed across countries. To complement this synthesis, and based on the findings of the qualitative study, we depict the users' requirements for each of the originally defined layers in the project proposal in the form of propositions.

Fourth, this deliverable also describes in detail the use cases and functionalities of the ecosystem. The already-describe qualitative study was one of the inputs for the definition of a first draft of the ecosystem functionalities. This draft was then reviewed in the co-creation sessions held with project partners. In addition to proposing the addition or change of functionalities, these sessions focused on specific functions of the app, i.e.: gamification, mobility, comfort and data. As a third step, and once

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the suggestions made during the co-creation sessions were added to the ecosystem prototype, seven validation sessions were held with potential users from the four countries. In these in-depth interviews, the ecosystem was presented to these users and their feedback obtained about the ecosystem as a whole and its specific functionalities. These interviews also greatly enriched our understanding of how to design a social network that could provide value to users and of sensible or hot topics regarding users' data management and disclosing. The ecosystem described in this report is responsive to all these inputs.

As depicted in Figure 1, the ecosystem responds to five design principles formulated based on the insights obtained through the dialogues with users and project partners. These are personalization, visibility, simplicity, discoverability and managed automatization.

The ecosystem is then structured into three modules or functionalities: *dashboard, advisory tool or wall* and *challenges*.

The *dashboard* comprises the information about the energy consumption that is shown to consumers using three different impact variables: community (impact to the local communities), environmental (environmental impacts summarized as CO_2 emissions) and economic (impact to the users in euros). Consistent with the principles of simplicity and discoverability, the information is given in three layers, from simplified to exhaustive; users can choose the depth and comprehensiveness of the information they can visualize in the dashboard.

The second module, the *advisory tool*, provides personalized suggestions for doing a more efficient use of energy and for greater flexibilization. Finally, the *challenges* comprise the gamified goals proposed to users. They can be individual (reduce your consumption while doing the ironing by 20%) or collective (beat the nearby village in energy flexibilization).

The social network is embedded across modules and the non-energy services are also embedded either in the *advisory wall* (suggestions to increased comfort at home/workplace) and in the *challenge's* modules (mobility-related challenge).

Finally, it lists the main social KPIs whereby we expect to track users' participation and engagement (see Annex 2 and 3). Based on the analysis of this information, we will optimize the ecosystem so that it enables the users' behavioural change that will ultimately lead to achieving the targets of this project.

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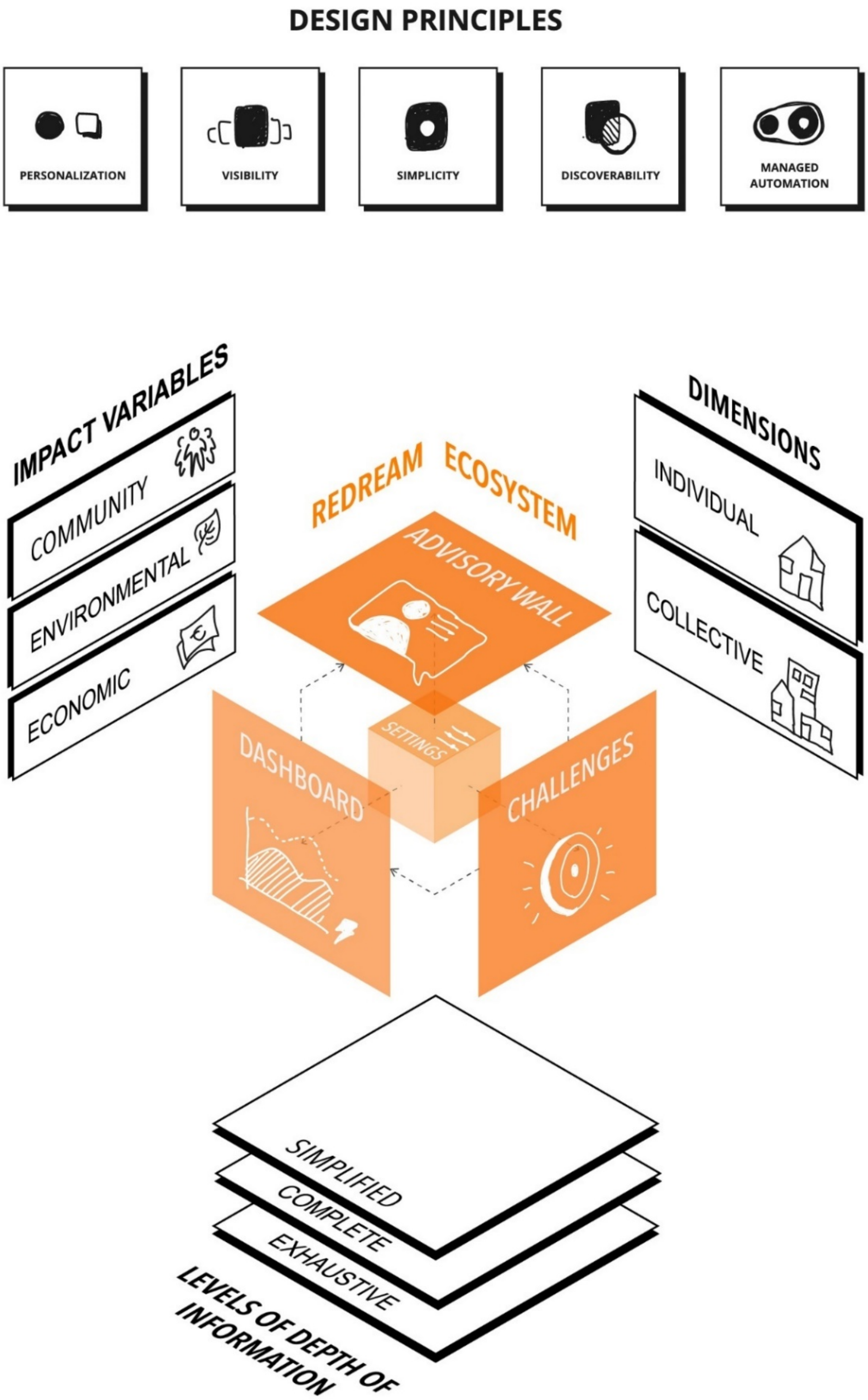
Figure 1 - Strategic overview of the ecosystem



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1 Objectives

With the social objective of placing the users at the centre of the service system and ensuring their engagement in co-created energy markets, this report aims to analyse the best way to implement a service-dominant logic in the design and operation of energy service systems. Using a user-centric methodology – i.e., involving users in the design of the ecosystem so that is tailored to their value sought and resources-, this report seeks to propose an ecosystem or the socio-technical context to be implemented in the pilot projects and through which users' engagement is expected to occur. Technically, this ecosystem will be delivered to users via an app-based device that needs to be attuned to energy users' profiles, current users' practices and contextual settings.

This report shows how new energy integration systems should be adapted to meet users' needs and enrol them in flexibility services. A set of requirements both in the form of overall design principles and functionalities is defined in this report. The ecosystem consists of separate layers (energy efficiency, demand response, advisory tool, social network and gamification, virtualization and non-energy services) that will be technically integrated and shown to users in a single tool.

The report is based on the insights obtained from four sources: stock of studies on flexibility, energy efficiency, gamification and prosumption; in-depth interviews with potential users both to understand their motivations and barriers and to validate the ecosystem design; workshops with local stakeholders and co-creation sessions with project managers.

The specific objectives of this report are specified next.

Objective 1: Define the ecosystem social requirements to develop a consumer-centric model. Requirements are the user's needs and preferences to enrol the project and act on how to meet their needs the best we can.

Objective 2: Understand the possible consumer archetypes and users of the ecosystem, their primary motivations and barriers, and how they relate to energy so they can start using flexibility products. Archetypes are patterns on users' behaviours that can help us personalize interaction to blur the barriers they have while relating to energy and flexibility products. We understand flexibility products as residential demand response energy management or how households can actively and consciously participate in energy markets.

Objective 3: Define de social Key Performance Indicators (KPIs) to measure engagement and user's participation. The way we measure the ecosystem is crucial for a constant iteration needed to meet consumer needs. The ecosystem cannot be static, and we need to measure both their energy behaviour as their behaviour.

Objective 4: Explain the use cases related to ecosystem functionalities. Use cases are essential to explain the number of functionalities the ecosystem has and how users would experience it. That is crucial for the rest of the partners to deeply understand the ecosystem's essence and nuances.

Objective 5: Define a Minimum Viable Product (MVP) so that the rest of the partners can begin working on their specific goals with a consumer perspective. An MVP has two main benefits: (1) it helps explain the ecosystem in an agile way knowing the things from where you are and where you want to be in

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the future; and (2) it helps developers understand where we need to start to make this possible. Being capable of seeing a holistic view but at the same time knowing from where to start makes development agile.

To meet these objectives, it was necessary to start with the so-called task 1.5 that consists of "[defining] a consumer engagement project methodology". This involved obtaining an initial understanding of the context of the four demo locations by analysing existing quantitative data to understand the needs and profiles of actors in the service system. This first exploratory work was complemented with a deeper, more structured qualitative study of users and stakeholders in the four demo locations. Based on the insights emerging from this research, the users' requirements, functionalities and use cases of the ecosystem (task 1.1), and KPIs were outlined.

2 Introduction to Service-Dominant Logic (SDL)

The service-dominant logic (S-DL hereafter) was articulated by Vargo and Lusch (2004) as a new paradigm to inspire the study and practice of customer relationship. It was proposed in opposition to the good-dominant logic (G-DL) that, at the time, pervaded the marketing discipline and the marketing practice. The S-DL can be better understood as a change in worldview as it offers a new set of assumptions to understand the marketing discipline (see Table 1 - A comparison between G-D Logic concepts and S-D Logic concepts). This worldview is so influential that the American Marketing Association changed the definition of marketing to better reflect this paradigmatic view. The current definition (2017) reads as follows: "Marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large" (AMA website1).

Table 1 - A comparison between G-D Logic concepts and S-D Logic concepts

Goods Dominant Logic Concepts	Transitional Concepts	S-D Logic Concepts
Goods	Services	Service
Product	Offerings	Experiences
Functionality/Attribute	Benefit	Solution
Value-Added	Co-Production	Co-creation of value
Value-in-exchange	Value-in-use	Value-in-context
Profit Maximization	Financial Engineering	Financial feedback/learning
Price	Value Delivery	Value Proposition
Equilibrium Systems	Dynamic Systems	Complex Adaptive Systems

Source: Lusch and Vargo (2006)

Vargo and Lusch (Vargo and Lusch, 2004, 2008, 2016; Lusch and Vargo, 2006, 2014; Lusch et al., 2007; Greer et al., 2016) articulated this paradigm by means of a set of 11 foundational premises (FPs) that were subsequently grouped into five over-arching axioms. This meta-theory has been applied to study value creation and service systems in different contexts enriching our understanding of the micro-process underpinning value creation, ecosystems and networks, or customer engagement *inter alia*.

This document first summarizes the axioms proposed by Vargo and Lusch in different papers. Each axiom has been enhanced with other seminal papers that have enriched the description of the corresponding propositions. In the second part, this report summarizes the key insights about value creation, resource integration and service systems, providing a deeper understanding of the micro-foundations of value creation processes.

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The third part analyses how this logic has informed the study of energy ecosystems, by reviewing existing literature. This review shows that whether energy studies have acknowledged that S-D logic may provide a framework to define and structure energy ecosystems, extant studies have only explained the lexicon but have not examined in depth the axioms in this industry. Indeed, there is missing a good articulation of the ecosystem together with their institutional design and flows among actors, a good understanding of the dimensions of value in this industry and the resource integration process leading to value co-creation (or co-destruction).

2.1 Axioms and Foundational Propositions (FP) of S-D Logic

This section explains the axioms of S-D logic that are summarized in Table 2.

Table 2 - Summary of axioms and FPs of S-D logic

Axiom1	FP1	Service is the fundamental basis of exchange.
	FP2	Indirect exchange masks the fundamental basis of exchange.
	FP3	Goods are a distribution mechanism for service provision.
	FP4	Operant resources are the fundamental source of strategic benefit.
	FP5	All economies are service economies.
Axiom2	FP6	Value is co-created by multiple actors, always including the beneficiary.
	FP7	Actors cannot deliver value but can participate in the creation and offering of value propositions.
	FP8	A service-centred view is inherently beneficiary oriented and relational.
Axiom3	FP9	All social and economic actors are resource integrators.
Axiom4	FP10	Value is always uniquely and phenomenologically determined by the beneficiary.
Axiom5	FP11	Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

2.1.1 Axiom # 1. Service is the fundamental unit of exchange

Service is "the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself" (Vargo and Lusch, 2004: 1). Service understood as a process of value creation is the central aim of marketing as service is the unit of exchange. In S-D logic no difference is established between goods and services: all offerings are service offerings, albeit with different degrees of materiality.

The shift from a G-DL to an S-DL is based on the distinction between operand and operant resources (Vargo and Lusch, 2004: 2). **Operant resources** are resources on which an operation or act is performed to produce an effect; **operand resources** are employed to act on operant resources. Operant resources are infinite and dynamic whereas operand resources are finite and static. Whereas operand resources are limited (think of material resources restricted by planetary boundaries), operant (i.e., the skills and knowledge to create value with matter) are not: knowledge and skills can be continuously augmented as actors can always acquire more knowledge and sharpen their skills. To illustrate, in the service "pre-packaged salad", the lettuce is an operant resource. However, the value of this offering comes from the operand resources applied to the lettuce: it was planted, cropped, washed, cut down in pieces, and packaged in protective material.

Knowledge and skills are the fundamental units of exchange: people exchange not to get a product (an operand resource) but to get a service, an operant resource (knowledge and skills encapsulated into a material object or not) that will be later used to produce some effect.

This may be easier to understand continuing with the example: people do not buy a pre-packaged salad (this is an operand resource) but use this salad to perform a healthy and convenient dinner for their families so to perform a mothering role afforded by the culture. They use the salad as an operant resource: a resource on which an operation is performed to produce some effect. Goods (the materiality or embodied operant resources, in this example the pre-packaged salad) are a recipient or distribution mechanism for value provision but not the object of exchange per se.

Exploring these consumers' performances (what the consumer does with the operant resources or how they use them) is fundamental to understand how value is generated.

The first axiom also implies that knowledge is the basis of any competitive advantage; in particular, we can think that companies may have three forms of knowledge: propositional knowledge, prescriptive knowledge and techniques that may refer to product, processes or management. By extension, all economies are service economies where a twofold process is observed: a process of specialization in knowledge to gain competitive advantages and a process of integration to produce value. Existing economies are usually classified using operand resources (the end good produced-agriculture, industry, services). It would be more enlightening to classify economies using the operant resources involved (knowledge and skills for mass production, cultivation, etc.).

2.1.2 Axiom # 2. Value is always co-created

The G-D (Goods Dominant) logic understood that value was performed by the product; thus, the value was created by the company and destroyed when the consumer buys the product. This is the notion of *value-in-exchange*. As we have argued above, it is apparent that this is not when value is realized: it is the use of the product that produces value, not the mere acquisition. In our example, buying a pre-packaged salad per se does not create value. Only when the salad is served and enjoyed by the customer it creates value. This gives rise to the idea of *value-in-use*: value is produced when the consumer uses the offering.

But still, context matters: in every encounter value may change. This is why we would better speak of "experiences" and "*value-in-context*", as value-in-use is a too static view to capture the notion of value when one considers the dynamic and fluid nature of markets and consumption experiences (Chandler

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and Vargo, 2014). Context affects the actors' access and leverage of resources that can be introduced in the process of value creation. Thus, each instance of value creation is contextual, or context shaped.

The example of the pre-packaged salad above also allows understanding the second axiom of S-DL: value is always co-created. The salad as an operand resource does not provide value by itself. The value (healthy and convenient dinner) is co-created by the consumer as s/he opens the package, serves it into a bowl, adds dressing and other ingredients, and serves it in the table and is enjoyed/appreciated by the family etc. The customer adds her own resources to produce the value and the pre-packaged salad will produce different types of value depending on the resources that are integrated into each instance of experience: it can provide a boring experience if only salt is added to the pre-packaged salad, or it can provide a more fulfilling experience if several ingredients are added and aptly combined.

This is sometimes called co-production of value, rather than co-creation of value. Co-production is a subset of co-creation and concerns the participation of users in the offering. For example: making an Ikea table is co-production; enjoying a dinner with friends around the table is co-creation. Co-production is more likely to occur when the consumer has the expertise, wants to exercise control over process/output, has the physical capacity, is willing to take risks, enjoy co-producing activities, and obtain an economic benefit from engaging in co-production activities (Lusch et al., 2007). In sum, co-creation demands consumer involvement (Payne et al., 2008). Value co-creation is an intentional activity (Neghina et al., 2015); therefore, it can be planned: actors involved can be identified, their roles can be depicted, and there is a need to build awareness about the actions leading to value co-creation.

Even more, **this dinner is only an operant resource in a social and cultural context that affords that this object is a carrier of value**. If consumers did not know how to prepare a salad from the package, the value would not be realized. Or if consumers would not be culturally afforded to serve salad as dinner, the value would not be created. These cultural or institutional shapers of value are fundamental as they affect value-in-context.

From this, the idea of consumers as prosumers gained momentum. The distinction between producers and consumers blurs when we accept that value is co-created. Instead of establishing monotone relationships between actors/roles, we have to distance and flexibly assemble actors-roles-skills in each instance of value (Payne et al., 2008; Ramaswamy and Ozcan, 2018).

In complex societies as ours, knowledge and skills are distributed as actors tend to specialize. This is why all exchange is an exchange of knowledge and skills. To emphasize this point: **all actors have specialized knowledge and skills (not only companies), and value will be created when these different pools of knowledge/skills are integrated.** When thinking of knowledge and skills we should adopt a broad view to include cognitive, emotional and behavioural resources and individual, social and cultural resources (Baron and Harris, 2008; Fryberg, 2013).

This leads to the mechanism that explains the creation of value: actors' resource integration. Value is **produced by resource integration,** bearing in mind that resources integrated are not only materials but fundamentally knowledge and skills (organizational and consumers' knowledge and skill). Continuing with the example of the pre-packaged salad, the resources provided by the producer (encompassing the knowledge and skill to plant, crop, wash, cut and package) are integrated with the resources provided by the consumer (dressing added, ingredients added, served into a bowl). Unless the consumer ingrates these resources, the pre-packaged salad would not produce value.

Resource integration is multidirectional: it would be detrimental to think of firms as primary resource integrators of customers' own resources. This would deny the network ubiquity in the creation of value, as the exchange is produced in the network interaction (Fryberg and Jüriado, 2009). Resources can be of different types: private resources (self, friends and family or community); market resources and public resources (Greer et al., 2016). From a different point of view resources can be classified into physical, social or cultural (Baron and Harris, 2008; Fryberg, 2013).

Resource integration demands consumer engagement (Brodie et al., 2011; Grönroos and Voima, 2013). But not all consumers are capable or willing to engage. We will abound on this in the second part of this document.

Despite value being co-created, most service systems are indeed governed by firms and firms operate as the fundamental resource integrator. As we will later discuss, ecosystems need a governance system to harmonize or coordinate actors' goals and behaviour (Ertimur and Venkatesh, 2010) and usually firms take this role. Co-creation is chaotic if no one has control (Fisher and Smith, 2011). Yet, these firm-centric governance systems are not devoid of problems and may be associated with lesser trust, commitment or reciprocity on the part of consumers (Gummesson, 2002).

This centrality of firms in the governance of service systems is also a legacy of how markets were constituted. As Prahalad (2004) aptly summarizes in his comment to Vargo and Lusch seminal paper (2004), first firms try to engage consumers with advertising and promotion. In the second stage, they involve them in a specific co-production activity or self-service. In the third stage, the company stages a context where the consumer co-creates the experience (e.g., Disney). In the fourth stage, the firm allows the customer to navigate the firm system to solve a problem. In the fifth stage, consumers engage in the co-design and co-production of services. Some firms are born in a third or fourth stage, but most companies pursue these stages in their business model development.

If the value is co-created, we cannot say that companies offer "value" as value is realized or performed when consumers apply their own (or others') operant resources. **Companies can only supply value propositions that, when accepted by users, will create value as resources are integrated**, as explained above, with the example of the pre-packaged salad.

This axiom also implies that S-D logic is a **customer-centric model**. The value proposition must be necessarily defined by understanding first what value the consumers seek and is afforded by context, what resources s/he has and how these resources can be integrated with the company's resources. The process does not start with the operand/operant resources of the company (what the company has or can do) but with a deep understanding of what users seek and what resources they have to integrate with those of other actors in the service system, notably producers.

If value co-creation depends on resource integration, then it is obviously a relational process and as such should be studied and defined. A recent study of smart grid deployment (Darby, 2020) also concluded that the success of the demonstration was the integration of a large set of actors, each integrating different resources into the value network for value to be co-created. Table 3 provides examples of the operand resources that different actors in energy service systems can integrate to

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ultimately produce value, as defined by Darby (2020). These resources go from simple actions such as using an app to passing know-how to others.

Table 3 - Application of actors-resources for value creation in energy

Actor	Action
Customers	Using the equipment, programming, switching
Installers (of heaters, water cylinders, sensors, smart meters)	Installation, explanation, advice, maintenance, repairs
Neighbours, friends, family	Advice, passing on practical know-how
Housing managers	Advice, checking, general support
Electricity supplier call centre staff	Advice, referrals to other middle actors to resolve customer problems
Project coordinators	Central communications role, orchestrating and explaining the activity, resolving misunderstandings, troubleshooting
Designers and manufacturers of devices, controls, apps, software	Acting on feedback to develop products further
Demand aggregators	Recruiting, advising, planning, coordinating, building a market
Network operators	Evaluating the viability and value of DR in their area, giving or withholding permission to carry out DR
Grid operators	Monitoring system conditions, planning future supply and estimating DR requirements.

Source: Darby (2020)

Whereas value co-creation has been the object of much research, more recently attention has shifted to **value co-destruction**. Value creation is not the unique outcome of value networks: value can be non-formed or destroyed (Harris et al., 2010; Fryberg, 2013). When we observe a decline in at least one of the value systems and/or one of the participating actors does not meet her goals, we would speak of value co-destruction or co-reduction (Camilleri and Neuhofer, 2017) if this occurs in the interaction, or, more broadly, value diminution (Vafeas et al., 2016). Usually, value is co-destructed, when resources are not integrated or they are not integrated in such a way that the expectations of actors are met (e.g., Echeverri and Sklären, 2011; Harris et al., 2010; Laud et al., 2019; Yin et al., 2019).

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2.1.3 Axiom # 3. Zooming out: value is created in service systems

The example of the pre-packaged depicted a very simple experience of value co-creation in a dyad. However, for the pre-packaged salad to produce value, many actors (individuals, households, firms, nations, etc.) need to apply knowledge and skills and integrate these resources to produce value. This gives rise to the notion of the **service system** where value is co-created. A service system is defined as "relatively self-contained, self-adjusting systems of resource-integrating actors connected by shared institutional logics and mutual value creation through service exchange—rather than individual (e.g., the firm) or dyadic actors (e.g., firm–customer)" (Vargo and Lusch, 2014: 3). A service system is comprised of value networks or "spatial and temporal structure of largely loosely coupled value proposing social and economic actors interacting to coproduce service offerings, exchange service offerings and co-create value" (Lusch et al., 2010).

Understanding the provision of value thus implies understanding the service system and its value networks and identifying all actors and their operand/operant resources that will be later integrated to produce value. Some of the resources will be public and some will be private. Some may be easily identified, and some may be hidden or embedded in other resources/actors and we need to disentangle them.

Again, this view depicts markets as relational: actors become connected because of their joint access to resources. Resources "are not; they become"; they are not finite entities; rather, they expand and contract in response to human actions (Chandler and Vargo, 2014). For instance, the knowledge about energy savings a consumer has expands every time she shares it with other actors, and this expands the ability of this knowledge to create value. In contrast, a lack of knowledge among actors limits the potential of this knowledge as a source of value. Depending on the context, a given resource may have or not the potential to be integrated and produce value.

Moreover, actors do not operate in a social vacuum, but in institutions, understood as the norms, rules, symbols and artefacts that shape the value co-creation process. Institutions are the glue that holds ecosystems together and makes joint value creation possible. Following a structuring approach (Giddens, 1997), institutions are not fixed systems either: they are ever in flux, as actors simultaneously comply with their institutional orders (they reproduce the institutional order contributing to its stabilization or institutionalization) and challenge them (they aim to transform them with their institutional work). Applying this idea to markets, consider the energy ecosystem. New incumbents such as consumer cooperatives aim to disrupt the institutional order by offering a new value proposition and simultaneously aim to stabilize the new institutional order they envision. Traditional incumbents aim to defend their value proposition and stabilize it. **The business of these actors has more to do with market-making than with managing markets.** We will abound on the role of institutions in Axiom # 5.

Market making reinforces the idea that service systems are dynamic: "composing, recomposing, and decomposing over time" (Maglio et al., 2009: 404). Changes can occur because operand resources change (e.g., the addition of smart meters create a business model based on household data analysis) or because operant resources change (e.g., the in-home device provides valuable information to the

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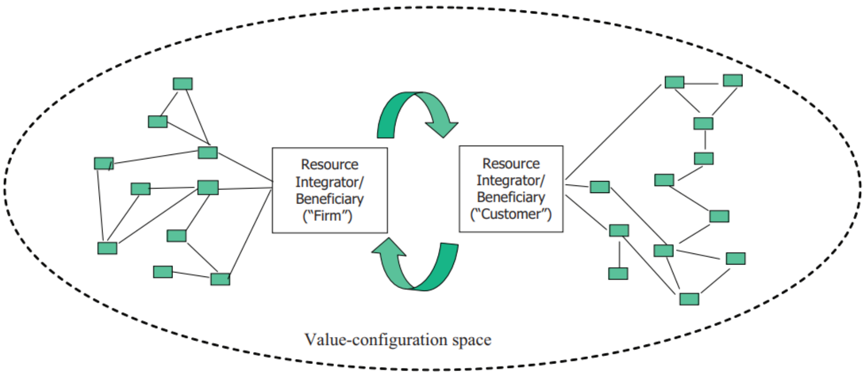
household so that based on this gained knowledge, the household acquires other services that fundamentally alter the grid and the service process).

It is fundamental to bear in mind that service systems are nested into **overlapping institutional orders**. Think of a salad producing firm: it is nested on the institutions governing firms, institutions governing food-producing processes, institutions governing plastic for packaging, institutions governing supply-chains, institutions governing marketing, institutions governing accounting, institutions governing health and so forth. These multiple layered systems are complex and thus difficult to visualize and manage for understanding value creation.

Not only are producers embedded in networks: as Figure 2 shows, customers are also embedded in networks such as families, consumers communities or other forms of relational communities (neighbourhood associations or building-based communities) (Vargo, 2008). If a consumer lacks resources to integrate and produce value, she can draw from other resources (consumer-to-consumer co-creation process) but these networks may constrain also the resources at hand to be integrated into the resource integration process.

Figure 2 - Contextual nature of network-to-network exchange



Source: Vargo (2008: 214)

This complex and dynamic system implies that "value creation is an unfolding process, for which there is no end state to optimize or toward which to move. Rather, it is an emergent process within an ever-changing context, including ever-changing resources" (Vargo and Luchs, 2014: 4).

The implication of this axiom is the need to zoom-out: studying value co-creation demands understanding exchange in the micro, meso and macro levels, each embedded in the context of the other levels. None of the levels is reducible to one another and should be understood separately and jointly to understand how value is co-created in the ecosystem (Chandler and Vargo, 2014). To illustrate, we need to understand the embeddedness of energy users in their own networks (family, building, community, city) as well as their relations with energy firms; of firms with other firms; and the institutional design of the market. And we need a model to capture these three levels simultaneously. Also, we should bear in mind that each experience or instance of value may invoke different layers of context (Chandler and Vargo, 2014) (see Figure 3).

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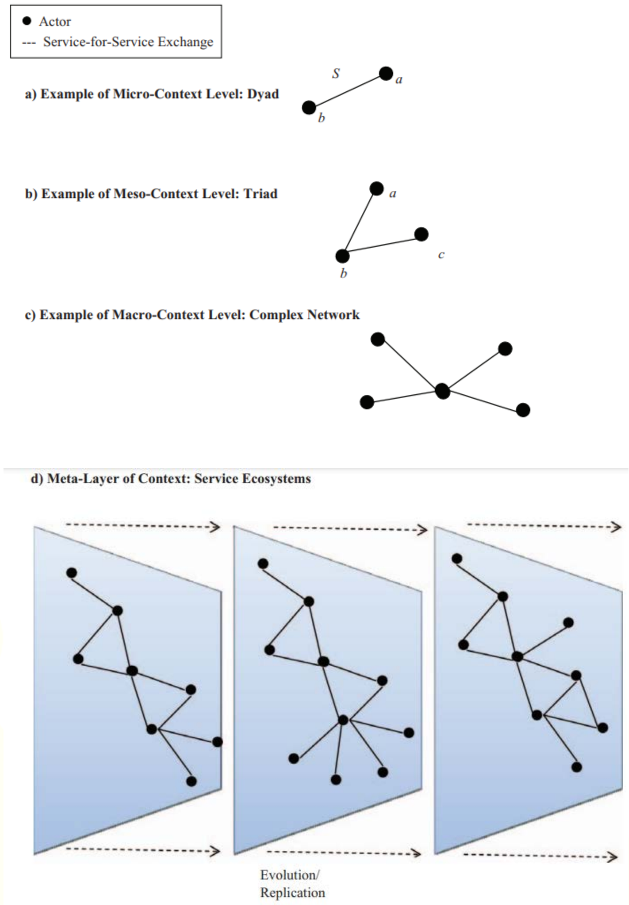
Figure 3 - Network-based ecosystems



Source: Chandler and Vargo (2014: 43)

Finally, a point worth remembering is that not all assemblages of actors are service systems. A grid or a device can simply be an operand resource unless an operant resources effect changes in the resource to create value (Maglio et al., 2009). The mere deployment of technology is not per se a system unless the technology enables relations among actors and they integrate resources.

2.1.4 Axiom #4. Value is always uniquely and phenomenologically determined by the beneficiary

The understanding of "value" in S-DL draws from Holbrook's conceptualization of value (1994). He defined value as an "interactive relativistic preference experience" (27). This definition foregrounds that (1) it is the user who defines the value created in an experience (relativistic or phenomenological) and (2) that this value is relational or co-created (interactive). The value may change from one actor to another and from an instance of experience to another.

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Value is also multidimensional. The G-D Logic emphasized two dimensions of value (quality and price), but research has shown that value may adopt many forms. The most comprehensive taxonomy of value dimensions was elaborated by Holbrook (1999) and is presented in Table 4 - Typology of value forms. Posterior work on value forms has added other categories (e.g., community or social value, identity value, episteme value, environmental value) but these other forms can easily be included in Holbrook's overarching framework. Another more parsimonious taxonomy applied in the IT-energy domain is the E3 o e^3 framework with three dimensions of value (economic, experiential and environmental) (Kim et al., 2011). Experiential includes functional, hedonic, social and epistemological value. However, we have opted for showing a more granular view of value as this helps understand the manifold forms of value that consumers seek in energy service systems.

It is important to bear in mind that when consumption is collective (e.g., a family) each member of such family may seek and obtain a different form of value. Human activity is goal-directed, but we do not share the same goals, not even in close units such as family. Energy studies of households have shown the disparate practices and values sought by household members and how this divergent interpretation of value may pose problems in intervention studies for energy efficiency (Gram-Hanssen, 2010, 2011).

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Table 4 - Typology of value forms

		Utilitarian	Hedonic
Self-oriented	*Active*	**Efficiency** (output / input, convenience	**Play** (fun)
	Reactive	**Excellence** (quality)	**Aesthetics** (beauty)
Other-oriented	*Active*	**Status** (success, impression management)	**Ethics** (justice, virtue, morality)
	Reactive	**Esteem** (reputation, materialism, possessions)	**Spirituality** (faith, ecstasy, sacredness)

Source: Holbrook (1999)

To study the value forms, the laddering method is usually employed. This method is based on the assumption that knowledge structures can be organized into some means-end chains that articulate connections among attributes of the offerings, benefits, and value (Gutman, 1982; Zeithaml, 1988) since individuals understand attributes as operant resources or means to affect some ends (Gutman, 1982). These end states are the positive consequences or benefits that consumers aim to achieve through the attributes of the brands that they purchase. Furthermore, these attributes and their consequences (benefits) might be perceived as a means of meeting a higher-order goal and thereby obtaining value (Peter et al., 1999). Understanding the network of links among product attributes, benefits and value, usually referred to as a 'means-end chain', provides deeper insights into consumer motivation when choosing a product, service or brand (Gutman, 1982). Means-end chains help to explain why an individual chooses a certain brand or accept a certain value proposition. Means-end chains allow researchers to understand the direction of individuals' behaviour by determining what individuals are trying to accomplish, how they are planning to accomplish it and why they are pursuing this particular goal (Pieters et al., 1995). The laddering method (Reynolds and Gutman, 1988) is the

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corresponding methodological instrument for means-end theory and is based on the assumption that individual behaviour is driven by the pursuit of personal values or goals (Gutman, 1982).

This understanding of value has received many criticisms because **it conflates value with well-being and the two are separate constructs** (Hietanen et al.; 2018; Järvi et al., 2018; Peñaloza and Venkatesh, 2006). Consumers may seek and obtain hedonic value and this form of value may jeopardize the value of future generations or other consumers. Think for instance of the value-creating potential of plastics in terms of convenience or sanitation and the value destruction potential of plastics for the planet and other communities where landfills reside. For this reason, others propose to define value as "an improvement in the system" (Maglio et al., 2009). But this leaves open the question of who decides what an improvement is, improvement for whom and at what point in time. For this reason, some authors (Peñaloza and Ventakatesh, 2006) claim that value should be complemented with a theory of well-being and understand value not only as an individual but also societal, compensable (we should be willing to forgo some dimensions of value for others), longitudinal and layered.

This is a valid criticism that should be born in mind when applying S-D logic in policymaking: when we research the consumers' lifeworld, we need to be reflexive and critical because consumers are not necessarily aware of the "context of contexts": value creation for a particular consumer should be compatible with value creation for society.

2.1.5 Axiom #5. Value co-creation is coordinated through actor-generated institutions and institutional arrangements.

In axiom #3 we referred to institutional designs as a fundamental part of the service systems: actors are embedded in institutional orders (institutions and assemblages of institutions) and these orders act as a meta-layer of the service system. The narrative and process of S-D logic are usually depicted in Figure 4 - Narrative and process of S-D logic. We can start studying the value creation process from any point, but the analysis will lead us eventually to examining all stages.

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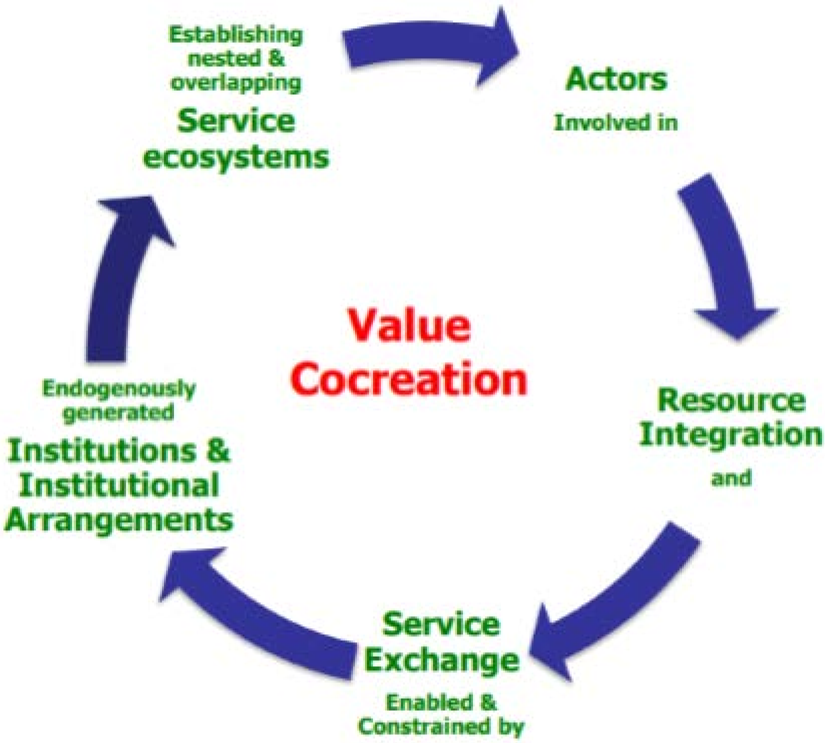
Figure 4 - Narrative and process of S-D logic



Source: Vargo and Lusch (2016: 6)

Institutions come in many forms. Regarding the degree of typification, we can find codified laws, informal social norms, or conventions. Also, we can find symbolic, conceptual or material practices. Traditionally considered as the structure shaping human agency, more contemporary understandings of institutions depict them as the context where human agency unfolds, insofar as humans reproduce but also challenge institutional orders with their discourse and practices.

The introduction of this axiom provides a fertile ground to bridge institutional studies with S-D logic. Notions such as institutional logics, legitimacy and legitimation processes, isomorphism, institutional work may complement our understanding of how a service system works to co-create value for participating actors. This axiom demands zooming out to understand if institutions are supportive or constraining and what institutions need to be overcome/changed/maintained for value co-creation to occur.

2.2 Service systems, resource integration, and value outputs

As aforementioned, S-D logic is a meta-theory about how value is created and how markets are formed. This meta-theory has been applied to explain value creation in specific domains and with this application our understanding of how value is actually created has been enhanced. This application thus contributed to our understanding of the micro-process underpinning value creation.

In particular, this application has nuanced several of the original axioms. First, that service systems self-adjust to produce value. In fact, research has shown that service systems may fail so that value is

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not formed or is destroyed. Second, we have gained a better understanding of the resource integration process. Third, the over-optimistic outlook of S-D logic (resource integration leading inevitably to value co-creation) has been abandoned as it has been shown that the outcome of resource integration may be value no-creation, value creation or value destruction. Moreover, these three forms may coexist in the same service system.

This second part will provide more details about these three notions to build a more thorough understanding of how value is created and what may destabilize energy systems.

2.2.1 A more nuanced understanding of self-adjusting service systems

The original definition of service systems emphasized that they were "self-adjusting", "loosely coupled", "guided by shared institutional orders" and formed by "resource-integrating actors" (Vargo and Lusch, 2014: 3). However, a recent study demonstrated that these assertions did not systematically hold.

First, some service systems are tightly coupled (Mustak and Plé, 2020). Indeed, energy service systems could be considered a case of tightly coupled service systems as they are guided by hard contracts that "explicitly formalize and specify the terms and conditions of the actors' association" with clear specifications and clear power centres. In tightly coupled systems, there is less possibility of self-adjusting and more risk of destabilization unless these contracts allow for resource integration and value creation for all (Mustak and Plé, 2020). Because in tightly coupled systems actors tend to experience limited agency or to limit other actors' agency (Mele et al. 2018; Mustak and Plé, 2020), the possibility of the system's self-adjustment is reduced. Consider the case of energy automatization: the contracts formalize the terms and conditions and clearly specify the tasks and roles of each actor. However, if users disagree with these terms, she has limited agency to rewrite or renegotiate them. The only alternative she has is to opt-out of the system; with this decision, the value will not be created, and the system may eventually destabilize. The service system and the social system in which is embedded thus affect the willingness and ability to integrate resources and with this the outcome of the process (Edvarsson et al., 2012).

Second, actors may not share the same institutional logics (Mustak and Plé, 2020). Neoinstitutional theories have long shown that when there are divergent logics, there are more possibilities of conflict and destabilization. In the case of energy systems, if an actor is guided by the "environmental logic" and another by the "economic logic", their goals may conflict, and value may not be eventually created.

Third, the notion of actors as willing and capable resource integrators and value creation as the main outcome of resource integration has long been challenged (Mustak and Plé, 2020). They will be reviewed in the next sections.

2.2.2 Value co-creation, value creation and value destruction

The original formulation of the S-DL was "overoptimistic" (Mustak and Plé, 2020) as it assumed that value creation was the usual outcome of resource integration (Vargo and Luchs, 2004). Many studies have since then shown that there are three possible outcomes of resource integration: value creation, value destruction or value no-creation (Makkonen and Olkkonen, 2017; Mustak and Plé, 2020) and the

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three may coexist at the micro, meso or macro levels of the system (value may be created in a level and destroyed at another level).

Value destruction occurs when there is a decline in the value created in the whole system (Camilleri and Neuhofer, 2017; Vafeas et al., 2016) or one actor perceives diminished wellbeing as a result of resource integration (Bruce et al., 2019; Plé and Chumpitaz-Caceres, 2010). Moreover, value creation and destruction can co-exist, when one actor in the network accomplishes its goals, whereas another fails to do so (Chowdhury et al., 2016). Value no-creation occurs when the expectations about resource integration are not realized and, consequently, the value proposition or the promise of value is not turned into actual value (Makkonen and Olkkonen, 2017).

Typically, studies have examined value co-destruction, occurring during dyadic interactions (Echeverri and Sklären, 2011; Yin et al., 2019); however, only limitedly has value no-formation been the object of research (Makkonen and Olkkonen, 2017). Value no-formation is however relevant in this context as if actors fail to integrate resources the service system risks destabilization and, consequently, the energy market may not be formed.

Value destruction or no value-creation are likely to occur when resources are not integrated (Makkonnen and Olkkonen, 2017) or when they are misintegrated, namely, they are integrated in such a way that the expectations of actors are not met (Echeverri and Sklären, 2011; Harris et al., 2010; Laud et al., 2019; Plé and Chumpitaz-Caceres, 2010; Smith, 2013; Yin et al., 2019).

Given the centrality of resource integration to explain value creation (or destruction), the last section focuses on antecedents and activities comprising resource integration and explains the routes leading to value no-creation or value destruction.

2.2.3 Limitations in and problems with resource integration

Resource integration can be defined as "the incorporation of an actor's resources into the processes of other actors" (Gummesson and Mele, 2010, 192). The interactive and collective value creation process encapsulated in S-DL draws attention to the mobilization and use of resources by actors that are integrated "across and through networks" (Caridà et al., 2019, 67). The centrality of resource integration in value creation and service systems is a fundamental axiom of S-D logic and service literature. Indeed, service systems can be simply understood as constellations or configurations of resources (Edvardsson et al., 2012).

Although Vargo and Lusch (2004) distinguished between operand and operant resources, subsequent research has provided more granular views of resources. For instance, Hunt and Derozier (2004) classified resources into five types: "(i) physical (raw materials or physical products); (ii) human (skills and knowledge of customers and employees); (iii) organizational (routines, cultures, and competencies); (iv) informational (knowledge about markets, competitors, and technology); and (v) relational (relationships with competitors, suppliers, and customers). They can also be classified as static or dynamic (Baron and Harris, 2008; Fryberg, 2013) since a system may lack some resources (e.g., customers may lack skills to integrate resources) and they can be developed through consumer learning (Hibbert et al., 2012). Actors may own them or simply have access to them (Edvardsson et al., 2014) from other networks or they may be public-common- goods (Greer et al., 2016).

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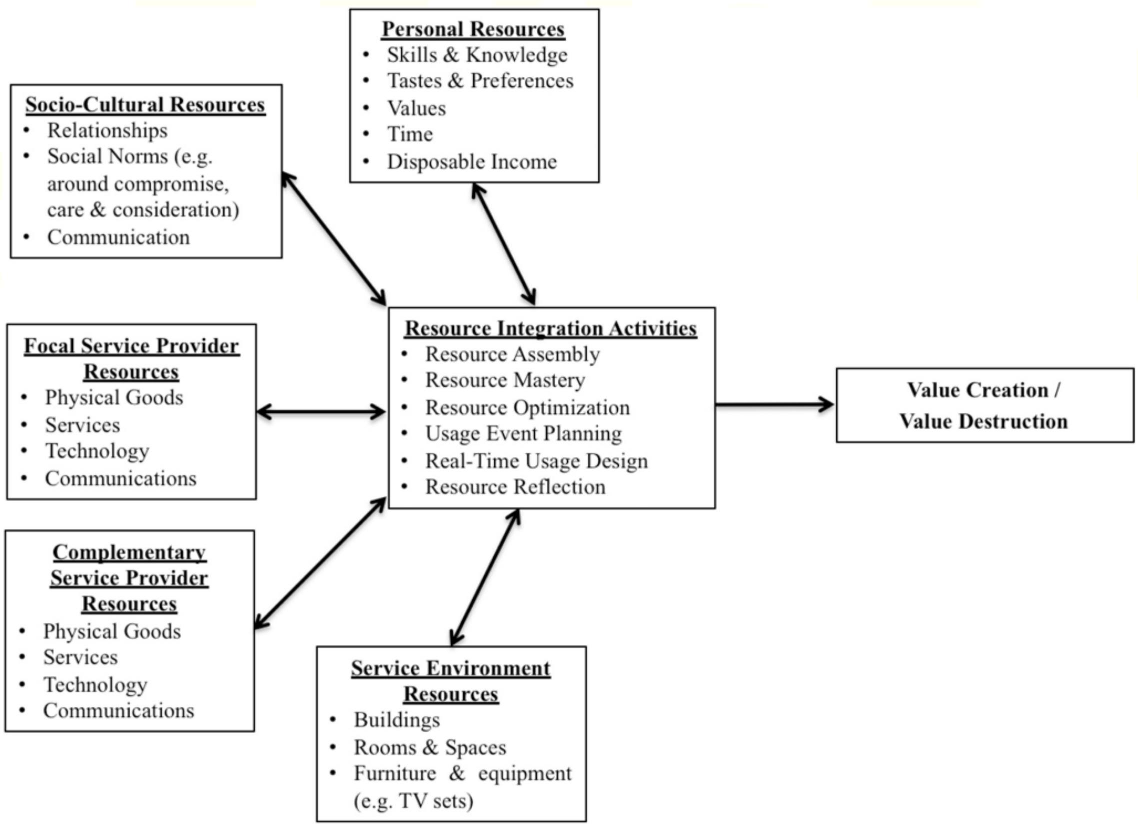
Resource integration is said to occur in three stages (Caridà et al., 2019): matching, resourcing and valuing. Matching concerns the fitting of existing resources. Resourcing concerns the integration of actors' resources whereby basic operant resources become composite operant resources and interconnected operant resources. During valuing, actors assess the process and determine the value outcomes (value has been realized or not); this assessment will feedback and affect subsequent processes of resource integration. In our case, matching concerns the identification and management of actors' resources (e.g., users need to have a heat pump and the skills to manage the automatization tool); resourcing occurs when we integrate our cloud-based system with their installed devices so that the users' and ESCO's resources increase synergistically in the smart management of energy intending to provide superior economic, comfort and environmental value. In the valuing stage, users will assess whether such value has been created and if so, they will be inclined to maintain, or even increase resource integration.

From a different point of view, other studies have identified the activities included in resource integration. They include here the framework proposed by Bruce et al. (2019) to explain resource integration in collective consumption contexts. Although their framework was applied to explain resource integration in TV platforms, the analytical constructs may also apply to our case, as energy value is also created in a collective consumption context.

Figure 5 - Activities involved in resource integration



Source: Bruce et al. (2019)

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This framework can be complemented by Neghina et al. (2015) who identified the preliminary activities that will later facilitate resource integration; in particular, communicating, relating and knowing.

All these frameworks assume that participating actors are willing and capable of integrating resources and that resource integration is unproblematic (Echevarri and Skålén, 2011) leading to value creation. This is not certainly the case.

Resource integration may fail at the matching stage if actors are unwilling or incapable of integrating resources. Resource integration demands actors' engagement (Brodie et al., 2011) and not all actors are willing to engage in the energy system. This may be due to perceptions of risks, perceptions of limited value or trust-issues (Blut et al., 2020; Heinonen et al., 2012). Resource integration is a laborious activity so that users need to dedicate time and other personal resources to manage their own processes for later integration. This planning and application of resources may create anticipated or actual stress; consumers are demanded to invest their own resources in resource integration so that if the created value does not compensate for this emotional and time/cost investment, they are likely to feel burn-out and abandon the service system (Blut et al., 2020; Heinonen et al., 2012). Indeed, research has shown that not all consumers want to engage in value co-creation: they may show an array of emotional reactions from apathy to ambivalence to outright annoyance at being asked to perform certain activities to integrate resources. For instance, think of annoyance experienced by customers at self-managed checkout points in stores or when trying to assemble their own pieces of furniture. Also, lack of trust among actors may explain the reluctance to integrate resources, as the expectations about future value creation are unclear or deemed unlikely.

In addition to lack of willingness, actors may lack the necessary resources, may lack access to them, may lack the abilities to integrate them or to adapt them (Anderson et al., 2016; Bruce et al., 2019; Hibbert et al., 2012; Laud et al. 2019). This may be especially the case in expert systems, such as energy service systems, although it can be remedied with strategies for consumer or other actors' learning (Hibbert et al., 2012).

Also, the absence of clear expectations from each actor, absence of information or limited trust among the actors may halt this stage (Järvi et al., 2018). As noted by Mele et al. (2018) the *resourceness* of actors is not given; rather actors have to realize and appropriate this *resourceness*; or in other words, actors have to become aware that these resources are necessary and that actors have them or can acquire them and use them to obtain value. Institutional arrangements shape not only the actual resources that are available to actors but also the actor's perceptions that she possesses and can effectively use these resources.

If consumers are not willing or capable of integrating resources and this is not remedied, the value will not be created. Anderson et al. (2016) criticize the growing trend to "responsibilise" consumers to co-create value in expert systems. More often than not, we confuse consumers' agency with enhanced well-being, and we overlook that consumers may lack agency or may not be willing to exercise it; resource integration not only demands having a skill, but it is a laborious and ongoing interaction process with other actors (Anderson et al., 2016) and users may not be willing to invest in this process. If this happens, their well-being may be affected. Or said otherwise, if I lack the ability or money to install PV panels and I do not have the ability or money to trade my surplus energy, my well-being would be affected. However, demanding that the consumer acquires this expertise by herself (to

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"responsibilise" the consumer) may be a misguided expectation. In S-DL lack of willingness or ability on the actors' side is seen as a failure of the whole system and must be remedied by the system; it is not the sole responsibility of the consumer's, and the whole network must integrate resources for value to be created (Anderson et al., 2016).

Thus, be it for lack of willingness or lack of ability, if actors do not play their defined roles, value is co-destroyed (Zhang et al., 2018). This route fundamentally halts the first stage in value creation (matching).

During the resourcing stages, resources may be misintegrated. Misintegration may occur because of opportunism or misbehaviour including negligent integration of resources (Järvi et al., 2018) or because of misunderstandings or disagreements of/on how to integrate resources (Laud et al., 2019). In sum, value creation may not occur if resources are not successfully integrated, accidentally or intentionally (Bruce et al., 2019; Yin et al., 2019). To illustrate, imagine a customer not following the instructions to assemble a bookcase so that the shelves bend; the value will be destroyed because of resource misintegration. Misintegration may occur due to ambiguity about each actor`s role and tasks, conflicts among actors regarding the tasks that each actor must perform or regarding the processes or values guiding the service system (Mele et al., 2018). This route halts the second stage in value creation (resourcing).

During the valuing stage, if users assess that value was not created or destroyed for them, they will engage in value destruction activities (e.g., negative WOM, retaliatory actions against other actors, or simply abandonment of the service system) (Järvi et al., 2018; Plé, 2017). When integration or application of resources by one actor in the service system is considered inappropriate by another, the valuing stage will be negative for this actor. So, the so-perceived negatively affected party will try to restore their resources through coping behaviours that will result in the destruction of value for the entire system (Laud et al., 2019; Yin et al., 2019; Zhang et al., 2018). Likewise, if one actor perceives the outcome of resource integration as unfair and/or unsatisfactory, value destruction is likely to follow as the said actor will refuse integrating resources (Gebauer et al. 2013). This second route halts the third stage in resource integration, valuing, and creates a negative feedback loop in the service system so that actors are less willing to integrate resources again.

To make resource integration more complex, in service systems, resource integration is multidirectional, as the exchange is produced in the network interaction (Fryberg and Jüriado, 2009). However, this multidirectional value flows need a governance system; otherwise, resource integration may be chaotic. Unless the goals of actors are coordinated and balanced, and unless each actor accepts and appropriates her role in the system, the value may not be created. If goals are not balanced, actors may try to integrate resources to achieve their objectives at the expense of other actors in the system. Opportunism (Ertimur and Venkatesh, 2010) is one of the reasons why resource integration may fail, but even non-opportunistic actors may try to achieve their goals without realizing that this may compromise the goals or stability of the entire system. Thus, the institutional design of the service system may also be a brake for resource integration.

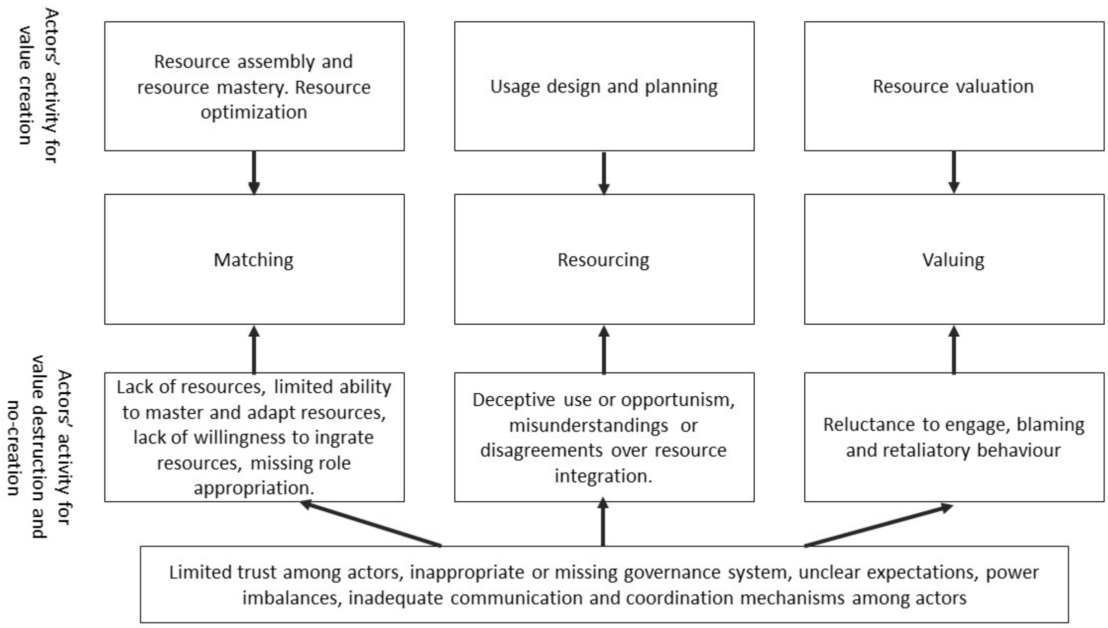
In sum, value no-creation is likely to occur when actors are unwilling to integrate resources or when they perceive or actually lack the necessary resources. In contrast, value destruction is likely to occur when:

- Actors have disparate goals and power imbalances are not corrected by the governance system so that one actor engages in opportunistic behaviour.
- Actors may not benefit equally from value co-creation (uneven value sharing creates perceptions of injustice and this may lead to revenge and value destruction).
- Interactions may influence negatively other actors and contradict, cancel out or nullify value creation in other value networks.
- Actors may have disparate information or there may be social disagreements as to the governance/institutional order that should be implemented.

These conditions are more likely to occur if these factors are present in the service system (Vafeas et al., 2016): absence of trust among actors, inadequate communication among actors, power/dependence imbalance, inadequate coordination mechanisms and inadequate human capital.

Figure 6 - Enablers and brakes of resource integration summarize the activities enabling or braking resource integration in the three stages, following Vafeas et al. (2016).

Figure 6 - Enablers and brakes of resource integration



2.3 Applying S-D Logic to the Energy Service Ecosystem

Several authors have already foregrounded the need to view the energy service system through the lens of S-D Logic as this will help develop successful business models and tap into the possibilities of consumer engagement for the benefit of the system (Ekman et al., 2019; Sadjadi, 2020; Smyth et al., 2018). Indeed, a recent paper identified and classified the prosumer-based energy business models which are, indeed, an application of S-D logic to the energy system (Brown et al., 2019).

It is apparent that the energy industry is presently the epitome of a G-D logic (Sadjadi, 2020). The producer was thought to be the only owner of resources thanks to which the good (energy) was

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unidirectionally provided from producer to consumer. As the consumer used the product, the value was destroyed, and payment was made in exchange for this destruction of value. The energy was understood as a commodity and little research was done to understand the sources of value that the offering provided. Moreover, as the institutional design of the industry was oligopolistic, there were limited incentives to adopt a consumer-centric view to guide the design or delivery of the value proposition.

The notion of smart energy or what we will call here the energy service ecosystem envisions a different form of flows: power is not only owned by producers, but propriety is distributed thanks to PV panels, batteries or demand management strategies. Thus, in the smart grid, the distinction between producer and consumer blurs.

The inclusion of technology is shifting the model from a commodity-based business model to a service-based business model. Consumers no longer want “energy” but “clean energy”, “transparent energy” or “trustworthy energy”. Once the energy loses its commodity status, new value propositions are launched to the market, often assisted with technology (smart homes, smart charging, smart pricing). Each of these value propositions demands a distinct set of skills and knowledge from all actors.

Similarly, it is clear that consumers are not interested in the “energy” itself as this good is just a carrier of other forms of value. Energy should be seen as an enabler of personal projects and it is here where energy acquires value for consumers: energy produces comfort, reduces emissions, or may signal status.

Also, smart energy systems cannot be visualized as a unidirectional flow model, from centralized producers to distributors to consumers. Rather, monitoring and feedback systems create multiple and multilateral flows (Sadjadi, 2020). These flows are being leveraged by other actors, such as ESCOs and aggregators, new incumbents in the industry. ICT developments, such as cloud services, artificial intelligence or the internet of things will also be the basis for new forms of resource integration and value creation (Ekman et al., 2019).

Notwithstanding the potential of smart energy systems to encapsulate the S-D logic, indeed, the institutional design is also embedded in a G-D logic and this may limit the potential development of a S-D logic. Indeed, a fundamental legacy of this institutional design is the widespread distrust in utilities. For example, in Spain commercialization and distribution are controlled by five private companies (Lillo and Pellicer 2014). These companies are closely aligned with the Spanish government which often results in complex energy regulations that restrict competition and citizen participation (Pellicer-Sifres et al. 2018).

Despite these inroads into the application of a S-D logic to the design and management of smart energy systems, it is apparent that extant studies have adopted the lexicon (value co-creation or service system) but failed to fully explain the implications of a S-D logic for energy service systems. In particular, the processes of resource integration for value co-creation (or lack thereof), the role of actors/actants in the system, the recursive relationship between institutional designs and actors’ work in shaping the value co-creation process, or the manifold dimensions of value have not been an object of research.

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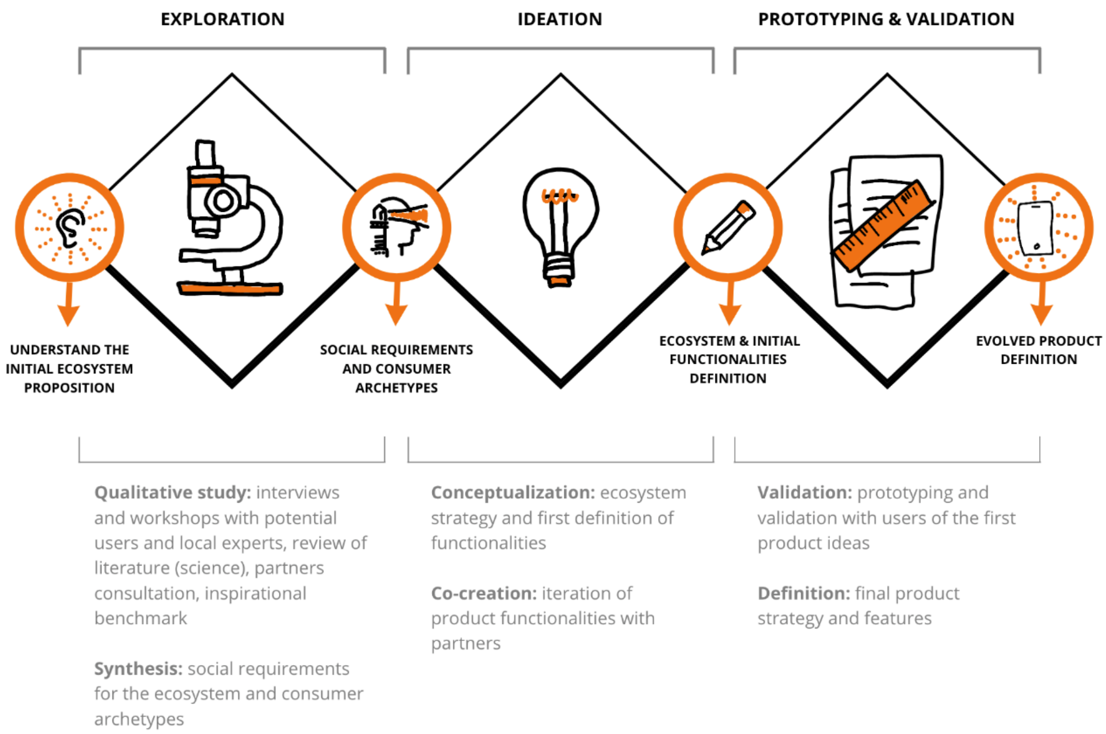
3 Method

This section presents the Method followed for the ReDREAM ecosystem design. We planned three stages - (1) Exploration, (2) Ideation and (3) Prototyping & validation - based on Human-Centric Design methodology (Design Thinking). We choose this approach consistent with the users-centric foundational principle of this project. Figure 7 summarizes the three stages and the sources of data used in each stage. It should be noticed that, before the formal first stage of research, interviews with project managers at the four demo locations were invaluable in understanding the local context and type of users, which was fundamental to design the sampling strategy and interview guide used in stage 1 (Exploration - qualitative study). These interviews were also used to understand the service system as a whole, by probing projects managers about the value sought of different system actors (namely, DSO/TSO, aggregators, retailers to name a few) in the project.

Figure 7 - Human-Centric Design method applied to task 1.1



According to the three stages represented in Figure 7, the findings of the exploration stage are presented in section 4. Social requirements: results of the exploration stage of this document. The outcomes of the ideation and prototyping & validation stages are developed in sections 5. Conceptualisation: a strategic approach to the ecosystem design, 6. Consumer-centric functionalities in the ecosystem, 7. Minimum Viable Product (MVP) and in the annexes 1 (Use Cases) and 2 (Social KPIs).

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3.1 Exploration: obtaining an initial understanding of users

For this first stage, we used a mixed-method approach. First, we conducted a thorough review of existing studies focusing on adoption, engagement and satisfaction with flexibility and smart thermostats, and we provided an overview of studies examining energy-savings feedback, prosumption and gamification to take stock of past studies and unveil evidence-based building blocks of the methodology. The results of this review will be reported in Deliverable 1.5 although the results were used to define the ecosystem. Also, a non-systematic inspirational benchmark on consumer apps was undertaken, comprising both energy and non-energy related apps. Also, the partners' consultation was conducted during this stage to collect key information about the electricity market and market actors' expectations and to verify the feasibility and possibilities of the selected technology to support ReDREAM ecosystem.

Second, we conducted a qualitative study in the four countries interviewing both potential users and local experts, as detailed next. The qualitative study aimed to (1) identify the value sought in energy services and the value attached to flexibility services, energy-savings feedback, as well as assess the missing and available resources for co-creating value with other energy actors; (2) obtain insights for recruiting and engaging local users in the project.

To accomplish the first aim, we interviewed potential users, both residential and business/organizations. Following purposive sampling principles, we searched for archetypical profiles that would match the potential households participating in the project. We aimed for 60% of the participants to be households, 30% small and medium business (SMEs) and 10% industrial. In the UK case, the Constraint Management Zone where the pilot will be implemented has no industry, so we to focus on residential. Regarding residential consumers, we searched for users with different energy infrastructure (with and without PVs, EVs, and heat pumps), different sustainable awareness and degrees of adoption of sustainable lifestyles and different sociodemographic profiles, albeit not seeking for statistical representability. All genders were fairly represented in each country. Croatian informants were the youngest (26-45 years old); Spanish informants were middle-aged (40-55); British informants represented the eldest consumers with a majority of informants over 70, whereas Italian informants spanned all ages. Overall, informants are highly educated, and none of them could be considered vulnerable. The disenfranchised consumer views were represented thanks to the community organizations in the sample that voiced their concerns.

For the field research in Italy, Croatia and the UK, and favoured by the COVID-19 travelling restrictions, local researchers were engaged for the job. The selection criteria considered previous experience in energy projects and the research's local area, among others. The experience was very positive as the interviews felt more comfortable and closer to a native speaker and fellow citizen. Soulsight, with headquarters in Madrid, ran the field research in Valladolid (Spain).

Regarding industrial consumers, they were mostly SMEs in both manufacturing and service industries, although we also included NGOs that could be potential users (e.g., universities and NGOs).

To accomplish the second aim, we interviewed in each country two or three local experts in citizen participation, sustainability and/or energy devices and solutions. Some of these experts were interviewed in their twofold role of the potential adopter and local expert. These informants have been ascribed to the residential user's role. In Italy, governmental actors are heavily involved in the pilot demonstrations; therefore, we included the views of local and regional governmental offices in the study. In other countries, the role of governmental actors was captured in the interviews with local experts as their role is not as central in the demonstrations. Also, participants in the focus group were chosen and asked to reflect on the most suitable means and messages for recruiting and engagement in the area.

Profiles were defined by the research team and sent to the interviewers in each country. With the aid of local partners, informants matching the theoretical profiles were identified.

In-depth interviews were held online or face-to-face depending on the COVID-19 restrictions in place in the country and the informant's preference. In particular, all interviews in the UK were held online as the country was in lock-down at the moment; all interviews in Spain were held face-to-face except for three (two residential users and a business organization); in Croatia and Italy, most of the interviews were conducted face-to-face except for the roundtables which were held online due to the COVID restrictions for social gatherings. In addition, nine interviews were held in Italy and 10 in Croatia (five of them face to face, five online and two questionnaires). Interviews lasted from 45 to 90 minutes.

Additionally, four focus groups or roundtables were carried out, one in each country. Whereas in-depth interviews examined meanings and habits about energy and the energy services proposed in this project, the focus groups aimed to explore common points and differences of opinion unveiled in the in-depth interviews. This research technique helped us confirm and contrast findings from the in-depth interviews, discover new relevant topics and motivations triggered by a group discussion, and verify if users share individual perceptions. The focus groups also provided insights from local experts about the drivers for recruiting and engagement with the aforementioned services. Table 5 provides a brief description of the participants.

Table 5 - Description of participants

	Croatia	Italy	Spain	UK
Potential users				
Residential users/households	8	7	10	9
Organizations (service & manufacturing for-profit and non-profit organizations)	2	4	4	-
Local experts				
Local organizations	2	5	2	3

The interview guide was slightly adapted to each country but followed the general ReDREAM project areas (automatization, demand-response, and prosumption). Additionally, the interviews and focus-groups collected their assessment of the interfaces designed as part of the recruiting and engagement methodology (app, gamification and social media tool).

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In compliance with GDPR and with EU ethical guidelines for social research, all interviewees were informed of the research's purpose and signed a consent form ensuring that the interview was carried out freely and voluntarily. The interviews were transcribed for analysis and anonymized. Transcripts were only analysed by the three analysts involved in the project, and they were saved with a pseudonym so that they could not be traced back to the informant's identity. Quotes have been slightly changed to maintain the anonymity of informants when their quote would reveal their identity.

The analysis was done separately by the researchers' team, who later joined to discuss and harmonize the findings and their structure in overarching themes. The core axioms of SDL inspired the thematic analysis; in particular, the analysis first examined the forms of value sought in energy services-as well as in each of the three non—energy services under study-. Second, we explored whether informants had the resources necessary to co-create value, which resources were missing, and which networks they could draw from to obtain the missing resources. Third, we explored each context's overall readiness for the adoption of the energy services tested in this project. Fourth, we examined the initial disposition toward the design elements based on which we will propose design principles.

3.2 Ideation

This stage concerns the creative process, called conceptualization, where a first draft of the ecosystem was defined using the insights from the research, as well as the guidelines defined by the Grant Agreement. The conceptualization stage bridges users' value forms, resources and limits to using resources with project goals. The conceptualization stage unfolded iteratively so that through different iterations the ecosystem was more and more aligned with the so-defined social requirements.

This conceptualization was followed by co-creation sessions with project partners. The main goal was to integrate stakeholders' objectives with users' needs, so to ensure that the service system would work harmoniously and create value for all actors. The relationship with stakeholders went from informing them about the research to co-create with them in subsequent iterations of the ecosystem ideation where collaboratively solutions were identified.

These co-creation sessions were held virtually due to COVID restrictions on mobility. Soulsight explained the archetypes and main learnings from the research phase, presented a broad overview of the ecosystem and discussed with each partner the specific functionalities at which a given partner had a stake. Figure 8 provides an example of the template used in a specific co-creation session focused on social network and gamification. In total, four co-creation sessions were held.

1. UTBM (Mobility services): the main goal was to define how mobility could be integrated into the ReDREAM ecosystem as mobility services were the least related to energy by users. Mobility will be data gathered to see how users could improve their general energy consumption mostly seined as carbon footprint.
2. Comillas & Stemy (Ecosystem, Energy efficiency, Demand response, Advisory tool and Virtualisation): This co-creation session aimed to define the service so that it responded to the users' needs.
3. NTUA (Comfort and air quality): the comfort co-creation session aimed at integrating comfort in efficiency and flexibility data for users.

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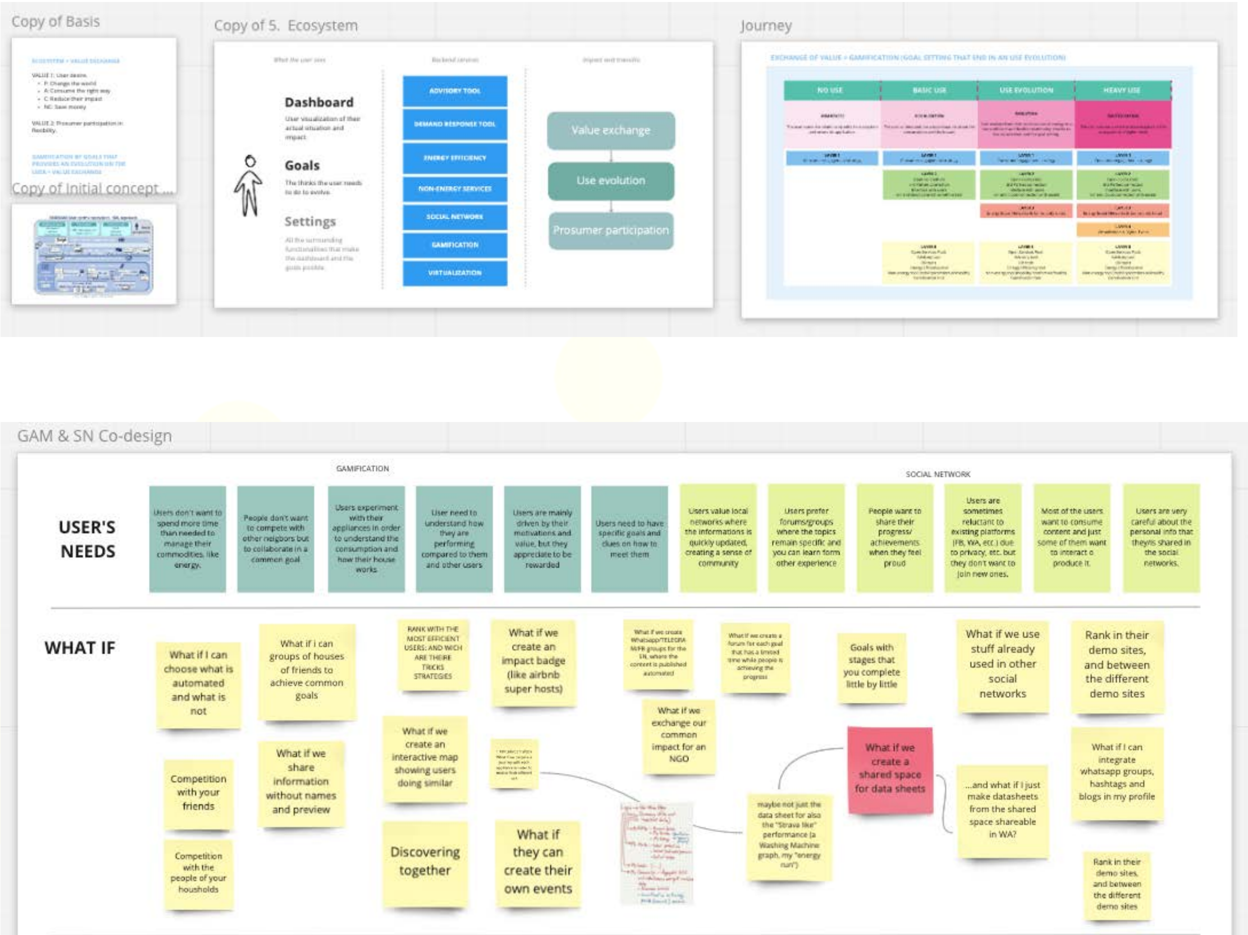
4. Rimond (Social network and gamification): this session was key to translate users' own understanding of a "social network" and gamification into appropriate functionalities in the ecosystem.

Figure 8. Example of co-creation template for social network & gamification aspect used in the workshop with Rimond.



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3.3 Prototyping & Validation

With the inputs of the previous stages, a first prototype of the ecosystem was designed in *Table 9* to validate the prototype and refine the functionalities, validation sessions were held online with potential users. Table 6 describes the number of validation sessions broken down by users type and country.

Figure 9 - Example of ecosystem and dashboard prototype

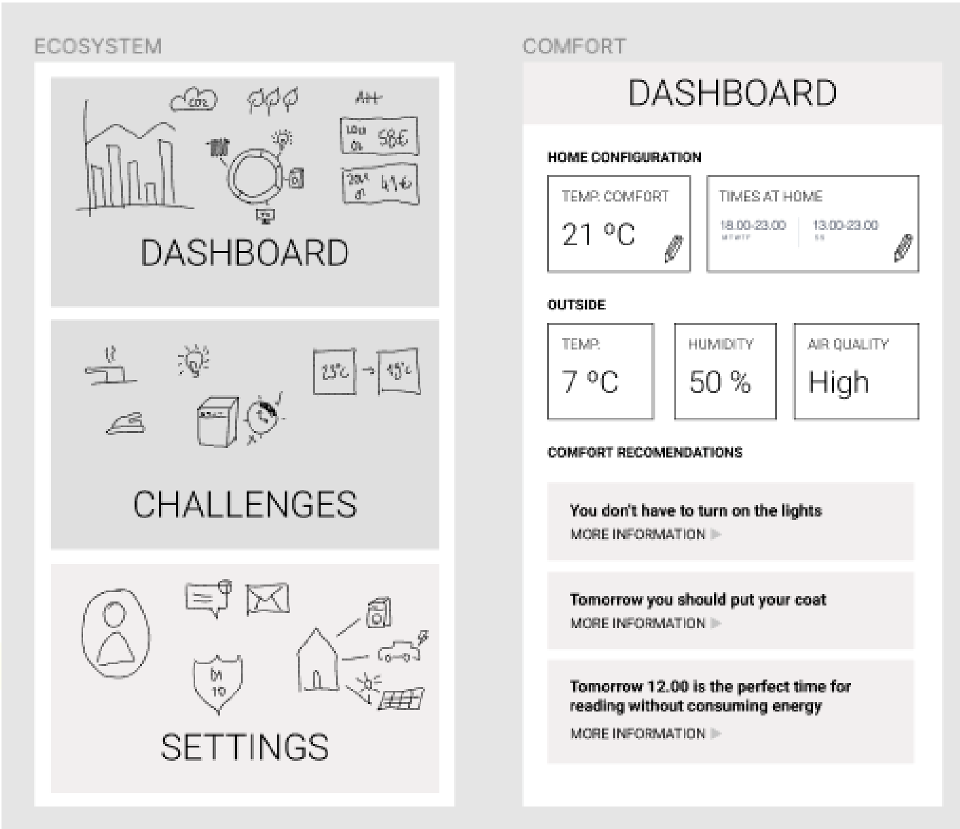

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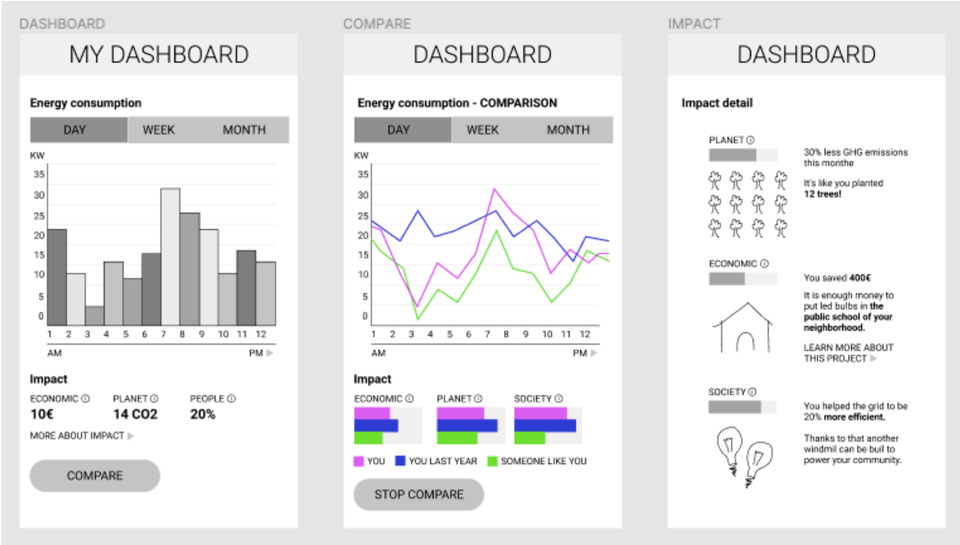
Figure 10 - Example of dashboard prototypes



The main goal was to examine how participants understood the general ecosystem overview and the functionalities designed with stakeholders to motivate their participation in the project. First, participants were asked to interpret what they were shown and their first reactions and understanding of the functionalities presented were collected. Second, after the explanation of each functionality, users were asked what they love, what they would improve or change. With this procedure, we could observe their first reactions and compare them with the subsequent reactions to assess any gaps in information explicitness.

Table 6 - Participants in the validation sessions

PROFILE	COUNTRY			
	UK	**Italy**	**Croatia**	**Spain**
Residential	2	1	1	1
Commercial		1		
Industrial			1	

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4 Social requirements: results of the exploration stage

4.1 Introduction

A fundamental axiom of S-DL is that value is phenomenologically and contextually assessed. Thus, although the value obtained may differ in each instance of service, it is also true that individuals have chronic preferences for some forms of value. Attending to these preferences is a cornerstone of a customer-centric model. Customization is a fundamental *a priori* condition of the engagement methodology: since individuals diverge on their preferences, different strategies to cater to these different preferences can be identified.

Second, we identify the user's available resources and discuss whether users are willing and capable to integrate them. We complement this explanation with a mapping exercise of consumers' networks where users can draw from to obtain their missing resources. Based on this analysis, we identify each demo location readiness state.

Third, we analysed the users' requirements for each of the layers originally envisaged in the project proposal. More specifically, we showcased users' needs per project layer (engagement methodology, open co-creation, social network & community cloud, virtualization & digital twins, advisory tool, demand response tool, energy efficiency, non-energy services -health, comfort and mobility- and gamification). These findings are reported in the form of propositions that need to meet in the ecosystem design.

Fourth, these findings are synthesized by identifying users' archetypes or profiles users based on two dimensions: (1) energy awareness and or energy involvement and (2) technology involvement or personal innovativeness. To validate the archetypes, we provide illustrations of real users and show their suitability by relating them with the forms of value sought identified above.

We conclude the section by explaining the value sought of other market actors in the energy service system.

When discussing the findings, four aspects should be borne in mind. First, there are country commonalities. That is not surprising given that the context shapes the codes of choosing and therefore, the value sought in services. Minor differences were found across countries, mostly regarding the prevalence of a given theme; patterns were common, particularly around the desire to have integrated and straightforward solutions embedded in the technologies consumers are already used to. There is a high need for "control" in some countries, so automation must be flexible and real-time matters to make decisions. Personalization is a must especially for users to move into a better "way of living" where the word "degrowth" was frequently mentioned in many countries, meaning consuming less, avoiding waste and reducing environmental footprint. Participation in communities was essential. And finally, a highlight about comfort and non-energy services: users appreciated comfort inside their households (reflected in the right temperature and sunlight) but the notion of comfort broadens to include the surroundings of their homes.

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Second, not only each individual prioritizes various forms of value; also, the same value – ethical value – is associated with various attributes by different individuals – e.g., for some this value is associated with low carbon emissions, for others, with lack of waste -. These value forms also seem to be shaped by context.

Third, if we accept that value sought is a type of goal, we should distinguish between approach and avoidance forms of value. This is to say, that individuals phrase the value sought both in positive and negative terms. What individuals avoid or escape from are also important behavioural drivers and should be included in the analysis.

Fourth, although we expected greater differences among residential and commercial users, the findings were contrary to our expectations. We observed that residential and commercial users were similar in manifold aspects, probably because the organizations were very small and usually led by one or two individuals. In other words, the motives and brakes for energy management at home were not that different from managing energy at the workplace. Indeed, we could easily place different commercial users in the archetypes defined. We have remarked in the analysis the differences seen among residential and commercial users. The adaptation of the ecosystem design to adjust to the different requirements of each profile are reported in section 6, specifically in *Table 26 - ReDream ecosystem list of functionalities*.

4.2 Self-oriented forms of value sought

4.2.1 Efficiency: minimize energy costs and get a return on investment

A fundamental motivator for all informants is the reduction of energy bills. All informants had enough income to afford their energy bills and for many, these bills are a not significant percentage of their monthly expenses, especially in the warmer months. Italian informants are an exception: they acknowledge that reducing the energy bill is the main motivator. Also, Croatian informants anticipate an increase in energy prices and this forecast is an incentive to change habits or to invest in structural changes in their homes. Others, however, recognize that the billing structure does not allow for important savings; taxes and smart meter rental account for most of the energy bill and consequently the impact of consumed energy on the overall payment is negligible (could represent yearly savings of 20 euros).

> *"It is a big mess, like mobile phones. It seems it is really expensive, but in reality, what makes the bill raise are distribution, infrastructure, etc". (Residential user, Italy).*

Energy reduction can be achieved in diverse ways: by means of better home insulation (pretty mentioned by UK participants) or retrofitting, use of more efficient devices (e.g., LED bulbs are mentioned by most of the informants) or shifting energy consumption to less costly time slots. In particular, shifting consumption seems easily adopted, since informants with a night or dual tariff shift energy-consuming tasks to off-peak time (e.g., washing machine or dishwasher). Similarly, usually, Photo Voltaic installation (PV) is accompanied by shifting energy consumption to daytime, to make the most of the produced energy. This shifting has provided some initial training in demand-response which may facilitate their engagement with the energy service provided in this project.

> *“We are careful to turn on the washing machine after 10 pm when the electricity is cheap and that is the only thing we do. I can recall that we save money on energy in any other way.” (Residential user, Croatia).*

However, this shift may not occur if it interrupts family routines or when the consumer is less price sensitive. This quote, from a British residential user, with a higher-than-average environmental awareness, shows that energy shift may be curtailed for other reasons, such as convenience.

> *“I am aware of it [emissions being reduced at off-peak times] and I like, you know, ignore it. So, I'm not one of these people who turn on their washing machine night time or on a timer. So, I just tend to use things when I want to, even though they're slightly more expensive, I just, we're getting on and do it.” (Residential user, UK)*

Similarly, those with PVs shift energy-consuming appliances to daytime, to take advantage of the energy they produce, as the following verbatims show:

> *“We've tried to push... we changed our tariff to an off-peak tariff and we got a very low energy cost in the middle of the night when the carbon footprint is at one of those low points. And so, we've tried to shift as much as we could the energy use to that time at night, which is a double bonus as the costs very low and it also has a low carbon footprint. Our electric car is on a timer so it's not charging until about midnight, therefore 99% of the electricity we use for transport is consumed during the middle of the night when the carbon footprint is low. Various appliances in the house are set on timers to start at the same time too. (Residential user, UK).*

> *“We set up all the expensive appliances like dishwasher, dryer, washing machine to run between midnight and 7 am. So, we're about to reduce costs by a third. We have solar panels fitted to the roof, for five years. So, they've almost paid themselves off. We got in when they were paying us to generate electricity. So, we hadn’t any problems with solar panels. If it's a good day, and it's generating lots of electricity, then we don't mind plugging in the dishwasher, or washing the clothes because you effectively get a free wash. Yeah, we're quite an energy conscious.” (Residential user, UK).*

Other informants report smarter use of energy, such as unplugging unused devices or not using an energy-operated device if an action may be performed without it.

> *“For me, it makes no sense to switch on the hairdryer to dry my hair…we have a pellet stove at home, so I seat next to it and I dry my hair…I think I do it because my mother taught me it since I was a kid.” (Commercial sector, Italy).*

> *“Drying clothes in lines instead of using a dryer machine.” (Residential user, Spain).*

However, not all these alternatives have the same impact on overall bills. We have observed wide differences in energy literacy regarding this differential impact. Whereas some informants are well informed and choose the alternatives with the greatest impact, others seem misguided in their conviction so that switching lights off is their ultimate energy-saving habit. Unless users can draw from an adequate network that provides this informational resource, they may not switch to the most impactful energy-saving actions. One of the participants in the focus groups in the UK provides a good example of this. He advises others about how to reduce their energy consumption and he was trying to persuade a friend about the actions with the greatest impact.

> *"He (referring to a friend) was worried about unplugging his phone charger at night. There are tiny amounts of residual energy in that, but his house is a big old sort of farmhouse, his wife felt cold and they keep it at 23 degrees Celsius all the time. But if you ask him how he saves energy, he will tell you that he is unplugging his phone charger at night. One thing that is probably three orders of magnitude smaller [than the house heating]). So, I find that people have quantitatively almost no concept of what the reality is, even though they might have very good intentions and they really want to do something." (Residential user, UK).*

Retrofitting is the most expensive alternative. Unless buildings are already constructed with energy-efficient criteria (e.g., Climate houses in Gallese owned by a couple of informants), it is very difficult to change them afterwards. As we will discuss later, there are many barriers to retrofit, notably the investment required, the heritage-like protection on houses (especially in Bath and Gallese) or the non-ownership of the house.

> *"We can't put anything on the outside. The alternative is doing it on the inside, it means taking all the plaster off. That's all major, major work, isn't it?" (Residential user, UK).*

> *"But when you've got these thick stone walls, that's where you lose most of the energy [you cannot retrofit]) unless you start putting external insulation all around the house which will change the appearance. In some areas, if you've got a grade two listed building or in a conservation area, that's not possible." (Residential users, UK).*

All informants complain and regret that new housing regulation does not impose building restrictions that make houses energetically autonomous and efficient. These complaints are even stronger among British informants: building works as a sort of nudging, as it will shape the energy-consumption habits of its inhabitants and it is regrettable that regulation does not impose some minimum energy-efficiency requirements.

> *"We find housing regulations absolutely outrageous, that new builds aren't having all solar panels and everything that they could have when you're constructing a house. That's outrageous, so that should be law from now. (…) If you go to Belgium, almost every house has a rainwater collection system. And they use this for I think their washing machines, showering, the washing, and toilet flushing, rainwater collected in a big tank, they put them in the ground in the garden. And they have filters and whatever. So, it's not dirty water you get but not as clean as comes out of the tap. This sort of thing could be incorporated in all housing estates. And for individual houses, and there should be a regulation saying `this should be the way you do it´." (Residential user, UK).*

> *"But even with a modern house, it's actually quite difficult to retrofit solar panels, you know, or the charging point for car, or to change the boilers and air source heat pump. It is just suddenly trying to think, okay, where we're going to put the pipes, where to put the wiring, you know, can we put a hole here?... you're trying to retrofit things and sometimes the restrictions on what you can do because of the design of the house [are a big barrier]". (Residential user, UK).*

Some informants have resorted to a sort of DIY (Do It Yourself) low-cost retrofitting, trying to fix the most urgent leaks to retain heat and not to waste energy. This DIY is especially common among British informants.

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"So, we've sealed off a lot of bits. We pushed in more rock wool and insulation where we can. The doors all fit closely. There's a space in the kitchen that needs something doing. I think a bit of air is coming up under the floorboards on the north face in the kitchen." (Residential user, UK.

SMEs experience similar difficulties, adding to this that the replacement of energy-inefficient machinery may be difficult or impossible. This is the case of an Italian entrepreneur, that operates a bakery. She would like to change the diesel-operated oven and get an electric one, but she is not going to change it because she already spent a lot of money to buy the business and because she would need to destroy the building to change the oven, as the bakery is built around the oven.

Reaching a zero balance is another form of efficiency value. In particular, those installing PVs were motivated by a desire to reduce their bills in the context of the growing usage of electricity. As they could not improve their efficiency by controlling demand, they turned to production.

"I'm almost certain that in the next five years' time, I'll be consuming considerably more than I am now. This is because I envisage over the next five years, we will change our second car family car, over to electric, at which point, you know, we'll have a far greater electricity requirement. So, reducing our demand, I don't quite see how [we can do it]... I don't see obvious ways to make any significant savings in the electricity that we consume. A far more interesting topic for me is just generating more locally." (Residential user, UK)

"The price of natural resources is rising; this is also a trend that cannot be stopped (…). I am investing in RES to lower my future costs, which could increase." (Residential user, Croatia).

Whereas energy savings is the major motivation for installing PVs, businesses have an additional incentive in obtaining eco-certificates of carbon neutrality which will provide a further competitive advantage and commercial appeal to their business.

"I was interested in RES because it will make my farm CO_2 free and I could get another certification and a label for my eggs, which are already bio 100%" (Commercial sector, Italy).

Finally, in the UK the participation in the energy community was motivated by financial goals: some members of BWCE recognized to have joined out of the possibility of making a greater return on investment than with a deposit in a building society.

4.2.2 Convenience: avoid any hassle

In addition to energy bills reduction, convenience and ease of use emerge as a fundamental value sought that may often conflict with other forms of value. Informants are not willing to experience stress or hassle associated with habit changes. For this, easy-to-adopt behaviours are prioritized over others that, albeit more impactful, demand more time and effort to be implemented.

"I have a smart thermostat at home, and it works great. You don't have to worry about it, it turns on on its own at a certain time in the morning. (…) You don't have to worry about a thing." (Commercial sector, Croatia).

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Although all informants recognize that they would not adopt a service that would be too demanding, Croatian informants were especially adamant about their goal to have hassle-free services and were willing to adopt technology or digitally enabled smart solutions that save them time and stress.

> *"Everything will be automatic (sic), so we don't have to think about anything too much. There will be computers and robots doing the work." (Residential user, Croatia).*

> *"Smart devices will become more available and better integrated into homes (…) for performing chores in the household." (Residential user, Croatia).*

> *"The goal is to solve the problem in the simplest possible way and once we solve the problem, I won't have to deal with it anymore." (Commercial sector, Croatia)*

> *"It is fundamental] that devices are reliable and work without a lot of maintenance." (Residential user, Croatia)*

Convenience (or hassle-avoidance) is also a reason for rejecting notifications with energy-savings tips or for rejecting apps that demand ongoing phone-checking. Even though informants are willing to spend more time initially, they also expect that time-demands drop significantly or they would discontinue using the app or service.

4.2.3 Experiential: meanings of comfort

Comfort is associated with different meanings, beyond energy or energy-enabled functionalities – such as a clean house). Focusing on energy-related sources of comfort, all informants associate it with having the right temperature at home-which may oscillate between 19 C degrees for some (An, Italy) or 23C (Residential user, UK).

Energy-producing such as log-burner is often mentioned by British informants as they associate them with "cosiness", even though they are aware that log-burners create polluting fumes and may betray their goal of living an environmentally friendly lifestyle.

> *"I find what makes the home really cosy is a very un-environmentally friendly thing, which is a log burner or fire. I've always had an open fire in every house I've had. And even if you don't have a very big one, it does make that sort of moving glow. So, I know burning logs is probably going to be outlawed. But just to have moving fire. I suppose. It's a very primitive thing that makes a house very cosy." (Residential user, UK).*

For others, comfort implies having free time and space to carry out much-desired activities. Energy plays a role here as it is used to power the appliances that help save time (e.g., washing machine) or enable leisure activities (e.g., internet).

> *"Comfort at home is about getting rid of many tasks and duties that can be successfully handled by the use of technology…" (Commercial sector, Italy).*

> *"Comfort for me is that internet is available." (Residential user, Croatia).*

> *"That I don't have to worry about anything. That I can live in a relaxed manner and use all the devices I need." (Residential user, Croatia).*

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In Italy, comfort is associated with silence (mentioned by two informants) as well as the absence of electromagnetic radiation (mentioned by two residential users in Italy and Spain, respectively). Obviously, comfort is also linked to functionalities where energy may not play a part, such as natural lighting, large rooms, the surroundings, and the outlook from the house.

> *"You know, we've got room, we've got the sun in the front… (Residential user, UK).*

> *"I think having good natural light is important. I don't want sort of, rooms which are too small or boxy with really low ceilings." (Residential user, UK).*

Another functionality of comfort is to have control over temperature and appliances. This search for control may become a brake for greater automatization and smart systems. Even though they would appreciate a system that reduces the hassle and time-spending, users also seek to retain control over it.

> *"You know, I don't want to spend a lot of time fiddling with things, you know, some people might enjoy doing that. So, I think, I think it needs to be quite easy to use and quite flexible. So, if your routine changes, you know, because it's a weekend or whatever, yeah, you want to be able to sort of switch it to manual." (Residential user, UK).*

Fewer mention reliability of supply (only Croatian informants mentioned it); notwithstanding, as some British informants reckon with increasing abnormal events such as storms or heatwaves, security of supply cannot be taken for granted. This realization indeed prompted some of the British informants to install PVs to gain greater autonomy, in the case of power cuts.

> *"So, I think there's a real risk that with more extreme weather events, we'll have more storms, and we'll have more power cuts. So, I think, I think looking over the next 10 or 20 years, is, there's a real risk that we'll have less reliable public utilities. And so that's one of the reasons why I thought if I put in some, myself, I'll never be independent of the grid, but it might give me a buffer". (Residential user, UK).*

4.2.4 Aesthetic value

Despite the importance of aesthetics in providing comfort, the aesthetic value was not often mentioned by informants. The aesthetic seems more of a requirement or a must-to-have functionality (if PVs are not nice, or the design does not match the style of the households) than a value sought.

> *"Most important for me is functionality and savings. If you ask my wife, she would say design is very important… and she's the one who makes the decision!". (Residential user, Croatia).*

> *"And why wouldn't you want to put solar panels...? I mean, they're not ugly. They´re quite discreet, I mean, they're dark in colour, they're pretty uniform in shape, they're just like large, very large tiles on a roof. I can't see any reason why anyone would object to solar panels, yet people do... Amazing!. Some people think that it would spoil the look of the environment. I don't see that". (Residential user, UK).*

The importance of aesthetic value is however found in the stores of rejection to PVs told by some of the informants. For instance, the next quote illustrates how neighbours oppose the installation of PVs on a church as locals were afraid of this changing the aesthetic of the place. This story underlines the

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need to cater to aesthetic styles so that these new systems are not considered invading and thus resisted.

> *"But there was one, you know, where they put some panels on a church. And you wouldn't believe the..., the bile and the vitriol around this because it changed the character of the neighbourhood. You know, it's like this really awful, ugly, 1950s building that used to be the gym for the school for the secondary school, and then became a, you know, is now a church. And, you know, so I asked me at the time, she said, you have to put in a comment in support, we need as many comments as possible in support, because there's a considerable lobby to stop this happening because it's ruining the character of the neighbour. [They want] to keep things the way they are wanting to keep the area looking the way it is." (Residential user, UK).*

4.2.5 Episteme value and play/fun value

Episteme is the form of value associated with learning and acquiring new knowledge. Overall, informants declared their interest in ongoing learning about their hobbies and personal projects for which they use a variety of resources. However, episteme value in energy was mentioned by some informants and especially in Spain. Informants were keen on understanding their energy consumption and how the energy system works. This learning is instrumental to obtain greater efficiency and reduce further the bill and have more control over their consumption or gain autonomy from the system, a goal associated with their environmental views (see section 2.1.2).

> *"I would love to track my consumption. There is a device…I considered buying it, but it is too expensive, so we didn't do it." (Residential user, Croatia).*

> *"I would like to have a detailed view of my consumption, some more detailed consumption statistics of my devices and to know which ones [appliances] consume more and less. I know the total consumption on the bill, but I don't know what devices consume more or less". (Residential user, Spain).*

> *"I used to use the app to control production a lot, almost every day". (Residential user, Spain)*

Episteme value is often associated with individual change since it is widely believed that if individuals are aware of their own consumption, they will be ready to change their practices.

> *"If every person, every household could see how much they spend and on what, it would shock them and cause them to change their behaviour and spend less" (Residential users, Croatia).* However, she later acknowledges that an energy app *"if it started being a burden and taking too much of my time and if I was feeling uncomfortable… I would stop using it" (Residential user, Croatia).*

As we will discuss later, in fact, information about consumption may activate guilt feelings that may not prompt a change in habits when these habits are fundamental personal projects of the individual.

Additionally, an energy app would provide episteme value for parents to educate children (Spain and Croatia), school students (Italy) or university students (Italy and Croatia). Learning how energy works and its impacts on the environment is considered an awareness-raising strategy by most of the informants.

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> *"I would be interested if people could understand the energy use as a whole, rather than just thinking about heating your home or your hot water". (Residential user, UK).*

> *"The fact that I have chosen a biomass heater somehow is a way for me as a mother of a family to implement the things my kids learn at school." (Residential user, Italy)*

Play and fun value are also associated with the episteme value. Whereas for some informants learning was a means to obtain other forms of value (namely, greater efficiency, more control or reduced impact), for others learning – and especially learning about the production of their PVs -was an end in itself as a playful and enjoyable activity, similar to a game.

> *"With the traffic light system, it would be very easy. If I had a panel that tells me what appliances I can turn in and which ones I cannot". (Residential user, Spain)*

> *"I think everybody's got a bit of competitiveness in them. And I think it is a good motivator for, making improvements, in a way... But if that means less carbon, then why not get people to compete against each other". (Residential user, UK)*

Play value or the enjoyment of self-improvement and learning was spontaneously associated with the gamification tool. Competition in a serious game was considered a driver by most informants. They diverge, however, in their understanding of the goal of the game. Croatian informants accept a more individual competition, where a neighbour competes against others to obtain the greatest energy savings. The other countries seem more prone to accept a collective or cooperative goal, that could be achieved with the cooperation of all incumbents. Such goal could take the form of efficiency gains (e.g., Italian respondents suggested competing with other nearby villages in energy efficiency) or environmental goals (achieving a target of emissions in the UK or shutting down a nuclear station in Spain). Individual competition is rejected in Italy because it would imply being singled out in town as a red or green consumer which in a small village would create more problems than advantages. Using a collective place identity seems easier to encourage competition, so that Gallese, as a whole, compete with other villages. This approach will tap onto villagers' pride to be placed above other villages (roundtable, Italy). Still, others disagree as they underline that enhanced status and individual efficiency gains are important values ("The energy community will be welcomed only if I -myself -gain: the typical Gallese inhabitant does not want that a neighbour gains!", local expert, Italy)

Although the idea of a gamified tool with a customized goal is attractive and informants tend to agree it would motivate their peers to participate and engage with their energy consumption, they are less inclined to share their data. However, sharing their "energy" data, in general, was not a barrier as they found it not relevant as personal data (name, address) is. Trust in "whom" were they giving their data to was a pattern in all countries, highlighting that if they trusted the organization and the community, they would not mind sharing data, but never for commercial purposes. Sharing all this data and making their own consumption data visible would be a condition for this tool to work.

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4.3 Other-oriented forms of value sought

4.3.1 Status: placing oneself above the neighbour

Another form of value that is associated with the adoption of certain energy services is status. Being an early adopter confers status in the form of social appreciation or admiration by others and this is a cherished goal by some informants. Obviously, they are not eager to recognize it, but this form of value surfaces in the interviews when, for instance, Croatian users recognize that having a PV installed is “trendy” or a sign of “modernization” that makes a household stand out, or when local experts emphasize that herd effects are powerful in driving demand (“If the neighbour has it, I have it” SME, Croatia). It is also found in Italy when users share with pride their decision to install a biomass heater and position themselves as more experts or more advanced users in the village as a result. Similarly, in the UK, a residential informant acknowledged the pride and joy he felt when he was among the first to drive an EV:

> *“And now our electric car, I wouldn't say looks mundane. But doesn't turn heads anymore. But when we first got it, people pointed as we went by. I enjoyed that”. (Residential user, UK).*

However, status is not a salient form of value in Spain, where esteem is more dominant, as discussed next.

4.3.2 Esteem

Whereas for some, adopting new energy services is a way of status-signalling, for others is a source of esteem. Even when their peers do not recognize their efforts and/or when informants do not experience their peers’ admiration, being an early adopter creates feelings of pride and achievement in the individual. This pride is the result of realizing or enacting their pro-environmental or pro-social identity: as individuals implement energy-infrastructure or adopt energy-related habits in accordance with their sustainability ethos, they feel positive emotions about themselves that boost their self-esteem. Esteem is an intrinsic type of value, experienced regardless of the actual impact of the behaviour on the planet. In other words, even if an energy-related practice adopted has not much environmental, or its effect is dubious, it may fuel feelings of self-esteem, as these quotes illustrate.

> *“We got a green energy supplier, which I've got some sort of reservations about how much of a positive thing that really is. I think the only effect that having a green energy supplier really has is making everybody else's electricity slightly dirtier, and making you feel better about it”. (Residential user, UK)*

> *“We know we need to reduce our emissions and burning any fossil fuels is a bad thing. So, if we were to get rid of the oil, we hope that would be... I mean, it's a drop in the ocean, I know, it's only us... But if millions of people, did it. So, the air source heat pump again might make us feel a little bit better”. (Residential user, UK)*

For others, esteem value is obtained by being among the first in trying out an innovation. Realizing this desired identity of an innovator or early adopter is a strong motivation to adopt energy-related services, even when adoption may not imply economic advantages, as the next quote shows.

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> *"I think I think when all said and done buying a Tesla Powerwall battery at 10,000 pounds is too expensive. And I'd only be doing it not on the basis, I think I'd be saving money or making money. But I think it'd be part of being an early adopter and finding out about the technology and how it works and what it does". (Residential user, Croatia)*

Similarly, representatives of SMEs and NGOs report feeling pride as a result of adopting energy-related more sustainable infrastructures, also in accordance with their transformative mission and values. Thus, the adoption of pro-environmental energy services not only provides a competitive advantage but also increases feelings of pride among the individuals leading or participating in the organization. For instance, the owner of one of the Italian SME acknowledges being proud of his self-sufficient energy-infrastructure as this demonstrates to others that a bio-business can be implemented. This form of value is obtained every time visitors tour his installation as he can demonstrate his accomplishment.

> *"The reason was political or ideological. Conceptually: it is a cooperative, it is social, the energy source is renewable... and it has more guarantees than other operators. It fits more with my vision of things." (Commercial sector, Spain).*

In contrast, esteem as a form of value is eroded when users consume more energy than they think they should. Informants confess having "guilty pleasures": energy-consuming activities such as baking bread (Residential users, UK) or having log-burners for a cosy atmosphere (Residential users, UK). Informants know that these practices are not environmentally friendly but still provide other forms of value for them; as a result, they are not ready to abandon these habits. Experiencing guilt does not seem to be a motive to drop these "dirty habits"; rather, according to their narratives, dissonance and ambivalence increases, and esteem value is destroyed, but this does not provide enough motivational strength to change their habits. A British informant explains what will happen when he realizes the energy consumed by the oven.

> *"I don't have a smart meter. I'll be getting one soon. But I imagine I'll be quite depressed when I see just how much an oven takes... the things I do, I do them quite deliberately, and I don't want to give them up really... Even if this sounds too selfish. I mean, we got to please ourselves a bit. And there are worse things to do. (…) When the smart meter is installed: So, I think I wouldn't maybe have to put it out of sight Otherwise, I will just be like, well, you know, checking it, every time I pass it or something. I've seen in other homes, people put it like in a prominent location. And that would just drive me mad. Having these numbers in front of me all the time". (Residential user, UK)*

This quote illustrates that information about their own consumption is not a source of change unless the individual has the motivation to change a particular practice. This information can be resisted, and users may reject exposing to it, to protect their cherished practices (in this case, baking bread). This informant acknowledges that he would put the smart meter out of sight to avoid experiencing guilt as he is not willing to change this particular energy-consuming practice. An implication of this finding is that engagement with energy-saving devices may be discontinued when they compromise the value of self-esteem by making the individual aware of their energy-consuming habits.

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4.3.3 Social or community

Social or community value is realized when users feel that they are part of a real or imaginary community of change. Feeling part of this community also provides esteem value but more importantly, it empowers the individual as their perceived effectiveness – as a result of their joint impact increases -. This community may be entrenched in their place of living so that social value is associated with place identity (especially in UK Wells and Glastonbury, or barrio de Belén) or transcend its limits (especially in Croatia, where users feel part of a cosmopolitan group aiming for modernization). Indeed, informants often used a "we-form" when explaining their aims and goals in the adoption of energy-related services, which is also an indication of the importance of this form of value.

The idea of sharing energy with their community reinforces this form of value. Indeed, we have found a widely shared inclination to distribute their surplus to their peers or to the neighbourhood (e.g., schools or streetlamps), even in absence of monetary incentives, which they envisage would never be large enough to make a living out of it. Thus, the reward for the users would be in the form of social or community value: energy communities would increase social empowerment and provide greater control to social groups over large companies.

> *"[I like the control that it gives people who aren't companies, you know, they can produce some of their own electricity. And if there's excess electricity, they can sell it into the grid. I think that is, that's great. You know, it's, I suppose it's empowering. (…) the means of production, are not in the hands of a corporation. And that's good. You know, they're individuals and communities. And it's so it's a really, really good thing." (Residential user, UK).*

The following quotes also illustrate the community-building and belonging motivation for participating in these innovative energy-services.

> *"It's one of the seven tenets of a good long and healthy life - community is in there right at the top along with good diet, exercise, a sense of belonging and all that kind of thing. So, if you were connected with others near you and you were sort of sharing your energy, your power, you would then have a connection to them. And also, you always feel better when you give things away, don't you? So good for the soul as well. For me, I think it's a great idea. It's a great system in the making. I love it." (Residential user, UK).*

> *"If we would be allowed, we would share the surplus of the energy we produce with someone who needs it." (Residential user, Croatia).*

> *"I would rather sell it to my neighbour than to [a big utility]." (Residential user, Croatia)*

> *"Selling it back to the grid doesn't really make any difference to me. It is not a big draw for me. I feel financially comfortable. And I'm also aware that even with government subsidies, the money that you're really talking about is fairly low. The idea of offsetting somebody else's high carbon electricity with low carbon electricity that we produce here that's very attractive." (Residential user, UK).*

However, industrial consumers, even those with a sustainability-related mission, are more likely to share energy in return for financial compensation, since they recognize that financial sustainability is

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the primary motivator for any decision they make. Different that household Spanish informants who agreed that selling their PV-generated energy would make them similar to the utilities they despise. This rejection to look alike to energy suppliers they despise is a high motivator to better share their over generation with their community.

> *"Anyway, as I am an entrepreneur, whenever I make a decision pro-sustainability in my farm, I need always to be sure I have a return on my investment: I can't lose money. Then I know that my action will also bring benefit to the environment as well. (Commercial sector, Italy).*

4.3.4 Environmental and ethical value

Environmental and ethical value is a fundamental form of value for informants in Spain and the UK, and to a lesser extent in Italy and Croatia. Adopting innovative energy-related services is fundamentally motivated by their desire to live a more sustainable lifestyle.

However, we have observed that environmental value takes different forms in the four countries examined. This probably reflects the different frames used by environmental and social movements across countries (Transition in the UK, Degrow in Spain, Slow movements in Italy) so that the frames used have shaped the specific narrative of environmental value in each country. Undoubtedly, these frames overlap to some extent but each of them is clearly dominant in the sociocultural settings examined (decarbonization in UK, degrow and circularization in Spain, slow living in Italy). In Croatia, there is not a specific environmental worldview. Thus, to uplift this source of motivation, messages in each of the countries should be adapted so that framing fits the specific value form desired by users.

In the UK, environmental value is associated with decarbonization and reduction of CO_2 emissions. In Spain, environmental value is associated with degrow or the idea of leading a life of sufficiency that minimizes the impact on the planet, using as fewer resources as possible. This degrow lifestyle has political and spiritual resonances.

Politically, the degrow agenda is different from that of decarbonization. Whereas decarbonization aims to reform the existing economic model, replacing carbon-based technologies with carbon-neutral technologies, degrow has a radical transformative view of the existing system. Whereas in the UK, activism revolves around claiming back public goods (e.g., public over private transportation), in Spain activism revolves around delinking from the growth-based system and a search for self-sufficiency, using as fewer natural resources as possible and resorting to self-production instead of buying in the market. Presumption fits very well with this value form and it is not surprising then that most Spanish informants had adopted self-producing energy infrastructure or built their houses with the idea of sufficiency in mind. In Italy, we also found informants having built Climate houses that use minimum natural resources.

In the case of energy, delinking from the system is also driven by other non-political motives. For instance, for some the distrust (and even hatred) towards utilities is a powerful motivator to install PVs and switch to community-managed operators.

> *"It is also that we are partners in Energética... We prefer dealing with cooperatives than with big utilities". (Commercial sector, Spain)*

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> *"I joined the cooperative because for some time now I have been more aware of whom I give my money to. It's not just a question of saving energy or recycling, it's also our responsibility. I did want to join Energética". (Residential user, Spain)*

Moreover, a form of value that seems to motivate some informants is revenge on utilities for the perceived exploitation of the land (local expert, Italy). Other British and Croatian informants aim to delink from the system as they anticipate power shortcuts or radical peaks in tariffs, as the following quotes show.

> *"My ideal scenario for the next five years or so is that we do get to build this house and we'll be completely off-grid and we wouldn't really be reliant on those systems and then it wouldn't make any difference to me at all." (Residential user, UK)*

> *"We never know when Russia is going to close our gas line. We don't have enough gas in Croatia, and I don't want to depend on It." (Residential user, Croatia).*

Degrowth is similar to the slow-life movement in its spiritual resonances of leading a simple lifestyle, more focused on self-actualization than on accumulation of material goods.

> *"Comfort also means being distant from other people and silence. Maybe it is about what I wanted to have when I was 20 years old: a bike, a fireplace and books". (Residential user, Italy).*

Although degrowth narratives were more articulated in Spain, we also found traces of this environmental frame in Italy and the UK, as the following quotes show.

> *"For the environment, it is important that humans search for ways of living with little impact. Getting rid of anything superfluous: that is my suggestion. I try my best to reduce the things I need or reduce the quantity I need. I also try to destroy the environment as less as I can." (Residential users Italy).*

> *We've got, you know, basically, we're living beyond our means to society. And it's got to stop. And this is a fact". (Residential user, UK)*

In all countries, the idea of avoiding waste and superfluous production by making the most of natural resources and the reutilization of materials is a powerful motivator. All informants express their desire to make use of existing resources, such as solar radiation or winds with the installation of PVs or wind turbines, to satisfy their daily needs. British informants also suggest reusing rain for sanitary purposes, as the idea of *"flushing the toilet with drinkable water"* is seen as the epitome of waste. Italian informants have installed stump-operated heaters, thus reusing a product that would otherwise be wasted (Commercial sector, Italy).

A waste concern may also be a barrier to adopt this self-producing infrastructure. Users are well aware of the environmental impact associated with the disposal of PV installations or with the production of EV. They are cognizant that these technologies may reduce emissions in Northern countries, but it creates social and environmental impacts associated with the extraction of minerals and transportation to production systems in Europe. Indeed, the more committed to the strong sustainability agenda, the more users reject these innovations.

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> *"And thinking electric cars are going to be the solution... Well, they're not, I don't know if you've heard this, by the way, the Natural History Museum have done a study. And they worked out the resources we need if every car in Britain was electric -- just Britain. You need twice the world production of cadmium, and all these various minerals, you know, there is just not enough resources in the world for all cars to be electric". (Residential user, UK).*

For this reason, users favour non-energy powered technologies: rather than promoting EV, they claim for using biking and walking as the preferred transportation means. These preferences are also an expression of their transformative agenda.

> *"I'm not going to put in batteries because of the lithium and the way they are made and so I wouldn't have an electric car either". (Residential user, Spain).*

In Italy, PVs on-land installations are rejected as it ruins the soil and renders it unusable.

> *"In 20 years, it is not possible to cultivate all the soil where now you see solar panels! I see many examples in Gallese already!". (Local expert, Italy)*

Similarly, informants' express concerns about using energy-powered technologies to gain energy savings, as they see a fundamental contradiction in this approach.

> *"Being able to control your heating from somewhere else, 99% of the time is completely pointless, it's just adding stuff isn't really needed". (Residential user, UK).*

The final form of ethical value is to help out the most vulnerable and disenfranchised members of the community. As we have explained before, most prosumers are not seeking to make a profit out of their self-produced energy. Especially in Spain, giving surplus to poor-energy households is seen as the most attractive solution. Nonetheless, they demand some guarantees that, in fact, the surplus is appropriately used to help these households.

> *"They would be willing to donate it to the community or to some members, under certain conditions (…) It won't actually be so important for me to choose, but I would like to know to whom my energy surplus went." (Residential user, Croatia).*

Others see a more complex mutuality scheme where the groups receiving the energy would commit to doing some community engagement in return for the energy obtained.

Table 7 - Summary of value sought by demo location

	Croatia	Italy	Spain	UK
Self-oriented (value obtained by interacting with the service regardless of their context)	Reducing bills. Convenience.	Reducing bills.	Reducing bills (industrial consumer). Comfort of customers (industrial consumer).	Reducing bills.
Other-oriented (value obtained or conferred by the impact on others)	Protect the environment.	Protect the environment. Degrowth/slow life.	Delink from the system. Degrowth.	Low carbon. Community value. Greater independence from the grid.
Demand-response (automatization) main value sought	Energy savings. Convenience.	Energy savings. Avoid hassle.	Energy savings. Avoid hassle. Convenience	Avoid hassle.
Advisory tool (energy savings for non-automatable actions)	Energy savings (financial gain).	Energy savings (financial gain and emissions reductions).	Energy savings and waste avoidance.	Energy savings and waste avoidance.
Prosumption main value-sought	Financial gains. Community value.	Energy savings. Revenge against large utilities. Obtain eco-certification.	Independence from the grid. Community value.	Independence from the grid. Community value.
Social network/ gamification	Status and play.	Status and social value if compared with other villages.	Social and environmental value if a collective goal is set.	Play and environmental value.

4.4. Available and missing resources for co-creation of value

A central tenet of S-DL is that value is co-created when actors integrate resources. Hence, value co-creation demands that: 1) Actors have the sources and 2) Actors are willing and capable of integrating these sources with other actors to co-produce value. This section examines whether users meet these two conditions. The analysis will focus on each of the resources necessary to co-produce the value (following the taxonomy proposed by Hunt and Derozier, 2004, and Hunt and Morgan, 1997) and will examine whether actors have resources at their disposal and their readiness (in terms of motivation and ability) to use them. Past work has shown that, even when actors lack resources, they may obtain them by drawing from the networks they belong to. Thus, we complement the analysis by showing whether and where the missing resources are available and who may procure them, so that value is eventually co-produced.

4.4.1. Physical resources

Physical resources comprise the material infrastructure, including financial requirements, that users must have to co-create value in the ecosystem devised by ReDREAM. These resources vary depending on the energy service module in question, as Table 8 shows.

Table 8 - Required physical resources

Automatization	At least a minimum of power of one or a combination of the following resources: • PV panels • Batteries • Heat pump • Hot water cylinders • Electric radiators • EV charging posts • Refrigerators • Freezers • Water pump • Electric ovens Internet connection Mobile phone
Advisory tool	Internet connection Mobile phone
Prosumption (PV panels)	Building functionalities Financial means

Regarding the heating systems, most informants use a gas heater which would render them non-eligible for the automatization module. To install PVs, some physical resources, other than financial, are fundamental for their installation. First, the building should allow it (sun-orientation and construction functionalities). In Croatia, the roof design in some houses prevents installing PVs.

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Second, if the household lives in a condominium or rents the property, s/he is unable to install it, as s/he lacks control. Finally, users living in houses under heritage regulation (users in Bath and Gallese) cannot install PVs.

> *“We looked into solar panels, but finances were still the biggest barrier. We also needed to fix the roof and some other things to install them.” (Community organization, Croatia)*

Networks can provide financial resources. Indeed, in Croatia, informants with PVs installed them when they were knowledgeable of a governmental co-financing programme. Similarly, in Italy, users install biomass heaters as a result of a co-financing scheme with the government. In Spain and the UK, energy cooperatives provide a line of credit (Energética) or grants (Avalon) to ease the financial burden for uses wanting to install PVs.

The other missing resources – related to building infrastructure-are difficult to be provided, as they would demand changing the institutional arrangements governing buildings, renting, and heritage.

> *“It's annoying when you live somewhere rented, and you can't start insulating it and doing all the cool stuff you want to do? This flat leaks like crazy. And what I'd love to, you know, spend, like, some time and some money on sorting that out. (…) rental properties, this is very important. I've rented loads in my life, and they're always neglected. You know, they're not insulated property. So why would they? Why would the landlord bother? Where's the financial incentive to do that? Yeah, they're, they're more energy-consuming. Almost by default, I would say, yeah”. (Residential user, UK).*

Another necessary resource is a smart meter. Deployment of smart meters vary greatly across countries, so this resource is not equally available. Moreover, we have found that some users reject installing smart meters, especially in the UK, for varied reasons. They have been framed by media as a source of radiation (health hazard) or as a security hazard since they provide information on dwellers that can be used for criminal purposes. In Spain, having wi-fi is also linked to health and security hazards and rejected by some informants, albeit this narrative was marginal.

> *“Also, the thing that people can somehow see what you're doing in the house to a certain extent, the surveillance somehow, so you don't know what goes on with all this technology these days, even with a smart meter, so...” (Residential user, UK).*

> *“Sometimes people are away. And you know, you don't necessarily want other people to know that you're away, therefore not generating electricity. Why is that? Is their thing broken? Should we go and have a look? Oh, they're on holiday or? Or they emigrated or something?” (Residential user, UK).*

> *“There are stories you read in the press about criminals hack into smart metres and, you know, get money, you know, they can sort of get credit for their own bank accounts, from somebody else's smart meter. Nobody has bothered to put in any security on them. And yeah, so there are concerns, on all sorts of levels.” (Residential users, UK).*

Rejection of smart meters is also a consequence of the profound distrust in utilities, as we will discuss later because as a British user acknowledges: “*my willingness to share data with a company depends on my opinion, my perception of the company or organization or whatever, are they trustworthy?*”.

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4.4.2. Informational resources

The second set of resources concerns informational resources. Users need some energy literacy to be able to understand the benefits of the energy services provided. Energy is probably the service most used for daily routines and the one about which user know the least. Users recognize that the energy system is opaque so that understanding sources of energy and tariffs exceeds the individual's resources.

> *"It is very difficult to figure out what the costs are, the levies imposed by HEP. (…) They could be much more transparent and communicate more clearly. I have the impression that they, like teleoperators, deliberately do not want to interpret some of the costs we pay, and we are not even aware of them". (Commercial sector, Croatia).*

Similarly, knowing of and dealing with co-financing scheme demands information resources, that they often lack. Thus, unless a user has individuals in their networks that can provide these resources, it is very unlikely that they gain the energy literacy needed to adopt more innovative energy services. Usually, they resort to informal networks to gain this knowledge and few of them use online information or call energy cooperatives to be informed. Or even if they do, adoption is preceded by chats with other adopters with whom they can solve doubts and appease the anticipated stress and anxiety. Information providing is thus a person-to-person process, relying heavily on the social ties within the group. Compare the following two quotes: the main difference between the two households seems to be access to a person in the network that could provide the informational resources.

> *"I had a friend working in the project who gave me all the information and I was among the first to apply and provide all the needed documentation and among the first to have solar panels installed." (Residential user, Croatia).*

> *"I would need someone to help me with the paperwork because I would not like to do that". (Residential user, Croatia).*

In the UK and Spain, energy literacy is built in group meetings organized by local transition networks. In Italy, we did not observe an existing network or community educating users in energy-related aspects of the transition. However, the village has an underused resource (the local theatre) that can be leveraged to provide sessions of energy literacy.

We also observed that once an individual becomes an adopter of these energy services, s/he becomes an information-sharer in their networks. Once they have made the transition to more energy-efficient or cleaner energy services, they are willing to help others to adopt. To illustrate, an Italian SMEs explains how they changed the energy infrastructure of the farm to obtain a bio label. Once they have finished the installation, they decided to become an "educational farm" so that others could see how to do it and replicated the scheme. Early adopters become, then, ambassadors of the innovation, feeding their networks with the necessary informational resources.

> *"At the beginning it is difficult, people worry because they are investing a lot of money…they need to be accompanied in this journey towards improving their life and their environment.". (Commercial Sector, Italy).*

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4.4.3. Organizational: routines and procedures

Another fundamental resource for value co-creation is having the right routines and procedures in place so that the new energy services can be ingrained or fit smoothly with these routines. Indeed, if energy use implies a major shift in existing operations or family routines the adoption is rejected. Alternatively, users may be willing to adopt a service, say automatization, but their existing routines limit the extent to which they can use it or the number of appliances that can be connected to the system. For instance, one of the Italian SME reckons to have only 30 minutes of flexibility to provide to the system during their operations ("just a range of 30 minutes during which some of my electrical equipment could automatically switch on and off to save energy. So, her flexibility is just of 30 minutes in between 2 particular moments of her process: when the oven has reached the right temperature and when the cutting machine is switched on"). Similarly, another Spanish SMEs said that only the refrigerators could be linked to the automatization service.

Adoption thus would depend on getting professional help to re-plan their operations so that they enable flexibility provision to the system. Energética in Spain performs this role providing expert consultancy to both households and SMEs. Users did not mention similar experts in their local contexts whom they can approach to redesign their operations. A similar gap is observed for retrofitting as users note the lack of local companies helping with insulation and energy advice.

> *"I've often thought, there's a good business for someone, a local bloke, someone who would do all this sort of thing and have the draft proofing materials at their fingertips? Go into houses and draft-proof it... The back of the house has got old, old Victorian sash windows. Two-three years ago, I went around all of them with plastic strip, you know, to make them draft proof. And that improved things quite considerably". (Residential user, UK).*

Households may also reject the installation of PVs if their in-home activities are not carried out during the daytime, as they could not use the produced energy for themselves. When energy selling is severely curtailed by regulation (as is the case in Croatia), not being able to use the produced energy is a major barrier to the adoption of PVs.

> *"Because it's not like we have a massive demand in the daytime when it's actually sunny (…) If we actually store it I'd be much more inclined (…) because I would think that I was really making more significant contributions and probably adding up financially". (Residential user, UK).*

In addition to routines/operations, a major organizational missing resource is innovativeness. Several users refer to inertia and resistance to innovations as a major barrier to the adoption of new energy services. This resistance seemed especially prevalent in Gallese.

> *"People are sceptical, as soon as one suggests something new and different from what is the status quo. You need to take into account that in the Gallese ecosystem there is also this "rejection of innovation" attitude that is consistent with the spirit of its inhabitants." (Local expert, Italy).*

Not only the user's operations are cited as missing resources for value co-creation. Governmental operations are mentioned as a barrier to adoption. The paperwork and bureaucracy involved in retrofitting or PV installation deter users from even contemplating adoption. Users, notably Croatian

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users, complain of a flickering legal framework that increases uncertainty as users make decisions according to a set of rules, so that if the rules change, the users may be negatively affected.

> *"My main barrier is the uncertainty regarding constant changes of the legal framework". (Residential user, Croatia).*

> *"Money is a big problem in Croatia. People apply for co-financing for RES and that's great, but the big problem is the bureaucracy that takes a lot of time and effort. (…) You really need a lot of patience to take on a project like that just to collect the documentation for starting the process. (…) It is easier for people to turn on the heating, turn on your electricity, pay the bills and have no worries." (Residential user, Croatia).*

> *"The procedure to get the needed documentation and to get it installed lasted a long time, 2 years." (Commercial sector, Croatia).*

This is attributed to the history of the country and the limited local social capital created.

> *"Trust in institutions is very low in Croatia, this is certain. I believe it is because of a history of corruption and because we cannot include citizens in the decision-making process." (Residential user, Croatia).*

4.4.4. Relational

Relational resources comprise the relations with other actors in the network as these relations constitute the social fabric upon which co-creation of value may occur. Existing relations among actors may be both a resource and a liability for value co-creation.

Existing relations among users are undoubtedly a resource to tap onto. As already said, these relations facilitate information sharing about energy services and build trust among users which would later facilitate the creation of energy communities. These social ties fuel social value and empower individuals so that they are cognitively and emotionally equipped to navigate the energy transition. Thanks to these pre-existing social ties, the adoption of energy services is facilitated. For instance, British informants explain how they got their PVs installed thanks to a community-based initiative to buy in bulk which significantly reduced the price.

> *"The fact that in our area, there was a bulk purchase going on, whereby if 10 households agreed to have solar panels, the installer would then go ahead and start with the first one. And everyone got the panels for half its price. And they contributed 50 pounds at each installation to a community project. So, I guess that's why they wanted to do it within towns or villages or something. But I think they've spread out more than that now. But that made a big difference because it was sort of eight 9000 pounds before, but I think we got it for under 4000. And we got 14 panels, five kilowatts. So, it was ideal for our needs. Yeah, it was just at the right time". (Residential user, UK).*

> *"When this story of the solar communities began, from the board of directors of the residents' association we said and why are we promoting this at a neighbourhood level, and in fact, one of the groups that I am talking about is called this: The solar community. And then four people who were a bit of guinea pigs started up". (Residential user, Spain).*

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Conversely, a major relational liability is the distrust in energy firms. They are largely depicted as greedy profit-seekers that disregard or betray their customers' needs to gain unilateral economic advantages.

This distrust prevents any form of reciprocity or mutuality: users are not inclined to share energy with utilities or even accept any service provided by them. Moreover, any information provided by utilities is resisted, discounted or apprehended with suspicion as users believe that they are trying to take advantage of them. In this context, value co-creation with big utilities is almost impossible.

> *"I don't know enough to not collapse into a confirmation bias around energy companies are evil, which is basically what I think. (…) I am deeply suspicious of a company that you know, offers a vital commodity for profits". (Residential user, UK).*

> *"If you're doing a house up getting a new boiler, or something, you want to find out about, you know, the latest, most efficient thing you can do, like how the air source heat pumps work, or ground source heat pumps, or you know, there's a lot of new technology, I think or people want to switch to you know, to a green tariff, but they don't really know if it's really green, or what that actually means. You're not necessarily going to go to a big energy company to have those questions answered. So, it's difficult to know where to get that kind of reliable information from if it's not from friends or organizations like BWCE". (Residential user, UK).*

Not only are utilities considered barriers for individual greater value creation, but also societal value creation. Utilities are considered major blockers of the process of the energy transition. They are often referred to as "cartels" (Residential users, UK) that use their power to block major reforms since the existing system benefits them (and basically only them). In Italy, they are specifically depicted as exploiters of local resources (a view that local utilities are aware of).

> *"So, I've seen some of the difficulties, certainly in the UK, you know, about trying to get these microgrids. And as far as I can see, the big six, you know, they've been lobbying on the regulator to delay it, you know, because I think they see it as a threat to their business (…) as I see it, you know, they've made it difficult for people to do it. So, it's been slow". (Residential user, UK).*

Because governments are seen as complacent to utilities' blocking strategies, these negative perceptions have spilt over other institutions, including the governments themselves. At present, rather than leaders or guides in the energy transition, they are considered passive spectators, at best, or active bullies of the transition, in the most negative constructions.

This situation has paved the way for small energy companies to occupy the front stage as they enjoy more trust from users. Green energy suppliers such as Octopus or Good Energy in UK or SomEnergía in Spain are often mentioned as suppliers of choice, not because of their superior performance but because they benefit from greater confidence. Still, these small companies need to be backed up by personal referrals, as sometimes users think that they are "large utilities in disguise" acting with a different name.

> *"The price is, of course, important but much more important are the added services of knowing whom you are talking to. The personal dimension gives confidence". (Commercial sector, Spain).*

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> *"The fact that energy has come from below generates a lot of confidence. Many of us participated in the creation of this cooperative". (Expert, Spain).*

Thus, the negative relations with utilities or commercial actors in the network and the greater trust and reputation of energy cooperatives explain why users widely see the transition as being community-led and community-executed. For instance, Italian informants much repeated that energy transition should be done collectively. Individual households cannot afford the installation of PV panels; however, if small communities are formed, investment is split among its members, then it would be affordable and it would work better. Likewise, they favour the idea of local mini-grids where energy is shared within a smaller circle of neighbours, under fairer arrangements that can be co-created by the community.

> *"If installing a RES plant was a collective project and a collective effort, on a financial level, it could work and could be really convenient. Single families cannot afford it: the benefits are lower compared to the cost of installing and maintaining." (Residential user, Italy).*

> *"Mini-grids are widely welcome. We ought to be thinking more along with those sorts of lines. A mini-grid...., I mean, if there could be a system that had half a dozen houses, clubbing together to do something, of course, I'd be very keen, very interested to sort of getting involved with that. I need a bit of expertise. It's no, I can't just go and...." (Residential user, UK).*

> *"I would love for energy production and storage, to focus on small groups, you know, if a street got together, and agreed to sort of energy plan, and an energy storage system, and stuff like that, I'd love to see that." (Residential user, UK).*

Table 9 depicts a summary of users' resources broken down by resource type and country. Table 10 summarizes the missing resources by users and Table 11 maps the networks where users can draw from to obtain the resources they lack.

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Table 9 - Users' resources by country

	Croatia	Italy	Spain	UK
Physical (including financial)	Gas heater Heat pumps in organizations PV Thermostats in radiators	Thermostats Biomass heaters PV	Thermostats Smart switches Electric accumulators PV Gas heater	Thermostats on radiators Gas heaters; log burners
Informational		Local gazette and magazines	Energy cooperative meetings and newsletter	Octopus or Electricity app
Organizational				
Relational		Local associations Biodistretto (for farmers)	Neighbourhood associations Solar community Energy cooperatives	Sustainability groups (local and regional)

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Table 10 - Missing resources across countries

	Croatia	Italy	Spain	UK
Physical (including financial)	Limited recharging stations for EV Roof disposition (not flat) Smart thermostats and metres are rare	Limited recharging stations for EV Premium prices of EV. Gas or biomass heater.	Government subsidies Smart thermostats are rare	Limited recharging stations for EV Smart thermostats and smart metres are rare
Informational	-	Educational farms	-	Most impactful energy-saving actions Limited smart meter penetration; monthly bills with overall kw consumption
Organizational	Limit to surplus that can be fed into the grid	Bureaucracy and paperwork to obtain funding for PV installation Business operations have limited flexibility Conservative inertia and resistance to innovations	Bureaucracy and lack of government support	
Relational	Disengagement with the government and policies for the energy transition	Distrust in large energy companies (i.e., Enel) as they are regarded as exploiters of local resources.	Profound distrust and rejection of big energy utilities	Profound distrust in big energy utilities

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Table 11 - Resources available in local networks

	Croatia	Italy	Spain	UK
Physical (including financial)	Governmental subsidies for PV installation and retrofitting.	Governmental subsidies for PV installation and retrofitting.	Energy cooperative (Energetica) line of credit.	Energy cooperative enabled collective purchasing to obtain discounts. Avalon Community Fund
Informational	e-Citizen's platform (E-gradani)	Local associations (e.g.: Drama group) Local school	Energy cooperative consultation Neighbourhood associations WhatsApp groups Solar community group of “Barrio Belén”	Extinction Rebellion ACE, BWEC Next Door
Organizational	-	Council of the youth Proloco	-	-
Relational	Women reviewing (Zenski recenziraj). 24stata	Museum of Gallese Biodistretto Facebook local group (Sei di Gallese se…)	Neighbourhood associations. Consumption groups. Local newspaper and TV. Scouts and student groups	Sustainable Wells; Sustainable Glastonbury; Larkhall neighbourhood (Oriel hall) Repair caffe Local churches Facebook groups Local newspaper and radios

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4.5. Consumer needs and desires based by layers

During the qualitative research in the four demo locations, we asked the participants specific questions related to the ecosystem, using as a baseline the main functionalities envisaged in the project proposal (Figure 12). The insights presented here are to be used as a guideline for the respective partners in charge of each layer/service so that they can adjust them to users' needs. These insights were also an invaluable input for the design of the ecosystem and to co-create with the partners the functionalities presented in section 6.2 Consumer-centric functionalities in the ecosystem.

Next, we report the findings in normative propositions that need to be taken as guidelines to follow for the design of the ecosystem. We maintained the original structure of layers described in the proposal so to make it easier to visualize the requirements that apply to each partner. However, we omitted any findings in relation to customer engagement methodology (Layer 1) as this methodology will be exhaustively developed in deliverable D 1.5 like main drivers, needs, barriers and levers for engagement.

Figure 11-ReDREAM'S ecosystem initial concept

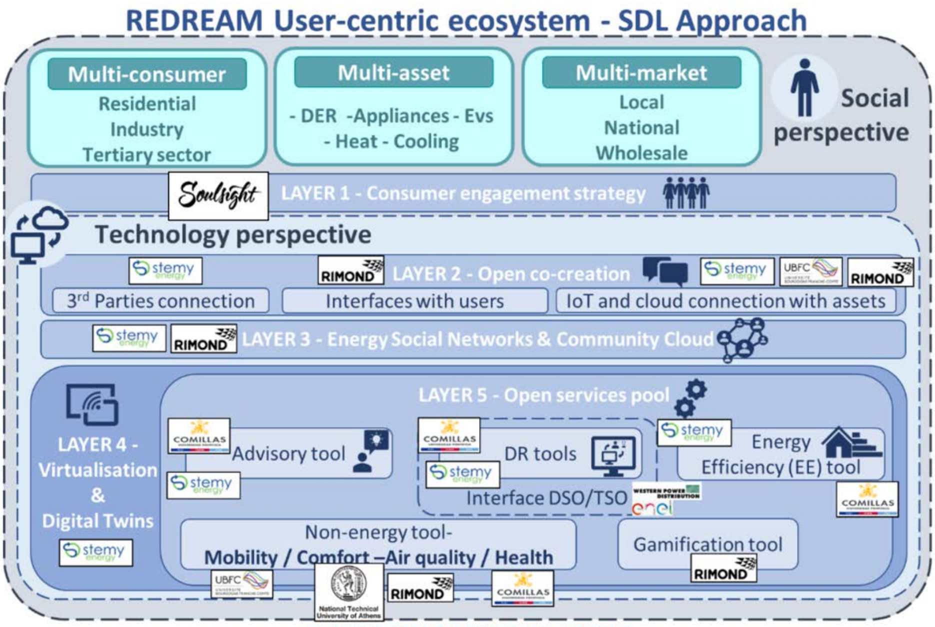

FIGURE 4. REDREAM OVERALL CONCEPT

4.5.1. Layer 2. Open co-creation

Users' requirements regarding the interface, third party's connection, IoT, cloud connection and devices are detailed in the following table (Table 12).

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Table 12 – Needs based on layer 2: Open co-creation

Propositions reflecting users' requirements for this layer	Illustrative evidence (quotes)
1. Users need to have everything integrated **into their mobile phones. The excess of devices and information sources is perceived as reducing simplicity and increasing the hassle.**	*"A single app for controlling everything would be ideal. We all have smartphones, and an additional device would be one more thing I need to have with me. It's simpler through an app." (Residential User, Croatia).*
2. Users need digital simplicity **and more if we are talking about energy, simplicity is core to make users relate with energy in a smoother way.**	*"If the process was easy and I could just download an app and be part of that community, that would be great." (Residential user, Croatia).*
3. Users need flexible **automatization so that energy management does not take up their time, but they still feel they are in** control**.**	*"It's about control actually... I don't like things being fully automated. I quite like it, so I don't even automate my heating. If you see what I mean. I like to do it myself. I would still want to be the one turning on the washing machine". (Residential User, UK).*
4. Users need the ecosystem to be liquid**, they want to see functionalities but not to differentiate whether it's efficiency, flexibility, demand response or a non-energy service.**	*"I would love to have it explained to me, something like `You are generating light so that you can use the fridge, the washing machine and cook, but don't even think about putting the hoover on´". (Residential User, Spain).*
5. Users need to know whom they are sharing their information with, **as they expressed that the problem is not only the kind of data they are sharing but also with what organization and purpose they are sharing it.**	*"If it was anonymous, I would not have a problem with that. Would you want it anonymous? If it was, if I had the occasional call from a local person to say "your name was given to me because you've done this particularly well", I would not mind, but I think I prefer to be anonymous." (Residential user, UK).*

4.5.2. Layer 3: Energy social network & community cloud

Requirements concerning the energy social network and the community cloud are detailed in turn in Table 13.

Table 13 – Needs based on layer 3: Energy social network & community cloud

Propositions reflecting users' requirements for this layer	Illustrative evidence (quotes)
6. User's value local networks **where the information is quickly updated, creating a sense of community**	*"There's quite a useful Facebook group - I detest Facebook. But there's one page, there's like a local community noticeboard, it's quite useful for information that I think, frankly, it's information that doesn't get spread in any other way. So that's great." (Residential user, UK).* *"Since the village is so small, FB groups work very well because they report local and quick information. The information quickly reaches the neighbours. Especially now with Coronavirus, online groups have a purpose." (Residential user, Italy).*
7. Users prefer forums/groups where the topics remain focused, and you can learn from others **experience.**	*"A WhatsApp group can have as many people as you want as long as it is used for its purpose and people do not send photos, jokes and everyone comments on everything. I have a working group with my work mates, and we only use it for work purposes. We do not send jokes and that's it." (Residential user, Spain).*
8. Users are willing to share their progress/achievements when they feel proud; **even more, if it is a shared objective.**	*"If there was a good rationale to it because very often, it's having somebody that you know or who's local who has done something. And so, if it was a means of doing that, I would be quite happy to share my energy data." (Residential user, UK).*
9. Some users are sometimes reluctant to existing platforms like Facebook or WhatsApp due to privacy concerns**.**	*"Probably if it was a bit more anonymized than that. I'm not really a big social media person. So yes, the Nest does that. But in a more kind of anonymized way." (Residential user, UK).*
10. Users of social media do not want to participate in additional social networks besides the ones they already use.	*"None of us uses social networks or mobile much. We use WhatsApp and telegram for things in the neighbourhood and not much else." (Residential user, Spain).*

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11. Most of the users want to consume content; few want to interact or produce it.	*"Local Facebook pages, and that kind of thing? I think there should be, there needs to be the option for this, essentially, just in terms of privacy, and people not wanting to interact on that sort of level with people in our local area. But yeah, it's a nice option to have." (Residential user, Croatia).*
12. Users are fairly careful about the personal info shared on social networks.	*"I think I control it pretty well. Since GDPR has been implemented, I've been thinking more about that topic. I also had negative experiences where my phone number was publicly available. I try to be careful about sharing my data, but it all depends on how the data is used." (Residential user, Croatia).*

4.5.3. Layer 4. Virtualisation & digital twins

Virtualisation was explained to users as a way to be capable of seeing the consequences of behaving in a different way or with different devices. This section reflects user's requirements regarding the possibility to foresight the consequences of their behaviours, and therefore make better consumption decisions. This only requirement is shown in Table 14.

Table 14 - Need based on layer 5: Virtualization & digital twins

Propositions reflecting user's requirements for this layer	Illustrative evidence (quotes)
13. Users would like to see the impact of their behaviour if they adopt or engage in different behaviours.	*"Well, electric cars. I thought it was a great idea and that everyone should have an electric car, but then I heard that battery production for those vehicles is very harmful and consumes a lot of energy. That actually causes a transfer of pollution from rich countries, in which people can afford electric cars, to poor countries in which batteries are produced." (Residential users, Croatia).* *"Well, really, I mean, the infrastructure is not really there for electric cars yet. We thought it was but when you drive round in an electric car you find that there are several problems. A lot of the charging points don't work, and there're not enough and there's only one plug to charge two or three cars." (Residential user, UK).*

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	"Let's say as far as electric cars are concerned, I'm afraid they are shown to be more environmentally friendly than they really are." (Commercial sector, Croatia).

4.5.4. Layer 5: Advisory tool, Demand Response tool, Energy Efficiency tool, Gamification and Non-energy services

The corresponding propositions reflecting users' requirements for the first four ReDREAM services are summarized in Table 15.

Table 15 - Needs based on Layer 5: Advisory tool, Demand Response tool, Energy Efficiency tool and Gamification

Propositions reflecting userss' requirements for this layer	Illustrative evidence (quotes)
14 (Advisory tool). Users want to be able to decide in real-time about their appliances and the way they can make better use of them, as past information is useless to make decisions.	*"I usually look at the energy consumption at the end of the month by comparing one bill with another. I make my calculations and find out why I have spent or consumed more. And then I look to see if it was colder or hotter on those days or find out why (Commercial sector, Spain).*
15 (Advisory tool). Users want to see how much energy they generate and consume as a way of controlling their appliances and their impact.	*"On the other hand, I value our overall consumption more than the bill. Because at home we are very committed to the environment". (Residential user, Spain).*
16 (Demand response). Users want to see their consumption and trading information in real-time to be able to make decisions and to find a useful point to their energy behaviour.	*"I usually check my mobile app of the inverters of the panels and it tells me the production. Then Iberdrola's app tells me what I produced and consumed the previous day, but since it's the previous day, it's no longer useful". (Residential user, Spain).*
17 (Demand response). Users want to know their impact of participating in flexibility either in their consumption, their community, or the planet.	*"I don't mind producing more energy than I consume, but now it is fed into the grid. If I could choose to give it away like I do now, I would give it away to energy or a neighbour, but not to Iberdrola". (Residential user, Spain).*
18 (Energy efficiency). Users want to understand their consumption and segregate by device or by appliances they can get value from.	*"You have to talk to people more simply, with examples." (Residential user, Spain).*

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19 (Energy efficiency). Users want to know how to make their consumption more efficient through personalized options depending on their context and their needs.	*"I would love to have it explained to me as: 'You are generating light so you can use the fridge, the washing machine and cook, but don't even think about putting the hoover on. (Residential user, Spain).*
20 (Energy efficiency). Users want to know their impact in diverse ways. For some users, the impact has to be translated into financial savings/gains, but for others into carbon emissions.	*"What pleases me most is that I'm aware of the carbon involved in producing electricity at different times of day, and we try to reduce our consumption, and also focus our consumption when the carbon footprint's lowest." (Residential user, UK).*
21 (Energy efficiency). Users want to see energy efficiency information in real-time.	*"It tells you what the carbon footprint per kilowatt-hour of electricity is, right now. Where that current electricity in the grid comes from and it breaks it down into percentage in real-time." (Residential user, UK).*
22 (Gamification). Users need to manage their commodities (like energy) in an agile way, so they do not waste time on it.	*"Living with less makes you have a lot more time. It seems that automation saves us time but sometimes it makes us do much more." (Residential user, Spain).*
23 (Gamification). Users prefer to collaborate rather than competing with neighbours; they want to have a shared challenge or goal.	*"In a wider community sense, I would love for energy production and storage, to be based on small groups, you know, if a street got together, and agreed to sort of energy plan, and an energy storage system, and stuff like that, I'd love to see that." (Residential user, UK).*
24 (Gamification). Users need to experiment with their appliances and energy devices so they can understand their consumption and how their house works.	*"It would help me a lot to see the consumption in periods of real hours because if at times when I do not produce, I have the same consumption I could play there and save." (Residential user, Spain).* *"I have an electric water heater that was on for two hours a night with a programmed plug and it gave me a good shower and scrub. Now it is broken, and I have it on all day and I don't really know what the difference is. I don't know if the savings are a lot and those little things if I would like to know them." (Residential user, Spain).*
25 (Gamification). Users want to understand how they are performing compared to themselves or,	*"I am interested in my consumption data, but not so much in the consumption of others' because*

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at most, with other users that have similar functionalities.	*they have other realities. Not everyone has the same cold sensation." (Residential user, UK).* *"I think that the "map of the neighbourhood" would work well if it was on a broader territory and instead of single citizens, there were villages compared among each other." (Residential user, Italy).*
26 (Gamification). Users are mainly driven by their motivations and values, but they appreciate to be rewarded.	*"I see that your prototype has a gamification factor and I think kids love it. Scores and prizes…" (Residential user, Croatia).* *"I think it's a good system that helps you make your home more efficient little by little. And if it is also with a reward system or it is like a game and makes it more lightly and fun, it helps to spread awareness." (Residential user, Spain).*

The requirements for the non-energy services are described in Table 16

Table 16 - Needs based on Layer 5: Non-energy services

Propositions reflecting userss' requirements for this layer	Illustrative evidence (quotes)
27 (Health). Users aspire to a new way of living (degrow, waste avoidance, mindful consumption).	*"And we don't buy much stuff. I mean, we've got to the stage where we don't need to buy more stuff. But we're doing more... making our own clothes, mending our own clothes, and that sort of thing. So, reducing consumption, I do understand that will have a knock-on effect at some stage. So that was something else I just thought of." (Residential user, UK).* *"I try to reduce car trips, the number of washing machine cycles and try to load it before I turn it on. I also buy less soap, to reduce plastic bottles as well as water pollution. I started to do my own eco soap in the traditional way." (Residential user, Italy).*
28 (Health). Users want to live a healthier life.	*"Health is something that people directly relate to in daily life. The same needs to be done in the battle to spread RES." (Expert, Italy).* *"I was trying to exercise 3 to 4 times a week. [...] My main motivation was to look better, feel*

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	better and be healthier." (Residential user, Croatia).
29 (Mobility). Users need to be certain about the best mobility options (flight, travel, car) and the lowest impact of their mobility option.	*"So, we're not flying, because we know how damaging that is. So, our travel attitudes have changed." (Residential user, UK).*
30 (Mobility). Users are aware of the need to use less cars.	*"The thing I'd love to see is less reliance on cars. So, I don't know if you're familiar with Wells, it's a small place like 12,000 people. In theory, you could cycle everywhere - I do cycle everywhere, but not many people do. So that would be my current dream to have more of a Dutch style, with cycling lanes." (Residential user, UK).* *"No matter how efficient we are at home, we are not going to reduce the emissions that we have committed to in the Paris agreement. If we do not stop driving, spending, and consuming as we do, we cannot fulfil our objectives as a society." (Residential user, Spain).*
31 (Mobility). Users need to know if they are ready to change to an EV or other mobility options.	*"We decided to put a lot of solar panels because we look long-term in case one day, we have an electric car or more electric things that we still do not know." (Residential user, Spain).* *"Well really, I mean, the infrastructure is not really there for electric cars yet. We thought it was, but when you drive round in an electric car you find there're various problems. A lot of the charging points don't work, and there're not enough and there's only one plug to charge two or three cars." (Residential user, UK).*
32 (Comfort). Users have different perceptions about comfort at home and they need to manage it between the people they live with.	*"We have a smart thermostat like a Nest so it's only on when we need it. Like many people, my wife and I don't precisely agree on the temperature of the house. The youngest child doesn't feel the cold. She doesn't like to have a radiator in any way in her room. She likes it to be about five degrees Celsius and my older one likes it to be that 25 but she's just realising that that's not good. We've come to an agreement." (Residential user, UK).*
33 (Comfort). Users need to have covered the basic needs to feel comfortable (water,	*"I think these are things that we take for granted. It's electricity, water, everything you have at your*

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electricity, heating, internet) and they don't want to worry about them (scarcity).	*fingertips and you don't have to worry too much about. That is basic." (Residential user, UK)*
34 (Comfort). Users need to have the right physical conditions at home to feel comfortable (temperature, sun, light).	*"Comfort in the house is associated with optimal physical conditions, temperature, humidity, lighting. And a person should not put too much effort for it to operate smoothly." (Residential user, UK).*
35 (Comfort). Users infer the comfort sensorial.	*"The storage heater in the living room has a thermostat and I turn it up when it's cold, but I don't usually look at the temperature. It's more from my feeling." (Residential users, Spain).* *"Yes, we use the thermostat a lot, every morning. But it is more a reference because sometimes you think that it is impossible that we are at the temperature that marks. We are the best reference." (Commercial sector user, Spain).*
36 (Comfort). Users need to have no friction or hassle to feel comfortable.	*"Comfort at home is about getting rid of many tasks and duties that can be successfully handled by the use of technology..." (Residential users, Italy).* *"I have a house comfortable since it is new, so everything is digital and connected." (Residential user, Croatia).*
37 (Comfort). Some conscious users prefer savings/efficiency over comfort (e.g, they wear several layers of clothes instead of rising the temperature in the room).	*"Yeah, there's a thermostat on the wall. But there're also temperature thermostats on each radiator. They get changed all the time! Maddie turns them up and I turn them down! She likes it warmer. I just stick a pullover on. Or go into a room with the wood stove. The wood stove is cheap to run. Very cheap to run." (Residential user, UK).*
38 (Comfort). Users understand their comfort needs related also to their surroundings.	*"Well, it's the view, it's the outlook. I mean, in our bedroom, I can lie in bed in the morning, and I can look across the allotments and I can see Bath Abbey. You know, we've got room, we've got the sun in the front." (Residential user, UK).*

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4.6. A synthesis of findings of the exploratory stage: archetypes of users

4.6.1. Introduction

It is fundamental to match consumers' motivations with technological solutions and design. The use of archetypes is a relevant way to guarantee users' participation and engagement, giving them a real personalization for the ecosystem functionalities and the user's engagement in the mid-term. Archetypes will define how people want to relate with the ecosystem from the beginning and through their experience either from an individual or collective experience.

We found that it was necessary to segment users based on a twofold dimension since findings showed that people differed along with their motives and willingness to use technology. Consequently, the first segmentation criterion reflects the user's awareness, participation, and consciousness in their relationship with energy. The second segmentation criterion reflects the diverse ways people want to relate with energy through technology. This twofold segmentation covers all the multisector profiles targeted in the project: residential, commercial sector and industrial.

This section subsequently describes each of these two dimensions and presents the four archetypes emerging from each of them. Next, we show the validity of the archetypes by combining the two proposed segmentations and completing with the value sought by the first one. We conclude the section by explaining the value sought of other stakeholders conforming the service system.

4.6.2. Segmentation by energy awareness and participation/involvement

This dimension comprises two user characteristics: energy awareness and consciousness and willingness to participate in community-led initiatives. Energy awareness and consciousness are relevant characteristics for users to relate with energy to change some behaviours. Alongside energy literacy, participation is fundamental: the energy transition will be enabled by community-led initiatives; hence, the willingness to participate in community-led initiatives is another relevant users' characteristic. Each of these variables comprising the first segmentation dimension are explained in turn.

Awareness or consciousness refers to the level of understanding of the energy market and the relationship between their energy consumption and environmental footprint. Users widely differed in this criterion, as the following quotes show. More specifically, they differed on their degree of understanding of the energy market and also on the impact of the energy market on users.

> *"I think the energy market is very complex, it is easy to say that you have produced a lot of electricity and give it away, but when you don't produce it, you don't lack electricity. It is very complex to understand, and I don't think almost nobody is aware of how it works".* (Residential user, Spain).

They also differed on their awareness of energy reduction and energy efficiency, and especially on the reasons why they carried out such practices. Whereas some users are only aware and concerned about energy bills, others see in their energy consumption a proxy for their environmental impact. Compare

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the following quotes: the first users seem only concerned about the bill, the other users reflect on the wider impacts that energy consumption has.

> *"I don't look at the consumption, but I do look at the cost on the bill. But I only look at it when the bill arrives…" (Residential user, Spain).*

> *"We are conscious, definitely conscious of our carbon footprint. So generally, the energy we're using the impact, that all our actions: our purchasing, our energy use, are all having an effect on even the birds in the garden. Becoming more aware of that." (Residential user, UK).*

Whereas the first variable reflects the knowledge and attitudes towards energy-related issues, the second variable - the willingness to participate and take action- reflects the distinct habits observed among users. Whereas some invest considerable time and effort in understanding their energy consumption and the behaviours that explain the overall consumption, others seem not to care. The following quote illustrates the involvement of some users in their energy consumption.

> *"Yeah, I'm kind of a geek. So, I've got a spreadsheet. So yes. 10,000 -10,500 kilowatt hours of gas, and that makes for the heating and hot water. And then just slightly over 2000 kilowatt-hours per year of electricity". (Residential user, UK).*

This variable also reflects the differential involvement and participation in groups or communities that are leading the energy transition.

> *"Well, there's a sense of identity, it's who I am. We're sort of likeminded people; we laugh at the same things. We enjoy going to the same sort of places. It's a sense of belonging, really. If I didn't belong to those clubs, I think life would be a little lonelier". (Residential user, UK).*

> *"I aspire to be part of a future energy community, or even to lead it, as a mayor of the village, to give the population back the energy that the territory has been producing for years". (Expert, Italy)*

By combining the differences observed in the two variables comprising the first dimension (Figure 12), four archetypes are identified, labelled as (1) the hero, (2) the explorer, (3) the wise and (4) the innocent. They are explained in turn.

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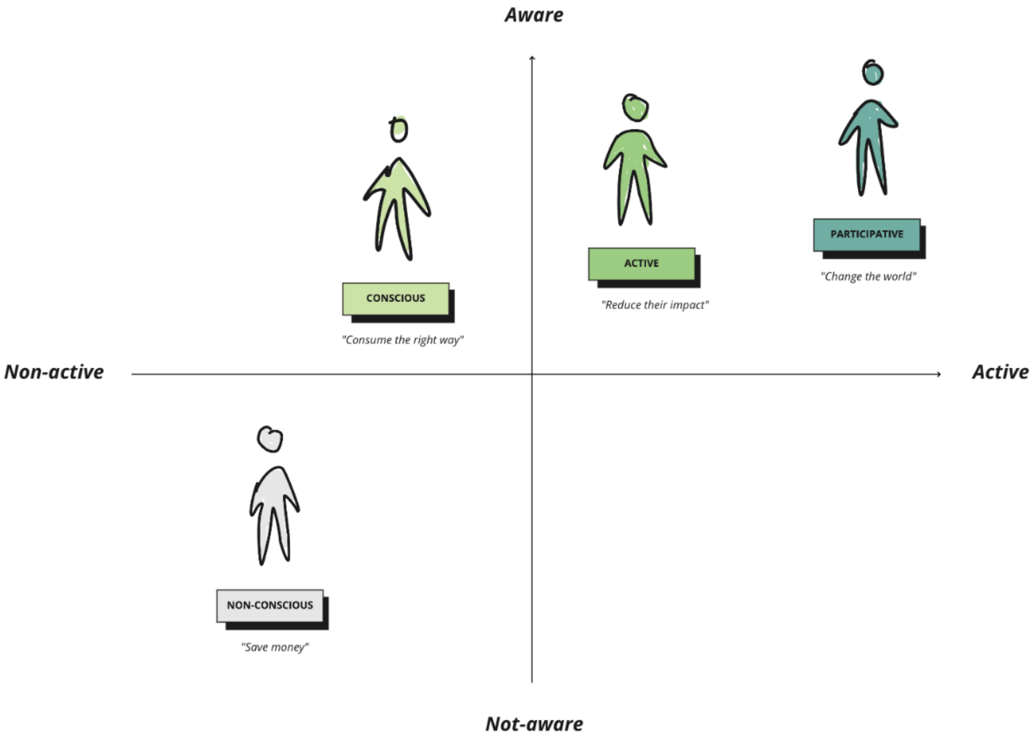
Figure 12. Archetypes segmented by energy awareness and level of participation or involvement



The hero (participative). As reflected in their motto, Change the world, this prototypical user is highly participative and involved, mainly motivated by a desire for change, not only their individual practices but also the community as a whole. They are aware that energy consumption is part of a broader set of transition dynamics. They see themselves as change-makers and share objectives with a community approach.

The explorer (active). This user is aware and committed to reducing energy consumption or obtaining energy from renewable sources. However, their involvement limits to their household and/or closest peers. They aim at reducing their environmental impact but are less involved in community-led initiatives. In sum, they have high awareness, but their activism is carried out inside their household or among their significant others.

The wise (conscious) are limitedly aware of how energy systems work. They aim to consume the right way and have routinized certain energy-reducing behaviours. However, they do not feel that these habits may have an impact on the energy system as a whole. Whereas they dream about a changed world, they also find it difficult to modify certain practices. Similar to the explorer, their activism is restricted to inner circles (family and friends).

The innocent (non-conscious) is a prototypical user that only shows interest in energy-related innovations as long as they lead to reduced bills. Thus, their primary motive to engage in the project is to save money. They generally acknowledge being short of time as a reason to justify not making an effort to understand energy-related matters. They are busy managing their lives to add something else to worry about, so convenience and hassle-free solutions are vital for this archetype.

A more detailed description of the four archetypes emerging from this dimension is shown in Table 17.

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Table 17 - Archetypes emerging from the awareness and participation dimension

	The hero (participative)	The explorer (active)	The wise (conscious)	The innocent (non-conscious)
Motto	Change the world.	Reduce their impact.	Consume the right way.	Save money.
Love	Share common objectives. Think solutions together. Degrowth. Live according to their moral standards.	To feel they have the control.	Return on investment. Saving money while doing good.	Save money.
Hate	Being unable to materialize results. Fighting to align common objectives.	Lack of options. Stay still and feel they are doing nothing.	To feel ignored by their community.	Having many devices. Pressure or demand to change their habits.
Needs	Standardization and eliminate bureaucracy.	Gain trust in communities. Participation and belonging. Impact on sustainability matters.	Find easy triggers to activate them. Start to participate.	Simplicity.
Desires and aspiration	A more sustainable world.	Energy independence.	Automatization.	Time and options to be different.

4.6.3. Segmentation by technology appreciation

Given that the interaction with the ecosystem will be mediated by a technology (mobile app, web app, and IoT devices installed at the buildings), we included a technology involvement criterion to segment users. We identified different behaviours around their relationship with technology and their digital activity in the four demo locations during the qualitative research phase. Specifically, we inquired about their relationship with a variety of digital services (e.g., banking, entertainment or home services) as well their use of devices for energy management (e.g., thermostats, apps, PV panels, inverters, etc.), and the use of social networks, social media and communication apps. With these inputs, we explored their innovativeness profile, their disposition towards technology and their trust in devices and software.

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Two variables emerged as key components of this dimension: the use of technology and trust in technology. In turn, the use of technology is a composite of six facets and trust in technology is associated with four facets. Each of them is explained next.

The first variable is the **use of technology.** More specifically, the use of technology is broken down into six facets and variations in each of these facets explain the overall variation in the use of technology.

- First, users differ in the **number of devices** used and the connection between them (smartphone, tablet, smartwatch, computer, IoT devices and appliances at home, etc.). Whereas some perceive a large number of devices as a sign of personal innovativeness, for others a large number of devices is burdensome, as the following quote shows.

  "A single app for controlling everything would be ideal. We all have smartphones, and an additional device would be one more thing I need to have with me. It's simpler through an app." (Residential user, Croatia).

  "Well, both. I think an app is practical when you're not home, but if you're home a device would come in handy. And apps can malfunction easily so a device would be a great back up." (Residential user, Croatia).

- Second, users differ in the **frequency of interaction** with technological devices, especially in non-working time.

  "Once per week would be enough. It wouldn't gather sufficient data every day and it would just bother. Maybe even on a monthly basis." (Residential user, Croatia).

- Third, users differ in the **number of digital services and apps used to manage their personal life** (social networks, chats, smart home management, personal productivity, services like banking, energy, insurance, and entertainment, etc.)

  "I do everything through my mobile phone so any tool I have there, it is great, if I have to use another gadget it would be a real effort." (Residential user, Spain).

- Fourth, users also differ in their **preferences for the type of channel to interact with**.

  "I do it all through my mobile, if I have to use another device it would be too demanding." (Installer, Spain).

- Fifth, another facet to explain differences among users is the **level of control** they like to have over the SaaS/apps they use, and therefore level of personalization and number of functionalities.

  "I think it's really important that it can be tailored to what you want. You can select exactly which ones you want to see and which ones you don't, that's brilliant. If it's just off or on, then that's probably no good, because there will be some that you want". (Residential user, UK).

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- Finally, they differ in the **amount, variety and depth of information sought** in the SaaS/app used.

  "But the app that you use to check where the charging point is, I think it is quite useful. Because you can go through the chats and you can see that somebody has put a comment in, like yesterday, it wasn't working and all that sort of thing. And you can check, and you can keep track and that's quite handy for keeping in touch and knowing what's working." (Residential user, UK).

The second variable comprising this dimension is **trust in technology**. Variations in trust are explained through four facets along which users differ.

- First, the **origin and manufacturing of the devices and materials they use** to create different trust issues among users. Whereas for some this is not a concern and they do not seem to be even aware of this issue, for others this may be enough reason to disengage or resist a given product or service.

  > *"I'm not going to put batteries at home because of the lithium and the way they are made and that's why I wouldn't have an electric car either." (Residential user, Spain).*

- Second, the **perceived reliability** of the accuracy of the information shown by the device (sensors, meters, etc). Some users trust digital devices to a greater extent (as the quote shows), whereas others find analogical information more trustworthy.

  > *"I prefer a more digital solution than a physical one because it would be more real data because not all refrigerators consume the same thing." (Residential user, Spain).*

- The third facet of trust is **confidence in the durability and performance of a device**. Some users are afraid of relying too much on technology so that if it fails, fundamental processes are interrupted or resources are wasted.

  > *"Lately the power goes out always at the same time here in the neighbourhood, and this can make you lose all the cold in the fridges. This is one of the things that scares me the most because it spoils everything. And it also happens to me with the WI-FI." (Commercial sector, Spain).*

- Fourth, users differ in the importance attached to **data privacy policies, agreements, and management:** data collected, data shared or sold, the destination of the data, anonymization of the data. Some (few) users do not really care about how their data is used, whereas others are very sensitive to the data protection policy of a given provider.

  > *"I suppose my willingness to share data with a company depends on my perception of the company or organization or whatever, are they trustworthy? Do they have a good reputation? You know, do I trust them? Is it a UK company? Or is it someone in China? Essentially, I'd be very happy to share data, as long as I had that trust?" (Residential user, UK).*

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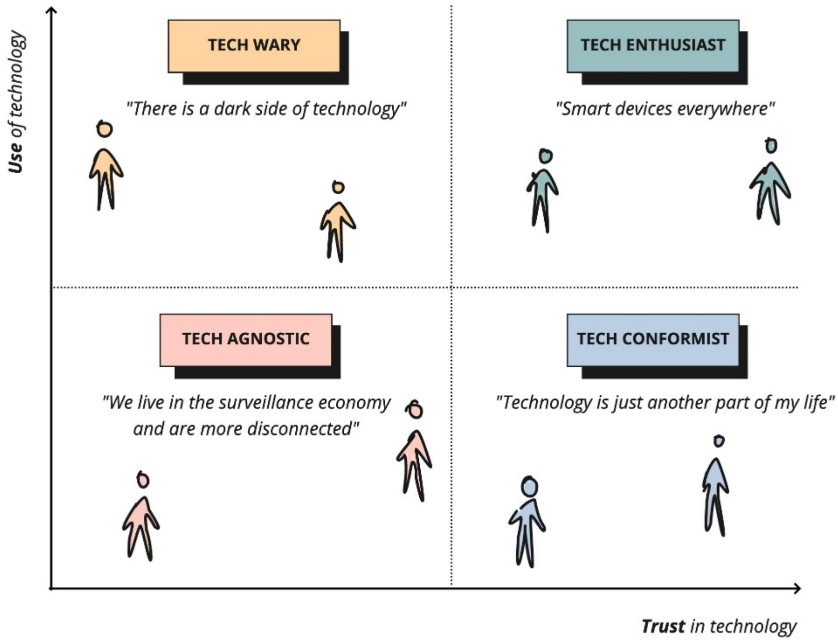
Using these two variables, four user's archetypes are identified (Figure 13): (1) tech wary, (2) tech enthusiast, (3) tech agnostic and (4) tech conformist. Each of these archetypes is described next.

Figure 13 – Archetypes emerging from the relationship with the technology dimension.



Tech wary users are mid to advanced technology users but sceptical and concerned about the negative consequences for individuals and society. They care about their privacy, namely about who and how is using their data even in the devices' provenance and manufacturing. They do not reject technology, but they are very aware of their purchasing and use decisions. To illustrate, they choose Telegram over WhatsApp and they actively manage the cookies preferences while navigating the web. They are unsure about installing PV panels, batteries, or using EV because of the questionable ethics of silicon or lithium supply chains.

Tech enthusiast are users excited about technology, both for utilitarian reasons (i.e., functionalities of technology) but also for identity-related issues (they construe their identity around being a tech-savvy). They use their smartphones to manage their lives, both in personal and professional roles; some also amplify the experience through other personal smart gadgets (smartwatches, bands, etc.). Similarly, they use technology to manage their households and acknowledge having smart appliances, smart home devices (e.g., thermostats or AI assistants such as Alexa). They may also have energy-related technology such as smart meters, PV panels and inverters connected to apps or an EV. For this, their motto is "smart devices everywhere".

Tech agnostics live in a world that is regrettably seen as technologically dependent. Although they do not deny the utilitarian value of technology, they do not see that this value compensates for the negative bearings on technology in terms of social isolation and disconnection. Indeed, they regret that digitalization is disconnecting people from real life and eroding physical relationships; moreover, they are concerned about the big technology companies and their surveillance of individuals. They

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resist using technologies and reduce their use to the minimum. For instance, they may call friends or relatives, but only occasionally use messaging apps and do not use social networks. At home, they barely have electronics, and they trust more analogue services over digital devices. Furthermore, they have concerns about the impact on the human health of microwaves or mobile network infrastructure (some do not even have Wi-Fi). They use computers for work purposes.

Tech conformists are low to mid users of technology. They use it as they see it is convenient to communicate with others, it facilitates work, it helps manage their households, but they do not exhibit any real involvement, as tech enthusiasts do. They do not think much about it and are not much concerned about reliability, performance, or security. They have a smartphone to connect with people via messaging apps or social networks, to take pictures, and may use a selected set of functional apps like maps or entertainment-related apps (e.g., videos or games).

A more detailed description of these four archetypes is provided in Table 18.

Table 18 - Archetype's description in the use of technology dimension

	Tech enthusiast	Tech wary	Tech conformist	Tech agnostic
Motto	Smart devices everywhere.	There is a dark side of technology.	Tech is just another part of my life.	We live in the surveillance economy and are more and more disconnected.
Love	Integration between tech and devices. Hyper personalisation. Deep information. Controlled automation New technologies.	Technology that cares about data privacy and cybersecurity and meets high standards. When technology is ethical and purposeful.	Not being conscious of the use of technology when it disappears to enhance functionality. The possibilities of technology in their personal lives.	Connect with people offline. What works with low interaction with technology.
Hate	Superficial information. Not personalisation options. When technology fails.	Not knowing the purpose of the use of personal data that is required for some SaaS/apps.	When technology hinders their daily life because of a tedious user experience. Waste time trying to	Feeling of being tracked and invigilated. Invasive technology.

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		Feeling to be tracked and surveyed.	understand or use technology.	
Needs	Full and raw information that is exportable. High personalization options and functionalities. 100% of control	Know about the origin and manufacturing of devices. Full transparency about data	Reliable and invisible/silent technology solutions. Simple functionalities that allow them to keep their routines.	Evidence in paper-format apart from digitized information. Transparency about data management.
Desires and aspirations	Everything to be interconnected with IoT devices and can be controlled. To always have the state of the art in technology solutions	To be the owners of all their personal data and to be completely anonymous for the external world.	Own their personal data and to be completely anonymous for the external world.	Live without a smartphone. A life where technology is reliable, invisible and automated with low interference in real life.

4.6.4. Validity of the archetypes

The previously described criteria are not monotonically related; instead, archetypes are a mix of the criteria used so that 16 archetypes would emerge, by combining any of the four options related to awareness/involvement in energy with the other four archetypes emerging from the use of technology dimension. To validate the archetypes, we show next how potential uses interviewed in stage 1 fit in one of them.

For instance, an archetype combining the hero-tech wary subtypes is exemplified by one of the Spanish informants. She was highly active in the community and considered a local energy activist while intensely sceptical of technology-based solutions. She was against digital platforms and PV panels, which were most of the times manufactured with resources from conflict zones, which, in her opinion, diminished the ethicality of this solution. A combination of tech enthusiast and the innocent is exemplified by a Croatian informant who loved to control his life and home trough smartphone apps and his smartwatch but was significantly disconnected form the energy transition.

As the second test of validity, we cross-tabulated the archetypes emerging from the energy awareness/participation dimension with the forms of value sought described above (section 4.2. and 4.3.). The results of this cross-tabulation (see Table 19 and Table 20) demonstrates that archetypes significantly differ in value sought. Finally, a note on archetypes across countries. We found that all archetypes were found in the four demo locations, albeit their prevalence varied.

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The defined archetypes have validity also for the multisector users, where the two segmentations matched not only the residential but the commercial consumers identified during the research. As in the demo locations, the prevalence changes for commercial consumers, especially in the dimension of energy awareness and participation, as most commercial users fundamentally seek economic value. Nevertheless, there are no significant differences according to the technology appreciation dimension among these commercial users.

Table 19 - Self-oriented value sought by consumer archetype

Self-oriented				
Value	***Participative***	***Active***	***Conscious***	***Non-conscious***
Efficiency	**Degrowth:** reduce consumption (beyond energy) and belongings to minimize their environmental impact.		**Maintain:** ensure consumption is efficient.	**Economic:** efficient consumption to reduce the bills.
Convenience	Willingness to **sacrifice convenience** to **reduce their impact** on habit changing.		**Some inclination for** habit changing provided that it is **good for people and the planet**	**Some inclination for** habit changing if it **saves money.**
	Avoid the hassle with technology, also in all tech segmented archetypes.			
Experiential	Quite different meanings of comfort not related to the archetype segmentation.			
Aesthetic	Aesthetics of devices or energetical installations is a must and not a form of value sought, and it is not causally related to the archetype segmentation.			
Episteme	Learn about energy consumption, the market and the best solutions to incur in as less negative impact as	Learn about their energy consumption, the market and the best solutions to incur as less negative impact as	Interest in knowing some sustainable options/tips for their consumption.	No major interest in learning, except for some users superficially interested in tips to save energy.

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	possible and how to drive change in their communities.	possible.		

Table 20 - Others-oriented value sought by consumer archetype

Others- oriented				
Value	**Participative**	**Active**	**Conscious**	**Non-conscious**
Status	To be recognized by the community as lead **environmental/social activist.**	To be recognized as a referent of sustainable consumer.	No value sought in status.	No value sought in status.
	For some users, to be **recognized as a tech early adopter (tech enthusiasts).**			
Esteem	Feeling proud or guilty depending on a good or bad habit of energy consumption from an impact perspective.			Feeling proud or guilty depending on a good or bad habit of energy consumption from an economical perspective.
Social, community	Driving positive impact in society and the environment through their habits and social initiatives.	Driving positive impact in society and the environment through their habits.	Knowing they are not harming the society/community with their habits.	For some users, feeling part of the community.
Environmental			Knowing they are not harming the environment with their habits.	No value sought in relation to the environment.

4.6.5. The value sought of other stakeholders conforming the service system

The main goal of ReDREAM is to facilitate consumer participation; however, as S-DL explains, for value to be created, all stakeholders in a value network need to integrate resources and play their required roles. That implies that consumers (in a broad sense, including residential and commercial consumers) and the rest of the energy market players need to get involved. Although the rest of the stakeholders

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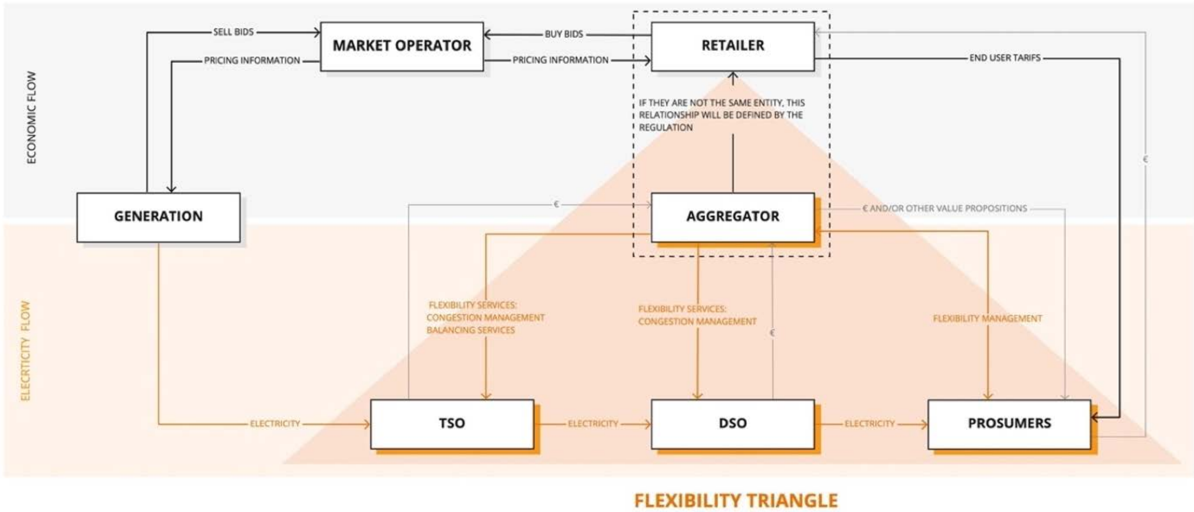
already participate in the energy market, we complement this section focused on users with an analysis of the value sought by other system actors: DSO (Direct System Operators) and TSO (Transmission System Operator), aggregators, retailers, centralized generation and the market operator. The following figure (Figure 14) explains the relationships between the different stakeholders involved, foregrounding the role of the aggregator and its fundamental role of primary resource integrator between the actors involved in the transmission of electricity (electricity flow) and the ones in the economic flow of the market.

Figure 14 - Stakeholder's map



Regarding **DSOs and TSOs**, European regulation is changing the approach of electricity grid maintenance and stabilization. The funds designated for that purpose are received by the DSO biannually; these funds are not oriented to reinforce physical parts of the grid, but for developing new intangible solutions like flexibility. The current investment in copper (thicker wires, new transformers, etc.) will not be a viable option in the future, as society's electrification is speeding up and physical reinforcements have a limit after which they will no longer be sustainable.

Therefore, the DSO will be one of the most benefited stakeholders with the ReDREAM project. Having access to aggregated households and business buildings willing to change consumption behaviours will ease the development of flexibility-based services. The knowledge obtained from the project will enable a better understanding of consumers' demands (real and forecasted) to send the right market signals when a flexible consumption is needed enabling demand response dynamics. As noticed in other European electricity market projects (like Integrid), participation in flexibility-based services may reduce the need for greater grid reinforcement investments, diminish maintenance and operations costs (energy losses) and, consequently, increasing profitability and reduced emissions related to RESs losses.

The Transmission System Operator (TSO) will also benefit from the increase of competitiveness in the market which is expected to drive a price reduction. This may trigger a virtuous dynamic so that in the mid-long term, it will favour a system that embraces more renewable energy generation.

In sum, the value sought by these actors can be summarized as follows: **understand the demand to be able to stabilize and procure an efficient grid, by offering flexibility services.**

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Second, **aggregators** are a fundamental actor in the system as they are responsible for gathering enough buildings and households' capability to change consumption behaviours based on market signals, to provide sufficient flexibility service to the DSO to mitigate the grid issues. Its revenue model is based on the offering of those services to the grid.

> Their main value sought in the system is to **engage enough prosumers to ensure a basis of energy flexible buildings to offer services to the grid.**

Third, **retailers** will be affected when flexibility services become a standard in the energy market, and more and more consumers will be willing to participate in those services, without considering what regulation could oblige in this aspect. Therefore, consumers will choose the electricity tariffs and services that meet their new needs. Those stakeholders will have to be updated in the new consumer preferences to offer the best solutions for a more flexible consumption scenario, such as fixed prices per consumption curves.

> Thus, the main form of value sought in the project is to **understand users' new behaviours and preferences to be able to retain them by offering adequate energy services and how aggregators are operating and how this affects their business.**

Forth, **centralized large generators** could benefit from the project for two reasons. At a first sight, the energy transition to renewables defines a future scenario where the offer is less manageable. In that case, a project like ReDREAM, which mitigates the grid's instability, either caused by the offer or the demand, is a catalyzer to renewables. In addition to this, currently combined cycle power plants or hydro pumped storages ReDREAM appears then as a direct competitor in those services triggering the jump to renewables, already pushed by the European regulation.

> In sum, the main form of value sought by this actor is **being able to maximize renewable generation without jeopardizing grid stability.**

The final market actor in the system is the **market operator.** With flexibility becoming part of the new reality of the electricity markets, generators will be a key stakeholder to ease this transition. It will provide negotiation platforms for the final consumer and aggregator, keep providing price signals to lever flexibility, define the best information flows for the markets, or enable access to the final prosumers.

> In a nutshell, the main value form sought by this actor is to **understand new dynamics generated by flexibility to be able to keep providing their services to the markets.**

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5 Ideation: a strategic approach to the ecosystem design

This section depicts the main findings of the Ideation and Prototyping & Validation stages of the methodology. In a nutshell, this section presents the strategic outline of the ecosystem. More specifically, this section first summarizes the value sought by each of the market actors as this was the starting point for the conceptualization of the ecosystem. Next, we specify the main objective of this ecosystem, the golden circle and epic win, as they are the strategic foundations of the ecosystem as emerged during the co-creation sessions. Third, the design principles are outlined and explained. The section ends with a description of the design guidelines that inform the basic architecture of the ecosystem and the orientation of the functionalities.

5.1. Value co-creation: prosumer and stakeholder value propositions

The ecosystem conceptualization is structured following the central tenets of S-DL, where value co-creation among users is the main goal of markets. Therefore, it is crucial to understand the value sought of different market actors (including the different archetypes of users) as a prior step to define how this value is going to be created in the service system (Axiom 1). Table 21 summarizes the value sought by archetype and stakeholders to understand the value proposition that the ecosystem offers to each of those.

Table 21 - Archetype's ecosystem value proposition base on value sought

Users' archetype	*Synthesis of the value sought*	*Value proposition*
Participative	Change the world	**Be a changemaker of the energy transition and embark others in the journey.**
Active	Reduce the impact of consumption	**Be part of the sustainable change through their own energy consumption behaviours.**
Conscious	Consuming in the right way	**Ensure you are doing the best you can do for people and the planet in electricity consumption.**
Non-conscious	Saving money	**Understand how you consume electricity to reduce your electricity bill.**

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Table 22 - Stakeholder's ecosystem value proposition base on value sought

Stakeholders	*Value sought*	*Value proposition of the ecosystem*
DSO/TSO	Understand demand to be able to stabilize and efficient the grid, proactive- and reactively with flexibility solutions.	**Transmit market signals effectively and in real-time to the demand base and get accurate consumption forecasting information to better mitigate grid instability.**
Independent aggregator	Engage enough prosumers to ensure a basis of energy flexible buildings to offer services to the grid.	**Access and control a flexible consumer base that ensures the capability to provide stability services to the grid**
ESCOs and aggregators	Understand users' new behaviours and preferences to be able to retain them by offering adequate tariffs and services for flexibility.	**Access reliable and updated information about consumption behaviours and preferences of the three sectors (Residential, industrial and commercial sector)**
Generation	Being able to maximize the renewable generation without worrying about grid stability.	**Increase securely the generation of renewable energy and speed up the energy transition**
Market operator	Understand new dynamics generated by flexibility to be able to keep providing their services to the markets	**Access to reliable and updated information about the market behaviours and preferences around flexibility (all stakeholders and consumers)**

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5.2. Ecosystem objective

The ecosystem objective is to involve citizens in the energy transition challenge by helping them have a more conscious and efficient consumption (that favours flexibility) both individually and collectively, generating an impact on their households, on society and the planet (profit, planet and people).

Next, we define the Golden Circle (Sinek, 2009), a strategic model that starts with the purpose (Table 23) and the Epic Win or best success scenario.

Table 23 - Golden circle of the ReDREAM ecosystem

Why	Because people's involvement and participation are needed for the energy transition success.
How	Increasing the level of awareness, generating behavioural changes in energy consumption with a positive impact on the energy system, people and planet and maintaining well-being.
What	1. Raise awareness about energy consumption and its impact: **Making consumption and impact visible (both individual and collective).**
	2. Raise awareness about positive and negative actions: **Promoting behavioural changes consumption and the energy system, people and planet.**
	3. Raise awareness about the need to work in the community: **Helping understand and activate the power of participation and the community to achieve common goals.**

Regarding the epic win or the best-case scenario imagined for the future of the ecosystem, we visualize two future scenarios, one for the system as a whole and one for the users.

For the market (ReDREAM):

1. People respond to the flexibility market demand signals (manually and/or automatically) and the grid gets stabilized when needed.

2. People are aware of the relevance of their active participation for the energy transition.

For the users:

People are perceiving value and the actual value is being created (economically, environmentally, socially and/or politically) by making little effort (participating in the ecosystem).

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5.3. Principles for design

Design principles (Figure 15) are key to understand how the ecosystem design works along with the detected user's needs, motivations and ways users want to relate with energy and the energy community. These principles must be "checked" in almost every process of the ecosystem design functionalities, as they are the guardians of the user's motivations and expectations.

Figure 15 - Design principles

Personalization: any setting could be able to be adapted to the user's motivation (value sought) and user's preferences. Settings may refer to, *inter alia*, privacy settings, notifications or details of the info.

> *"Yeah, I'm kind of a geek. So, I've got a spreadsheet. So yes. 10,000 -10,500 kilowatt hours of gas, and that makes for the heating and hot water. And then just slightly over 2000 kilowatt-hours per year of electricity." (Residential user, UK).*

> *"I'd like to set up the notifications and the alerts that are relevant for my operations. For me it's very important to know as soon as possible if a machine stopped working." (Commercial user, Spain)*

Visibility: information must be transparent. This concerns management, justification of its need, destination and visualization of the user's impact.

> *"I suppose my willingness to share data with a company depends on my perception of the company or organization or whatever, are they trustworthy? If they got a good reputation? You know, do I trust them? Is it a UK company? Or is it someone in China? Essentially, I'd be very happy to share data, as long as I had that trust?" (Residential user, UK).*

Simplicity: less is more; include only what is essential for users. Show other possibilities for curious or advanced users so that they can access deeper information or more complex functionalities.

> *"I think the most important part is simplicity. It would be great if the hardware already exists, or you buy it, rent it, whatever, that you only need to download the app, accept the terms of use, and you're a part of the community. A plug & play solution. Whenever something is related to energy, people shy away from it because it's usually complicated, dangerous, dirty...If there is some shortcut, that's the best." (Round Table, Croatia).*

Discoverability: provide an experience that unfolds in a journey depending on the curiosity, progress and engagement of the users, while maintaining the educational and empowerment *ethos* of the project.

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> *"I think it is really, I mean, everybody's got a bit of competitiveness in them. And I think it is a good motivator for making improvements, in a way, so keeping up with the Joneses, or whatever, or you know, trying to outdo each other. But if that means less carbon, then why not get people to compete against each other?." (Residential user, UK)*

Managed automation: always bet on the maximum automation possible, but still manage to make users feel and have the control whenever they feel like

> *"I imagine in the future everything will be automatic, so we don't have to think about anything too much." (Residential user, Croatia).*

> *"Having a smart thermostat that you can control from your smartphone just makes you feel a little bit more in control. And it gives you a little bit more flexibility." (Residential user, UK).*

5.4. Musts: technology features of the ecosystem

Musts are developed as a means to understand the role that technology, and other ecosystem items, must play since these elements have a bearing on the relationship with users. Given that the tech archetype has a different vision of the type of interaction they want to have and the purpose for doing it, the proposed "musts" are adapted to the requirements of the different archetypes (Table 24).

Table 24 - 2 Ecosystem "musts" defined by archetype

TECH ENTHUSIAST	TECH WARY	TECH CONFORMIST	TECH AGNOSTIC
Control: automation must give a sense of "control". Personalisation: technology must provide everything with a prominent level of personalisation. Depth: information must be deep and concise.	Commodity: automation must bring them commodity. Real-time: technology must make them capable to decide in real-time. Ethics: technology must be ethical and work towards a purpose. Transparency: transparency and data management are crucial.	Practicality: automation must make his life easier, as he is conscious but not highly active. Simplicity: technology must be easy but necessary. Security: technology and devices must help them take care of their data.	Trust: automation must be a tool to make them trust it. Service: technology must be a tool with few interactions. Privacy: technology must make them fell not surveyed or invaded.

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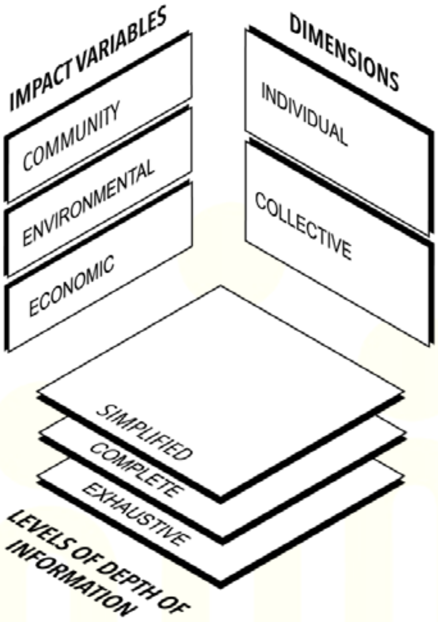
5.5. General design guidelines for the ecosystem

We propose a set of guidelines that jointly depict how content is structured in the ReDREAM ecosystem (Figure 16). More specifically, the guidelines comprise the approach (individual and/or collective), the dimensions used to communicate with users and the levels of depth of the information provided. These guidelines apply to all the functionalities in the ecosystem (Figure 16).

Figure 16 - Ecosystem's guidelines



5.5.1. The individual and collective dimensions

As shown in the research, and as S-DL defended, participation and community generation are fundamental to ensure we meet the target. Users feel more motivated when they belong to a community and achieve common goals together. Belonging is an important theme for all users' countries. At the same time, the achievement of community goals depends on individual performance. Consequently, these two dimensions need bridging in the ecosystem.

5.5.2. Language based on impact variables to meet users' needs

During the research, most of the users mentioned the complexity of energy in several aspects: the complexity of the market's functioning and the role played by different market actors, the ambiguity and abstraction of "energy", the units used to quantify it, among others. These quotes illustrate users' difficulty in understanding the energy system and energy consumption.

> *"Energy, for example, is a very abstract, invisible and complex issue for the majority of the population". (Expert, Spain).*

> *"I think the energy market is very complex. It is easy to say that you have produced a lot of electricity and give it away, but when you don't produce it, you don't lack electricity. It is very*

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> *complex to understand, and I don't think almost nobody is aware of how it works". (Residential user, Spain).*
>
> *"People need to be spoken to more simply, with examples." (Residential user, Spain).*

Therefore, to be coherent with the principle of simplicity, the ecosystem must communicate to the users in their preferred language, where language here is used to refer to the type of dimension or outcome to be visualized. Adapting to the archetypes, we propose to adapt the language to the value sought. Adaption does not imply a restriction of information provided, since all technical units will be included, so to cater for the different users' archetypes. In practice, this guideline implies that users will be given outcomes or units in three dimensions: economic, environmental and social.

Economic units. These units respond to the question "*How this impacts my pocket?". This unit is especially relevant for the less-aware users (the innocent) and the commercial users. Nonetheless, all users expressed concerns about how much participation in ReDREAM will cost. Given past evidence and users comments about the irrelevance and difficulties in understanding kWh, we propose to use a more meaningful currency. Given that euros saved are usually small, we propose to "translate" savings into an equivalent item that is more valuable for the users (e.g., two coffees, one ticket for the zoo, etc.).

If providing this unit is not possible, we propose to offer relative data such as percentage of savings, relative cost, instead of kWh of consumption. Consumers acknowledge not being able to interpret how a given figure of kWh means or how much they are spending if they reduce their consumption by 13%.

In sum, we propose to translate any information about consumption/savings of kWh into a meaningful economic outcome.

> *"I find that people often do care about energy usage, but their impression and accuracy of what that usage is is virtually non-existent. So, we try and make some carbon footprint calculators, which is pretty much a proxy for energy use in many ways and then help people actually calculate what is significant and what isn't significant." (Round Table, UK).*

Environmental units. They respond to the question *"How this affects the planet?".* Environmentally aware users want to know the impact of their consumption on the planet. However, most of those users are not expert environmentalists and have difficulties in deciphering the meaning of CO_2, so that they are unable to assess whether their emissions are low or not. This information should also be translated into more meaningful units, such as emissions equivalent to hours of car use and the carbon sequestration of a tree. It is recommended that the comparison is done according to the user's context and the moment of consumption. This is to say that if the users provided flexibility for two hours, we should compare the emissions avoided by X cars during those two hours.

In sum, we propose that environmental units should be translated into the equivalent of a car if the message has a negative connotation and the equivalent of tree sequestration if it is positive.

> *"The financial reward is always a good reward. But with CO_2 data that you haven't emitted, if you don't know what impact that has if you don't have a baseline, I don't know if it would do much good." (Residential user, Spain).*

Community units: they respond to the question "*How this affects my community?".* The ReDREAM ecosystem works towards increasing the flexibility rate on the demand side, but users find it very

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difficult to understand the flexibility concept. However, during the research, we identified how place attachment and community value are relevant, especially in the British, Italian and Spanish demo locations. People care for and strive to improve the communities they belong to. By providing flexibility, and especially with the introduction of local markets in the energy system, consumer behaviour is critical for the grid's stability. Flexibility provision will affect the market prices or the among of renewable energy available in a neighbourhood, and these are meaningful social units for users.

Users easily understand units around "buildings", such as a house, windmill or thermal power plant. Based on the findings of the exploration stage, we expect that users will engage more if they are told that four houses in their neighbourhood got access to renewable energy thanks to their flexibility provision, or that if 100 users provide flexibility, a new windmill could be embedded in the energy system.

In sum, we propose that the positive outcomes of flexibility should be translated into the equivalent of a house's consumption, the generation of a windmill or a thermal power plant.

> *"On an individual level you can do and achieve simple things, like turning on or off a washing machine, but on a community level you can achieve much bigger and better things for everyone." (Residential user, Spain).*

5.5.3. Levels of the depth of the information provided

As shown during the research, not all users are ready or willing to interact with the same depth or amount of information. Users will comprise tech enthusiasts who will want to know all the minor details of their consumption data or even perform their calculations or participative users concerned about the exact amount of GHG emissions related to each of their appliances' consumption, and users that are only interested in the economic impact of their actions. Therefore, we propose to offer three levels of depth of information. Consistent with the discoverability principle and the learning goals of the project, we should expect that, during the journey, users access greater levels of information depth.

Functionally, the first level will be shown to all users at first sight or a one-click level; the other two will be accessed over two-click or more access levels. It goes without saying that not all functionalities need to have the three levels of depth. These three levels are explained next and examples are shown in Table 25.

Simplified: this essential information should be read and understood easily and instantly, providing the users with a general overview of their consumption and impact. Also, this information should be enough to help some archetypes of users make decisions (notably tech conformists and non-conscious). This demands a combination of enough information but simple information. To accomplish this, the interaction buttons should be self-explanatory and highly visual (medium-big size, with colour coding and the use of iconography or pictures).

> *"It is easier to see consumption through graphs but with numbers, it is easier to do the calculations. I prefer numbers..." (Residential user, Spain).*

Complete information: simplified information will be shown at a greater level of detail by clicking and accessing a broader explanation about the figure shown at the simplified level. With this detail, curious users can complete their understanding of why and how they achieved a given level of consumption or impact. Also, this level will show the comparative information either with historic consumption (past week or months) or with other users.

> *"I find the idea very interesting. I like the part where you can monitor your production and consumption and compare your home with other households". (Round table, Croatia).*

Exhaustive: this is the information with the greatest level of depth and is expected to be used only by users with a greater need for control. This level should depict all (or almost all the available) information collected flexibly, so that s/he can use it as s/he finds it more useful: using graphs, tables, or even downloadable CSV files.

> *"To compare how much I saved by having PV modules. Something saying, `You would have spent this amount of money, if you hadn't had your PVs or if you wouldn't be flexible in the use of energy´." (Residential user, Italy).*

Table 25 - Examples of depth for different types of information.

	Essential	**Complete**	**Exhaustive**
Example 1: ***Energy consumption***	Figure of weekly consumption, showing if it's higher or lower than the average or the same day a year ago.	Bar graphic with daily consumption during the week with the average consumption curve and the consumption the same days last year, in kWh and spending.	Graphic of disaggregated daily consumption per appliance/device in percentage and kWh and with an option to show hourly consumption in a table.
Example 2: ***Savings***	Figure of money saved during the month	Graph with daily savings during the month	Monthly savings disaggregated by day and by device and/or challenge accomplished.
Example 3: ***Emissions***	Figure of equivalent CO2 emissions of the day compared to cars.	Graph with daily emissions during the month, in eCO2kg and equivalent in cars.	Monthly emissions disaggregated by day and by device and/or challenge accomplished.
Example 4: ***Self-consumption***	Figure or percentage of self-consumption in the day.	Graph of generation during the week with the percentage of self-consumption, weather information kWh generated and profits.	*[Not all cases need to have 3 levels of depth]*

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6 Consumer-centric functionalities in the ecosystem

In this section, we make tangible the ReDREAM ecosystem based on the outcomes of the Ideation and Prototyping & Validation stages of the methodology. We start with an introduction to a simple architecture of the functionalities of the ecosystem. Then we continue with defining those four main functionalities (F.1 Dashboard, F.2 Challenges, F.3 Advisory tool and F.4 Settings). We conclude the section specifying the management of the different type of users (6.6) and the adaptations to the user's journey (6.7), the multisector users (6.8) and the consumer archetypes (6.9). Finally, we define the part of the ecosystem in charge of managing the consumer base locally: the energy community app in section 6.10.

This section defines an ecosystem version for a residential user, as it will have all the features. In section 6.8, the differences that will apply to commercial and industrial users are specified. Despite the visual examples shown in the sections related to the functionalities are mobile screenshots, the entire definition of the ecosystem is both applicable to a mobile and web browser app version. Most of the interviewees expressed during the exploration of their preference for a smartphone app, albeit a minority would prefer a desktop version.

6.1 Introduction to the architecture of the ecosystem

The ecosystem's main goal is to make the users evolve so that they exhibit greater engagement with energy. For this, the original layers envisaged in the proposal will be visualized by users in three modules: Dashboard, Advisory Wall, Challenges. These three modules will be complemented with a Settings module. This modular architecture is more attuned to users' requirements. During the ideation phase, we observed that a structure on layers would be meaningless for the users. For example, the architecture considers gamification as a service, but for the users, gamification is going to be integrated into all the application as challenges (F2), profile (F4.1.), etc. or the Social Network that will be separated in the challenge forum (F2), the support forum (F4.4) and the public profile (F4.1.)

The definition of the functionalities is based on the current institutional context that establishes what is technologically and legally possible. We must keep in mind that, being a three-year project, we have to be able to iterate, optimize and include new variables and definitions in the future, if the context changes. A list of functionalities is shown in Figure 17; next, we present the architecture of the ecosystem by describing the functionalities included in each module and showing the correspondence with the layer originally defined (Table 21). Each functionality will be described in detail in the following subsections, following a similar template to maintain consistency and ease readability (i.e., purpose, description, functional requirements, examples). Since examples are taken from the benchmark and were identified in manifold apps and websites, they are not unified in format. Be aware that their look and feel may not match the look and feel of the ReDREAM functionalities. It is important to read the descriptions from the previous sections to understand the functionality correctly.

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Figure 17 – ReDREAM ecosystem main functionalities

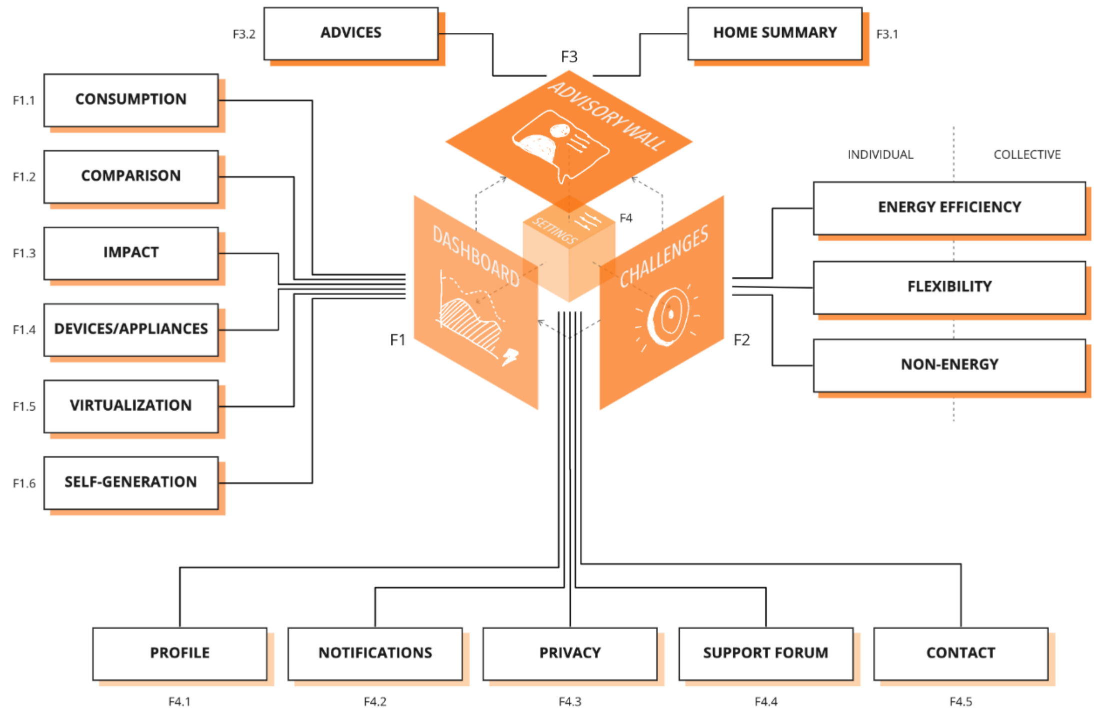

Table 26 - ReDREAM ecosystem list of functionalities

ID	Functionality Name	**Correspondence with originally defined layers**
F1	Dashboard	Layer 5 for all the visualization of the consumption and impact. Layer 4 for the virtualization.
F1.1	Consumption data	
F1.2	Comparison functionalities	
F1.3	Impact visualization	
F1.4	Consumption per device	
F1.5	Virtualization	
F1.6	Self-Generation dashboard	
F2	Challenges	Layer 3 for the Social network and layer 5 for all the information and the gamification.
F3	Advisory Wall	

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F3.1	Home/Building summary	Layer 5 for all the information, advice, and notifications.
F3.2	Advice wall	
F4	Settings	Layer 1, for the profile and profiling, and layer 5 for al de configurations.
F4.1	My Profile	
F4.2	Alerts and Notifications	
F4.3	Data & Privacy	
F4.4	FAQ section / support forum	
F4.5	Contact details and channels	

6.2 F.1 Dashboard

Purpose. This group of functionalities will help users visualise their current generation, consumption, impact and possibilities for improving their performance.

Layers & Services that support these functionalities. Layer 5 for all the visualization of the consumption and impact. Layer 4 for the virtualization. The services are:

1. Layer 5, Open Services Pool:
   - Advisory tool
   - DR tools
   - Energy Efficiency tool
   - Non-energy tool (mobility/comfort-air/health)
   - Gamification tool
2. Layer 4:
   - Virtualization & Digital Twins

Functionalities inside this group. The dashboard will be a combination of distinctive functionalities that will give users the visualization of their production, consumption and impact, and other data aimed at triggering their motivation to act (Table 27).

Table 27 - Dashboard's list of functionalities

ID	Functionality Name
F1	Dashboard
F1.1	Consumption data
F1.2	Comparison functionalities
F1.3	Impact visualization
F1.4	Consumption per device

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F1.5	Virtualization
F1.6	Self-Generation dashboard

6.2.1 F1.1. Consumption data

Purpose. This functionality will be a set of data pictured visually to depict the current energy consumption and its impact.

Description. When users access the dashboard, they will see a graph with their energy consumption in kWh. They will be able to access their data by different units of time (hours, days, months, and years) Also, they will be able to see the consumption of their household and their community.

They will also see their current impact through three different variables, as described in section 6: economic (how much they spent/saved), planet (how much its consumption impacts the planet), people (how much they are helping the grid). They should also see definitions for each of the variables in case they ignore the meaning. They can navigate into each type of impact to see more detail clicking and going to Impact visualization F1.3.

They will also see:

- Historic comparison.
- Origin of consumption: of the total consumption, how much energy came from which energy source.
- Type of energy consumed (Hydro, Wind, Nuclear, Coal, etc.)
- Request to download data consumption.

Functional requirements.

1. The information has to be shown in a visual way, with graphics. We should still determine which type of graphics; linear graphics were tested in validations, but they were not very well received.
2. Users should be able to see consumption data in real-time of the current day (per hours), week (per days) and month (per weeks).
3. They should be able to see consumption data of previous days (per hours), months (per days) and years (per weeks). They will not visualize all this information simultaneously; rather, we can call for the different data after users' interaction or page entering, for example: when the users charge the page, they see the data for the current day per hour and the impact (first call); then they change to the current week (we make the call and the previous data stops showing); then to the current month (we make the call and the previous data stops showing), etc. If we are in the middle of a day, week, month, or year we will only show the data that we have. The groups of data should be:
    a. A specific day (current or past) with the consumption per hour.
    b. A specific week (current or past) with the consumption per day.
    c. A specific month (current or past) with the consumption per week.
    d. A specific year (current or past) with the consumption per month.

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4. Time-setting for different variables should converge: if the users are watching the current day consumption, they should also see the current day impact, if they are watching the current week impact, they should also see the current week impact, etc.
5. Next to the consumption impact, we should depict a comparison with the previous impact. For example: “Today's economic impact is 10€, 2€ less than yesterday”.
6. This should link with the detail for each type of impact in functionality F1.3
7. We should save the data of the energy sources and the type of energy used in each consumption time.
8. Consistent with the individual-community dimensions, this information for the users could be depicted for users’ household or their community (i.e., how much their household has consumed or how much their community has consumed). They will have an option to select which of the data they want to see. They will not be able to see both pieces of information at the same time in this graphic.
9. Include the possibility of downloading consumption data.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. In Table 28, you can find illustrative examples for some of the functionalities described before. Be aware that their look and feel may not match the look and feel of the ReDREAM functionalities. It is important to read the descriptions from the previous sections to understand the functionality correctly.

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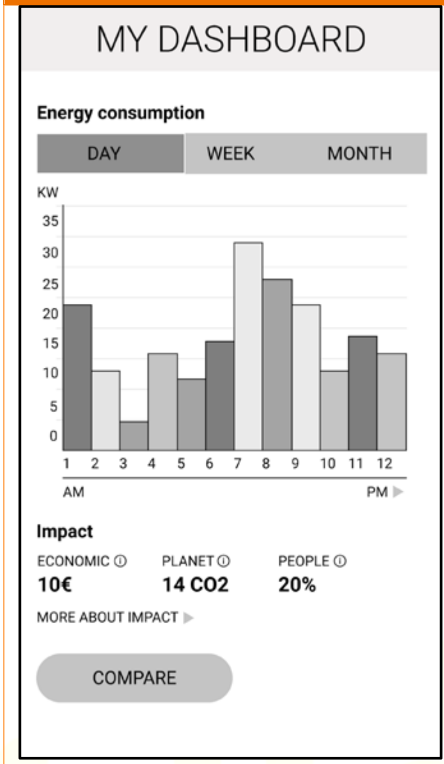
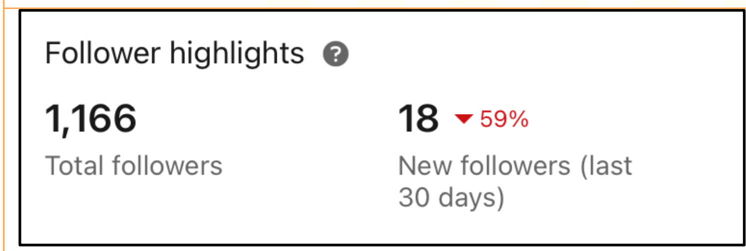
Table 28 - Consumption data dashboard's illustrative examples

Screens	Comments
	Wireframe with an example of a graphic with information about consumption with an option to change the unit of time. We can also see the impact on the three different variables and units. These graphics could share the screen with other functionalities or, as you can see in the illustrative wireframe, give access to them through links ("more about the impact" or "compare"). We showed this screen to users in validations and: ***Users agreed that kWh are not the most motivating unit and they would certainly prefer it on CO_2 emissions. Also, they agreed that linear graphics are not the most striking.*** *"Let them tell me about it in CO2 better. Less points, whatever, because the points are linked to spending more". (Residential users, Spain)*
	This is an example taken from the app LinkedIn, where you can see the impact with the little comparison (in red) with the previous impact.

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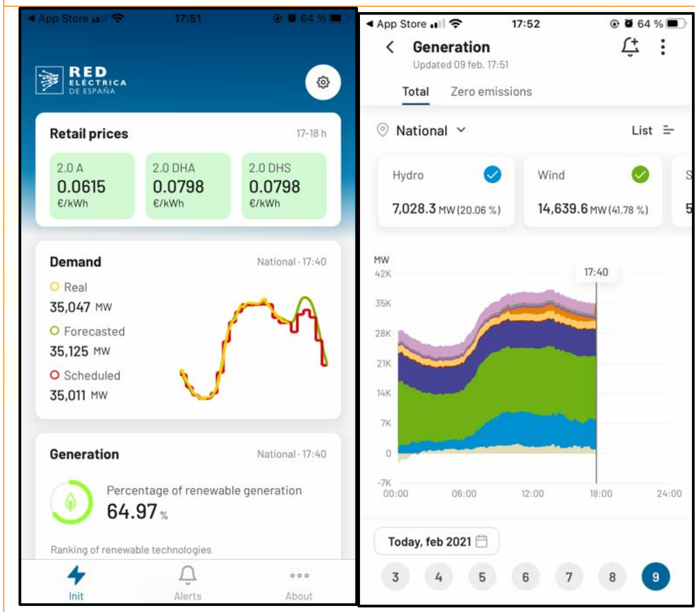
	Wireframe with an example of the depiction of energy sources.
	This is an example of the app redOS showing energy consumption.

6.2.2. F1.2 Comparison functionalities

Purpose. This functionality will be connected to the previous one (F1.1). Users will have the possibility to compare their data of consumption and impact with other consumption and impact data as a driver of motivation.

Description. Users will have access in functionality F1.1, they will choose what they want to be compared to from different options (historic comparison with themselves, with users similar to them, with their entire community). They could also compare the data of their community and other consumption data (historic data of the community, other similar communities, etc.). They will also see the comparison of the impact, and they will be able to change the units of time (explained in F1.1).

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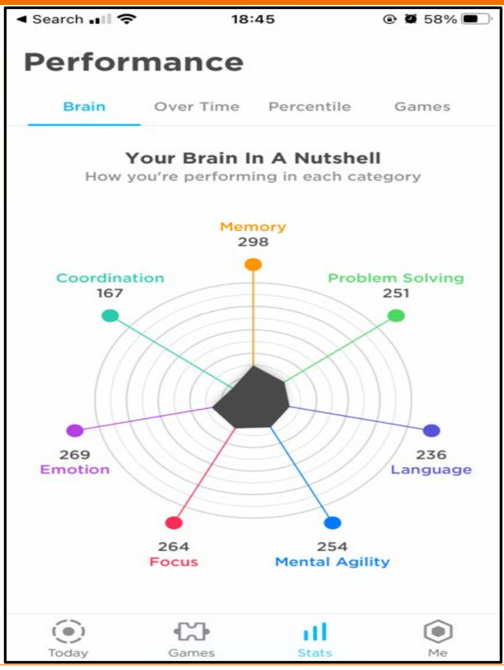
Functional requirements

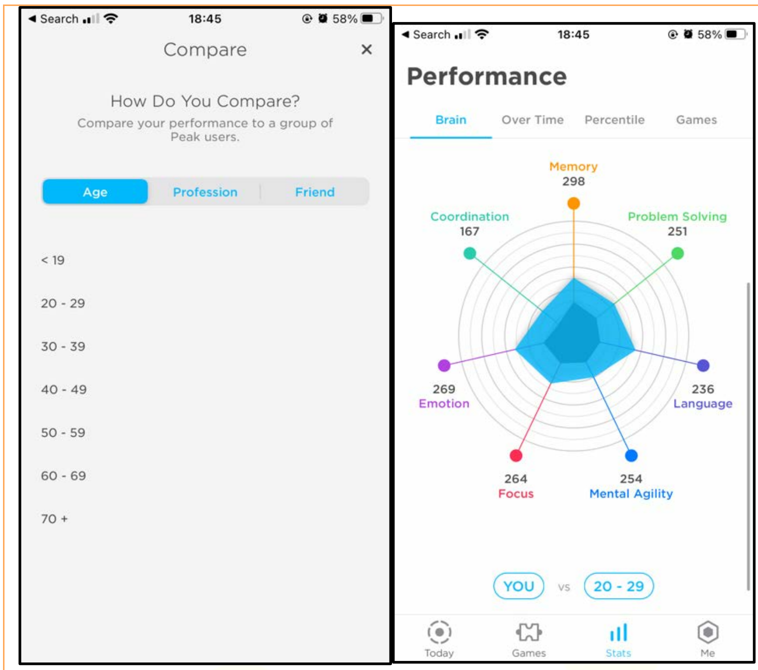
1. Users should be able to choose from the different possibilities of their consumption and impact data explained in F1.1 to compare with other data: household and community data and the current or previous day, week, month, or year.
2. Users will be able to choose which other data they want to use as a comparison. Although this is still to be determined, we envisage that these units could be:
    a. Historic data regarding their previous consumption and impact (in the same unit of time they chose to see their consumption and impact data). This comparison could be made with their household or with their community (choice given to users).
    b. Other households and communities similar to theirs.
    c. Others in their community: this variable will only be available for the household comparison, not the community.

All these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. Table 29 provides illustrative examples for some of the functionalities described.

Table 29 - Comparison dashboard's illustrative examples

Screens	Comments
	This is an example of an app called Peak where you can click on "compare" in the graphic and choose with which group of people you want to be compared to, and then it depicts the comparison. ***In validations users expressed the need to see data in a visual way, arguing that classical graphics do not help much.***



6.2.3. F1.3 Impact visualization

Purpose. Understand all the implications of their impact for each of the impact variables (economic, environmental and social).

Description. Although users will see a summary of their impact in functionality F1.1, they will also have access to deeper information about it here. We will have to validate with users if we depict all data on the same page or different pages, one or each variable. For each variable of impact, we could try to make comparisons and show the global impact accumulation.

For example:

1. For the economic variable, we could talk about "coffees you can buy" or "dinners you could have" with the money you have saved from the consumption of a specific day, week, month, or year and from the global consumption since you had the app.
2. For the environmental variable, we could talk about "trees planted" or "carbon footprint" with the CO_2 you haven't emitted from the consumption of a specific day, week, month, or year and the global consumption since you had the app.

In future validations with users, we could see how we can improve the perception of the impact and show the different impact variables.

Functional requirements

1. They will see deeper information about their impact in the three different variables, so they will need the data from the three of them (economic, environmental and social). These variables are explained in F1.1.
2. We should save data for the accumulation of impact.

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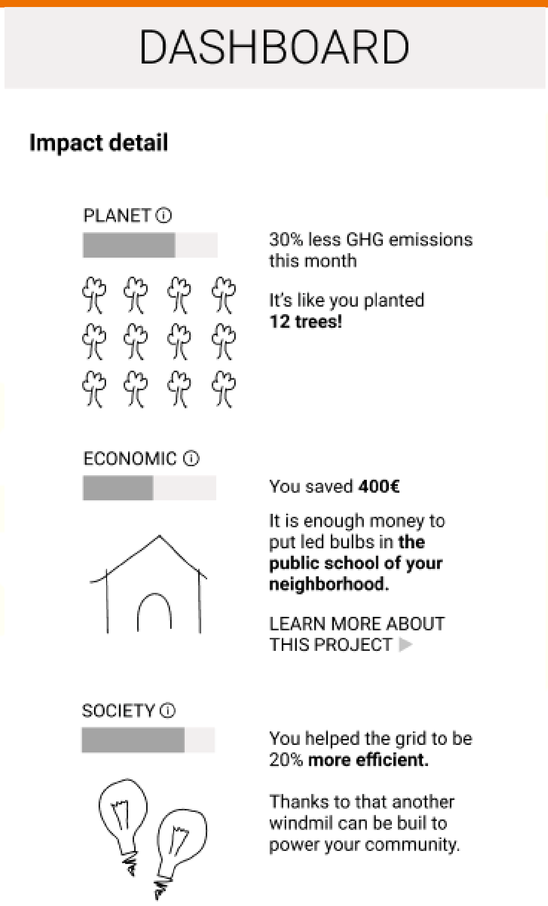
3. They will be able to choose in which unit of time they want to see the impact: day, week, month, or year. They will be able to choose from a calendar which day, week, month, or year they want to see.

All of these are current requirements, in the future, we can add more or give more definition to those we expose in this document.

Illustrative examples. Table 30 provides illustrative examples for some of the functionalities described before.

Table 30 - Impact dashboard's illustrative examples

Screens	Comments
	This illustrative wireframe shows an example of how to depict the information. ***In validations, users found this motivating to see.***

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This picture refers to the self-generation management app from one of the interviewees of Spain's field research.

The residential users showed considerable enthusiasm for the information provided. Both consumption and impact were translated into understandable units by common users like him (€ and trees equivalent to the CO_2 avoided).

The app SmokeQuitter was mentioned and showed to us by a residential consumer in Spain when asked about gamification and engagement experiences in his life.

He declared that one of the most useful and effective functionalities of the app that helped him quit smoking was the visualization in a dashboard of the avoided negative impact (left) and the positives health statistics related to his progress (right).

6.2.4. F1.4 Consumption per device

Purpose. Users will be able to see the consumption and the impact per device/appliance.

Description. Users will have a list with all the devices/appliances of their household so that they will be able to see the impact per device and a summary of the global consumption generated by all devices (we could use colours to differentiate within devices in the global summary). From that list, they will have access to a file for each device. In that file, they will see the consumption and the impact information of the device in a graphic like the one for the global consumption in functionality F1.1. They will also be able to see the time that each device has been working for the time at which consumption is depicted.

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They will also have visibility of the challenges (F2) and the advice (F3.2) related to that device. Devices could be specific appliances (washing machine) or big consumption devices like heating.

Functional requirements

1. There will be a list for all the user's devices with some information about the impact and an option to “add or erase devices.”

2. There will be files for each device with information about their consumption and impact. The information will be shown in a graphic (like F1.1) where users will be able to choose the unit of time, they want to see the impact of one day (per hour), the impact of one week (per day), the impact of one month (per week) or impact of one year (per month). They will also have the data for the time that each device has been used in the unit of time depicted.

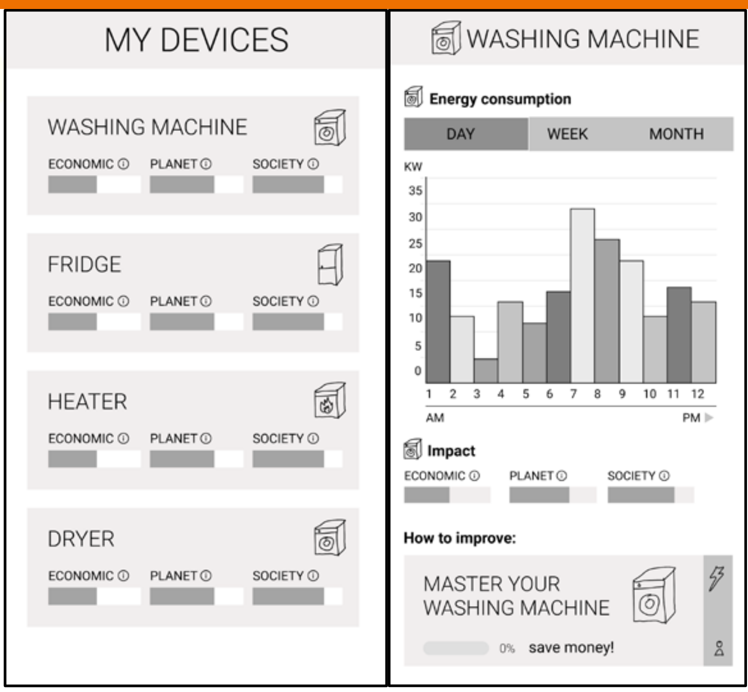
3. They will have links to the challenges (F2) and the advice (F3.2) related to that device.

These are current requirements; in the future, we can add more or give more definition to those we expose in this document.

If we cannot differentiate between devices, we will talk about areas of the house. In case some houses do not have the possibility of differentiating the areas, they will not have this functionality.

Illustrative examples. Table 31 shows illustrative examples for some of the functionalities described before.

Table 31 - Consumption per device dashboard's illustrative examples

<table>
<tr><th>Screens</th><th>Comments</th></tr>
<tr><td>
</td><td>These illustrative wireframes show how we can make a list with all the household devices with limited information about the users and then make a file for each device to show the graphic of consumption and impact and a list of related challenges.

In validations, users were interested in being capable of seeing consumption per device and impact per device. Also, they wanted to see the yearly data to understand their impact better.</td></tr>
</table>

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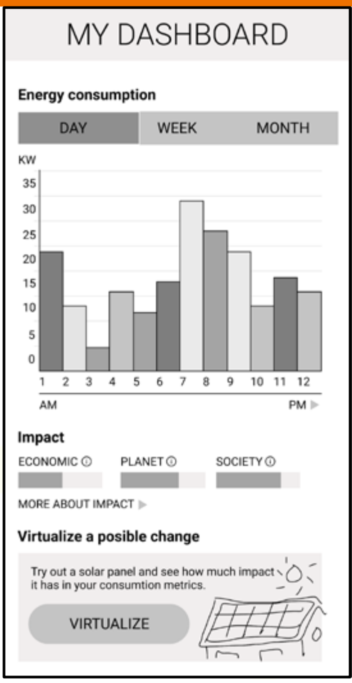
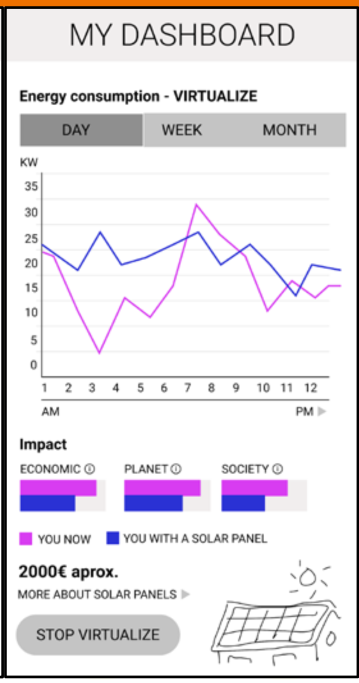
6.2.5. F1.5 Virtualization

Purpose. Users will be able to virtualize what will happen if they install new appliances or change their comfort temperature for a specific period.

Description. We want to help users see the impact that some substantial changes will have on their energy consumption and impact. We will make recommendations about adding new devices (like solar panels) and then show them the difference in the consumption and impact if they adopt them. We will also let them see what could have happened or what would happen if they changed their comfort temperature for a specific period. That will ease users change their behaviour and engagement.

Table 32 - Virtualization dashboard's illustrative examples

<table>
<tr><th>Screens</th><th>Comments</th></tr>
<tr><td>




</td><td>This is an illustrative example of virtualization on installing a new device.

In validations, users agreed that virtualisation must be very accurate for them to trust the ecosystem.</td></tr>
</table>

Functional requirements

1. Users need to be able to access virtualization from the consumption data (F1.1).
2. The virtualization will show the comparison of consumption and impact between their current reality and their virtual image if they made a specific change in a graphic of consumption and impact like in functionality F1.2.
3. We have to show them how much the change will cost (an estimation will suffice) and how much it will make them save or when they will repay the spending. This has to be very certain to have credibility; we have to show them an accurate estimation based on real data.
4. We will show them the characteristics of the appliance, but will not endorse any specific brand.

All of these are current requirements can be further modified to add more data or give more definition to those exposed in this document.

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Illustrative examples. Table 32 shows illustrative examples for some of the functionalities described before.

6.2.6. F1.6. Self-Generation dashboard

Purpose. This functionality visually shows depicts their energy generation, participation in the markets and energy donations. This will be only for users with solar panels.

Description. When users access the dashboard, they will see a graphic with their energy generation in kWh. They will have access to the data for different units of time (e.g., hours, days, months, and years), so that they will be able to see the generation of the current day, week, month, and year, and of previous days, weeks, months, and years.

Also, users will see the amount of energy used for their household and the surplus of energy dumped into the grid. Users will establish the percentage of energy they want to dump to the grid.

We also want to let them know they will have, at some point, the possibility of earning money from the surplus or donating the energy. We have yet to test this functionality; for now, we think they can be given the option to choose between donating the energy or having a discount on their bill. When they choose, they will see a message like: “you cannot do this in your country right now because of regulation”. When this becomes a real option, the functionality should enable users to make a discount on the bill or donate energy.

Functional requirements

1. The information has to be depicted with graphics.
2. They should be able to see generation data in real-time of the current day (per hours), week (per days) and month (per weeks).
3. They should be able to see generation data of previous days (per hours), months (per days) and years (per weeks). They will not see all at the same time, we can call for the different data after the user’s interaction or page entering. The groups of data should be:
    a. A specific day (current or past) with the energy generation per hour.
    b. A specific week (current or past) with the energy generation per day.
    c. A specific month (current or past) with the energy generation per week.
    d. A specific year (current or past) with the energy generation per month.
4. We should have the data of the use of the energy: which energy is used in the household and which is dumped to the grid.
5. We should let the users choose the percentage of energy that is dumped into the grid. They will be able to do this also from the settings (F4.1).
6. We have to start thinking about how we could make the processes for the earning and the donations, even though it is not possible right now.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative example. Table 33 offers illustrative examples for some of the functionalities described before.

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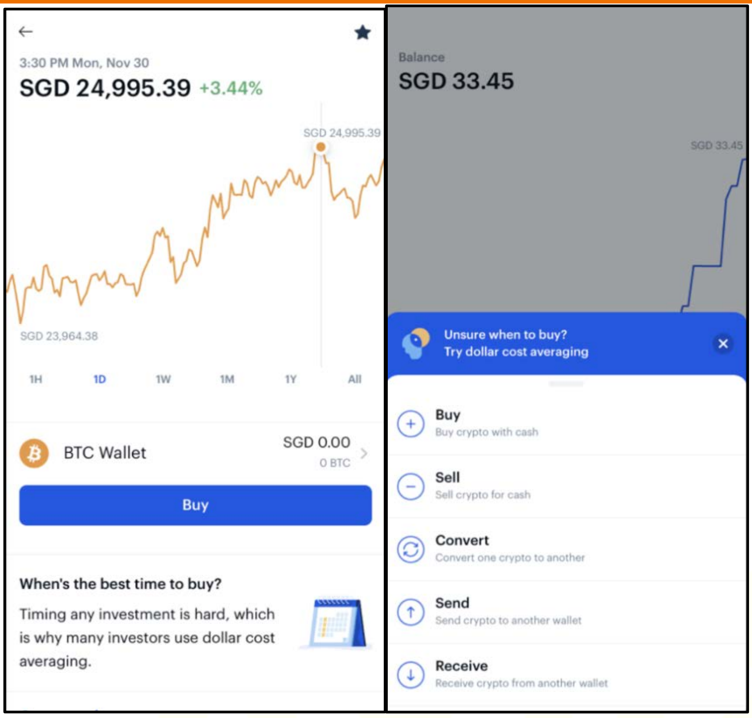
Table 33 - Self-Generation dashboard's illustrative examples

Screens	Comments
	This is an example from the app Coinbase: it presents information with time-based graphics and offers an action related to what the users are watching. In this case, is "buy" in our case will be to choose the percentage dumped to the grid and what to do with the surplus.
	In the previously mentioned Fronius app, the residential users declared to be very happy with the app Sol from the PV inverter Fronius, where information about the generation capacity in kWh was translated into saved money.

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6.3 F2. Challenges

Purpose. This group of functionalities will help users understand which changes in behaviour or their home infrastructure are needed to improve their impact. They will be motivated by different ways to increase their engagement with energy and to visualize how much they have progressed on a given goal and how much progress is yet to occur.

Layers & Services that support these functionalities. Layer 3 for the Social network and layer 5 for all the information and the gamification. The services are:

- Open Services Pool:
  - Advisory tool
  - DR tools
  - Energy Efficiency tool
  - Non-energy tool (mobility/comfort-air/health)
  - Gamification tool

Description. In this functionality, we will give users different challenges options to improve their impact using a gamified approach. Challenges will start from the current situation of the users to propose a change. The users will have access to a list with different challenges and a file for each of the challenges where they will be able to see the goal, the steps needed to achieve the goal, the number of participants and the badge they would get when they achieve the goal. Challenges can be of different duration; we can propose challenges that are only available for a few days or hours or challenges until the users complete them. When users complete a challenge, they will earn points for their profile evolution (F4.1). Challenge's content will be adapted to residential and commercial users.

There will be several types of challenges that can be classified depending on content (flexibility, energy efficiency and non-energy related) and approach (individual or collective), as depicted in Table 34. Collective challenges demand joining others to obtain a common goal to have a wider impact.

Table 34 - List of types of challenges

		Individual	Collective
FLEXIBILITY (DR)	*Real-time*	x	x
	Programmed	x	x
ENERGY EFFICIENCY	*Home consumption knowledge*	x	
	Device/appliance oriented	x	x
	Behaviour oriented	x	x
NON-ENERGY	*Mobility*	x	x
	Comfort	x	
	Health	x	x

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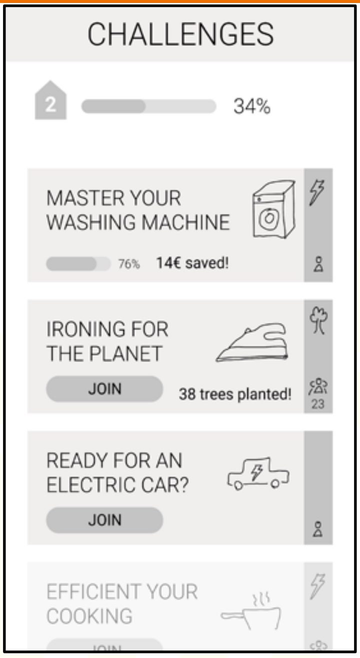
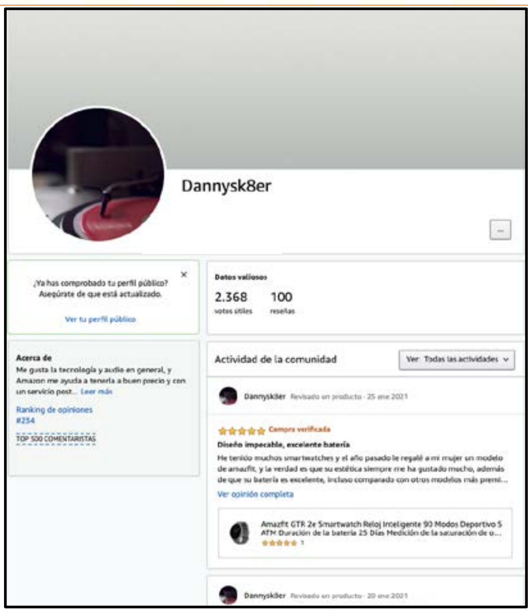
We could also link articles or videos with content related to the challenge in every moment of the challenge process.

Illustrative examples. Table 35 shows illustrative examples for some of the functionalities described before.

Table 35 - Challenges illustrative examples

<table>
<tr><th>Screens</th><th>Comments</th></tr>
<tr><td>


</td><td>Illustrative example of a list with different challenges for one user.</td></tr>
<tr><td>


</td><td>This is an example of a public profile in Amazon and the kind of information they give about the profile.</td></tr>
</table>

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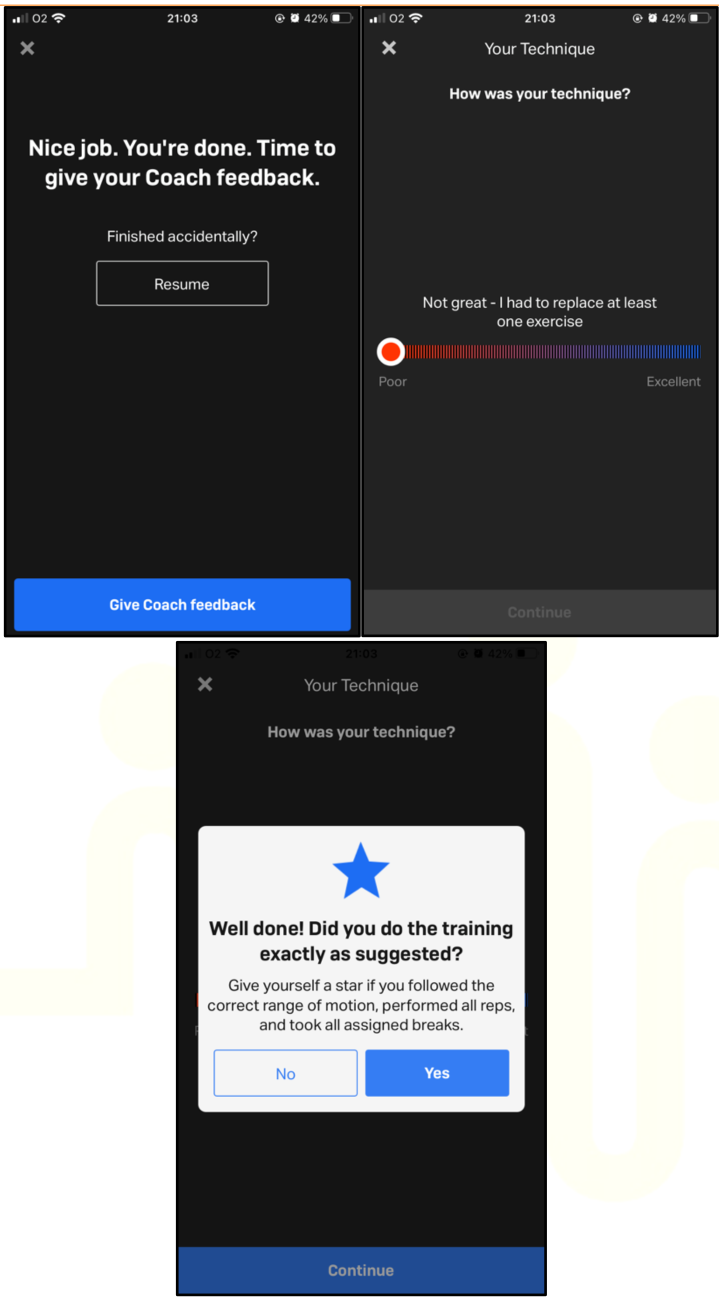

Here you can see an example of the app Freeletics on how to ask the users for feedback when they finish a challenge or, in this case, an exercise.

6.4 F3. Advisory wall

Purpose. It is the principal page of the app/private profile on the desktop version. It will give the users a summary of the current state of the house consumption with real-time notifications and advice.

Layers & services that support these functionalities. Layers: Layer 5 for all the information, advice, and notifications. The services are:

Open Services Pool:

- Advisory tool

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- DR (Demand Response) tools
- Energy Efficiency tool
- Non-energy tool (mobility/comfort-air/health)
- Gamification tool

Functionalities inside this group. The advisory wall will combine two functionalities (Table 36).

Table 36 - List of advisory wall functionalities

ID	Functionality Name
F3	Advisory Wall
F3.1	Home/Building summary
F3.2	Advice wall

6.4.1. F3.1 Home/Building summary

Purpose

This functionality will have two purposes.

- Showing the users real-time but fundamental information about the home comfort dashboard.
- Letting users add widgets to get additional information. The user will choose which widgets to include.

Description. At the beginning of the page, the users will have basic data about the current situation of the household and other inputs that may affect the comfort inside and outside the house.

The data will comprise

- Temperature (inside and outside de house)
- Home calendar (explained in F4)
- Temperature of comfort (explained in F4)
- Current consumption
- Humidity
- Air quality
- Wind

Users will be able to visualize their house calendar and the comfort temperature, they will be able to access directly to the settings to modify the preferences.

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Users could also have different widgets with other information so to create direct access. Users will choose which widgets they want to have there at every moment (we have to put a link to modify widgets). Examples of widgets are principal data of today's consumption, principal data of today's impact, principal data of the Self-Generation dashboard, etc.).

This real-time home comfort dashboard cannot occupy more than half of the screen (e.g., we can use sliders).

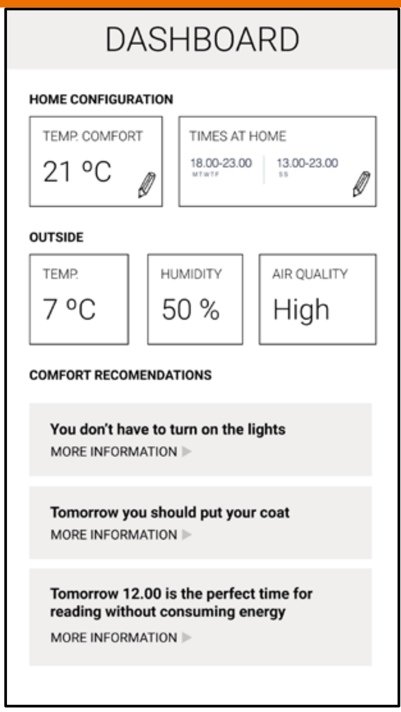
Functional requirements

1. All the information should be provided in real-time.
2. For the outdoors information they need to have access to data about the future (tomorrow's temperature, wind, etc.)
3. They need to be able to change the temperature of comfort and the home calendar.
4. We need to have different widget options and explain a procedure to add and modify them.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. Table 37 shows illustrative examples for some of the functionalities described before.

Table 37 - Real-time home comfort dashboard's illustrative examples

Screens	Comments
	This illustrative wireframe shows, on the top side of the screen, an example of how to put different information about the household and the outside comfort situation.

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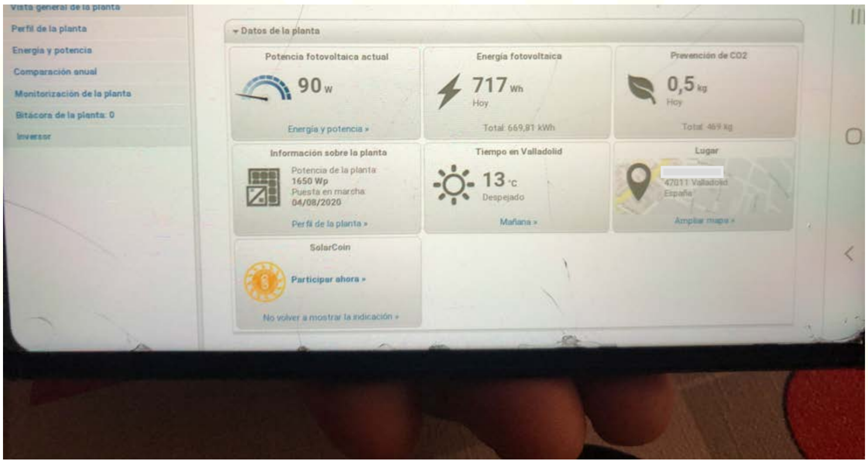
	Here is an example from an iPhone of a screen dedicated to widgets that you can edit.
	This picture was taken during field research in Spain. It shows the home screen of the inverter web app that a prosumer was using to manage self-generated energy. The dashboards serve both, as quick info and figures about the relevant (power, energy, CO_2 emissions avoided, tech info about the PV installation, weather, location and virtual coins), and as access buttons to the functionalities.

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6.4.2. F3.2 Advice wall

Description. The users will have short modules depicting the title of the suggestion or the notification/alert at the beginning of the description so then they click on them to obtain a larger description of the suggestion on a specific page.

Suggestions will be elaborated by us, and the notifications/alerts they receive here will be chosen by the users in the settings (F4.2).

Suggestions will be messages, actions, or contents (articles, videos, etc.) that we want to propose to the users to make their home efficient or to encourage flexibility; we will make these recommendations for those actions that are not easily translated into challenges.

The explanation about notifications and alerts is given in Alerts and Notifications settings (F4.2).

Suggestions and notifications/alerts will stay in the wall until we see it fit, or until the users delete it. If we give a piece of advice/notification/alert and we see that users use it, automatically, we will show the advice/notification/alert completed. We will also let the users tell us that the advice/notification/alert is completed/have been used.

Functional requirements

1. Each advice/notification will have a basic description for the wall and then a wider description for the individual page. The wider description could include:
    a. Straightforward text with a description.
    b. Steps to complete the advice/notification/alert.
    c. Bottom to erase the advice/notification/alert.
    d. Bottom to mark the advice/notification/alert as completed/used.
2. Each advice/notification/alert will have a timer, nor visible for the users, so that it is shown only when it is useful.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative example. Table 38 shows illustrative examples for some of the functionalities described before.

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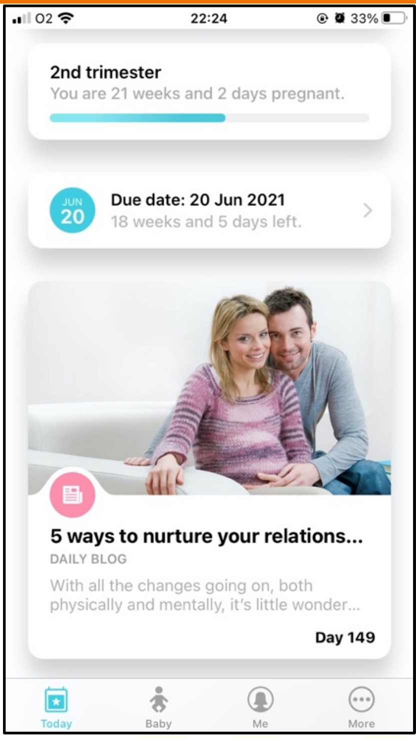
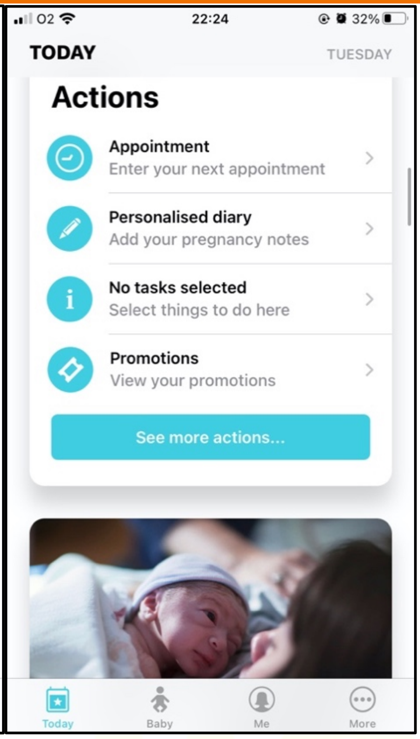
Table 38 - Advice wall's illustrative examples

Screens	Comments
 	Example of a pregnancy app called Pregnancy+ where we can see how they mix information about the state of the pregnancy, with actions users can do and with articles about valuable information in the same type of modules as a wall of announcements.

6.5 F4. Settings

Purpose. This group of functionalities give users the choice of personalizing the app. Also, they can make their profile public, see their own progress and what they can do to continue improving. **Layers & Services that support these functionalities**

Layer 1, for the profile and profiling, and layer 5 for al de configurations. The services are:

- Consumer engagement strategy.
- Open Services Pool:
  - Advisory tool
  - DR tools
  - Energy Efficiency tool
  - Non-energy tool (mobility/comfort-air/health)
  - Gamification tool

Functionalities inside this group. The settings will be a combination of five functionalities that will give users the choices to personalize the app (Table 39).

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Table 39 - List of settings functionalities

ID	Functionality Name
F4	Settings
F4.1	My Profile
F4.2	Alerts and notifications
F4.3	Data & Privacy
F4.4	FAQ section / support forum
F4.5	Contact details and channels

6.5.1 F4.1. My profile

Purpose. The functionality will show the progress of the households/organization be it in levels, points, badges, or any other unit.

Description. We will have different levels of progress. The users here refer to a household/organization. These levels will go from "nonconscious" or "unconcerned" to "master" or "pro" and to award this label several actions will be taken into accounts, such as efficiency flexibility or production.). We need to define yet the number of levels and the final labels that will be defined during the iteration phases of the project. Depending on the evolution of participants of each country labels will be defined in an iterative way from the beginning of the participation to the end of the project.

This functionality also helps to match users with archetypes. When the app is downloaded, users will be asked to fill up a short survey. With this information, we will know the starting point regarding energy engagement and the type of archetype a user's fits in.

On the global profile page users will have access to:

1. Profile configuration: they can change their account configurations (name, email, password, etc.).
2. Household configuration: here will be able to change their comfort temperature and calendar. They will also have access to the list of devices (F1.4). They can also set the periods where they will be out of home and the expected day of return so that the temperature can be automatically regulated accordingly. If they have solar panels, they will also have the option to choose the percentage of the surplus of energy they want to dump to the grid (F1.6).
3. Household inhabitants/organizational members: users will be able to add new users to the app and will be able to choose if they are administrators or observers (explained in the character "App Users.")

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4. Profile evolution:
    a. Levels: they will have information about the level they are in and the levels they can get to in the future.
    b. Badges: we will have badges for certain achievements of the users. To illustrate, users will gain the “super economic house” badge when they save up to 200€. Users will see those already completed as “achieved” and the remaining ones as “to be done” or “on progress”.
    c. Progress: they will also see how far they are from the next level and how many points they need to earn.
5. Public profile: users will be able to decide which information is shown when they leave comments on community forums (F2).

The profile evolution will move when challenges are completed (F2).

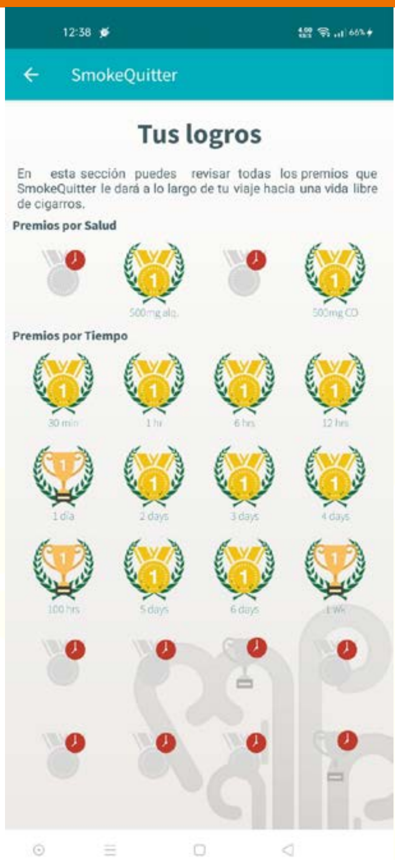
Functional requirements

1. Users will have access to the profiling form when they do the onboarding; however, if they do not want to do it at that moment, they can postpone it and have access to it through My Profile (F4.1.) or the Advice Wall (F3.2).
2. We need to have a process and a system to add new users with different permissions (administrators or observers) and to give them different views of the app.
3. Users need to be able to start their profile configurations processes through Profile configuration. Examples of configurations comprise, inter alia, change your name, change your email, change your password, and delate your account.
4. The temperature of comfort and the calendar of time at home can be modified from here and from the real-time home comfort dashboard (F3.1) in the Advisory Wall (F3).
5. We have to save progress and connect this profile evolution with the challenges so that they affect the progress when completed.
6. Users need to be able to see a preview of their public profile and be able to change it whenever they want.
7. We will have a functionality in the comfort settings where the users can set days out of home and day of return.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. Table 40 shows illustrative examples for some of the functionalities described before.

Table 40 - My profile's illustrative examples

Screens	Comments
	This screenshot was sent by an interviewee form the field research in Spain. This app (SmokeQuitter) helps in quitting smoking and gives badges to maintain motivation[1].

[1] The example is shown in Spanish because the app does not allow changing the language.

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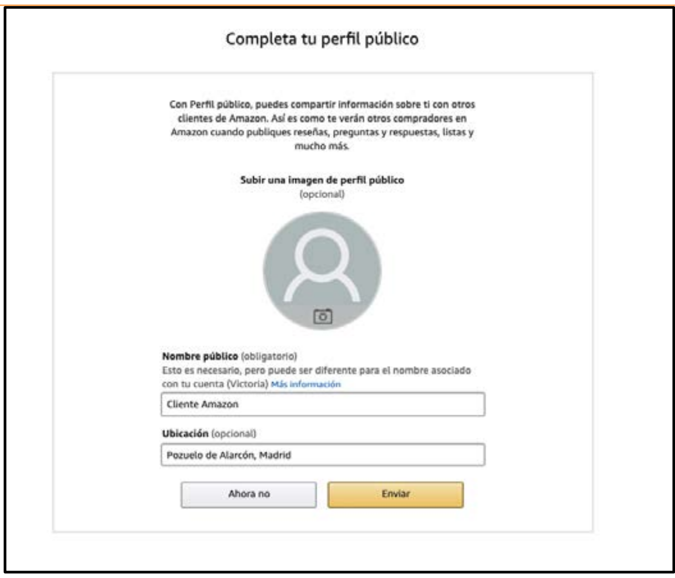
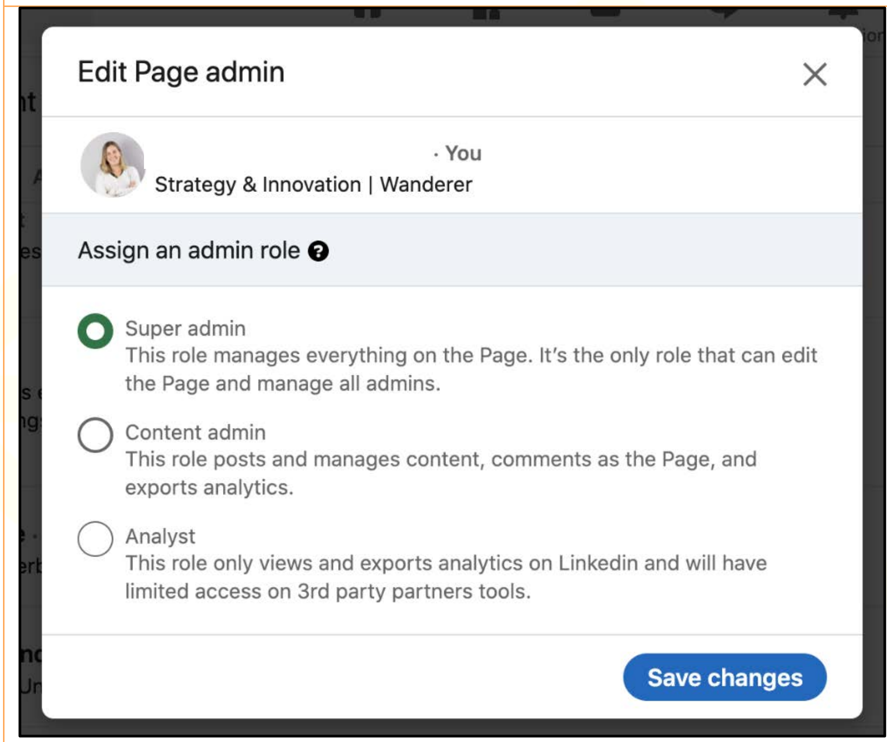
<table>
<tr>
<td>
</td>
<td>This is an example of Amazon's public profile configuration. Users can choose to add their name or leave it as an “Amazon Client.” They don’t have to give more information if they don’t want to.[2]</td>
</tr>
<tr>
<td>
</td>
<td>This is an example of the different types of users that a business account can have in LinkedIn.</td>
</tr>
</table>

6.5.2. F4.2 Alerts and notifications

Purpose. These functionalities will let the users choose how they want to receive alerts and notifications.

Description. Before explaining the functionalities, a clarification is necessary:

[2] The example is shown in Spanish because the app does not allow changing the language.

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- **Notifications** will be those events related to the regular use of the application, such as progress on the challenges, new challenges, normal changes on the consumption/impact, changes on the generation of the energy, etc.
- **Alerts** will concern extraordinary events, such as “looks like your kitchen has been cooking for 12 hours”, “there is no activity from the heater, even though it is 4°C outside, are you home?”

Users will have a section where they will be able to choose the settings for the notifications/alerts. They can choose which ones are to be received as push and which ones as pull alerts.

They will also choose which notifications/alerts they want to see in the Advice Wall (F3.2).

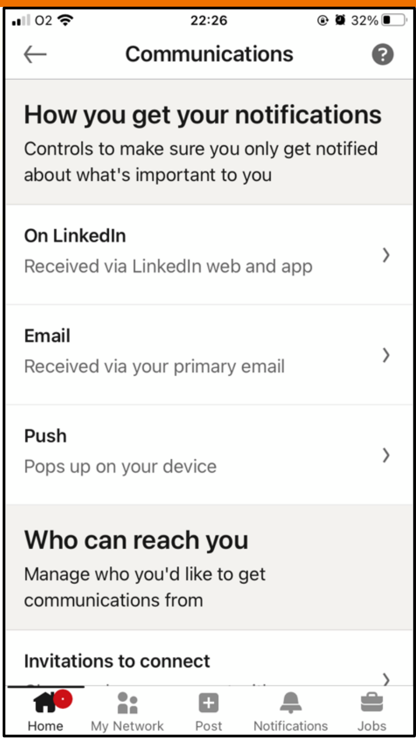
Functional requirements

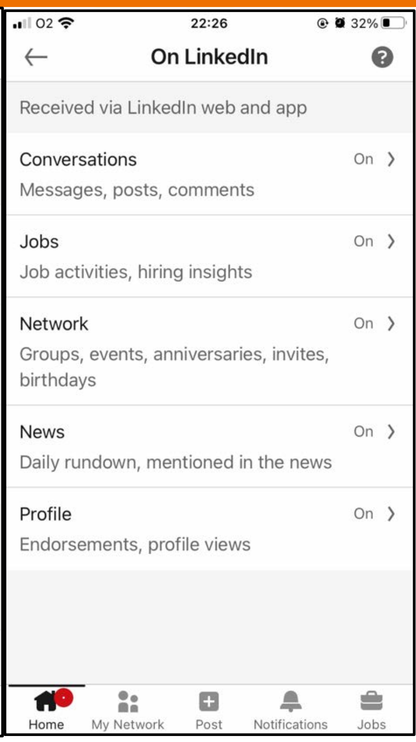
1. We will give the users maximum control over their notifications/alerts.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. Table 41 shows illustrative examples for some of the functionalities described before.

Table 41 - Alerts & Notification’s illustrative examples

<table>
<tr><th>Screens</th><th>Comments</th></tr>
<tr><td>




</td><td>The Linkedin app provides users with a lot of control and deep management of the notifications.

In validations, users agreed to receive notifications to make some activities or devices more efficient. They also want to see flexibility alerts on generation and consumption. However, they also want to activate and deactivate these notifications manually in an effortless way.</td></tr>
</table>

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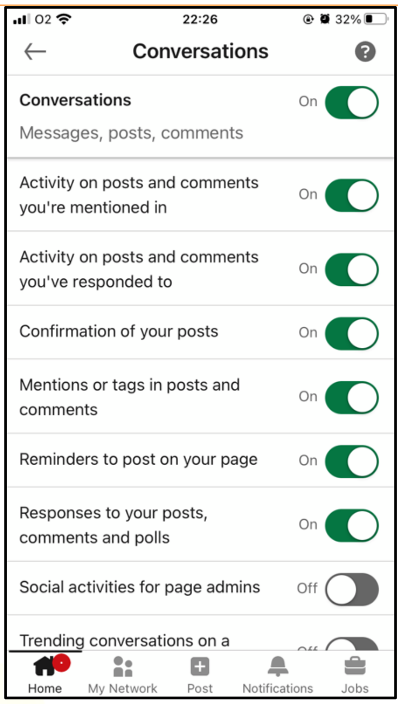


6.5.3. F4.3 Data & Privacy

Purpose. This functionality concerns all privacy settings. However, all the privacy policy issues will be defined in further project phases (specifically in WP9). This only explains the user's point of view about privacy and data.

Description. Users will have a section where they can see the data gathered and the settings for this data. Some data is fundamental for the success of the project, so we would emphasize that it is fundamental to share this specific data and/or that they cannot disable this type of data. For this specific data, users can decide whether they allow to share it for purposes other than the project and if so, for which purposes.

They will also see the privacy agreement explained in a very easy language and with visual resources to enhance comprehensibility. We will give them an extended explanation of how the data is being treated.

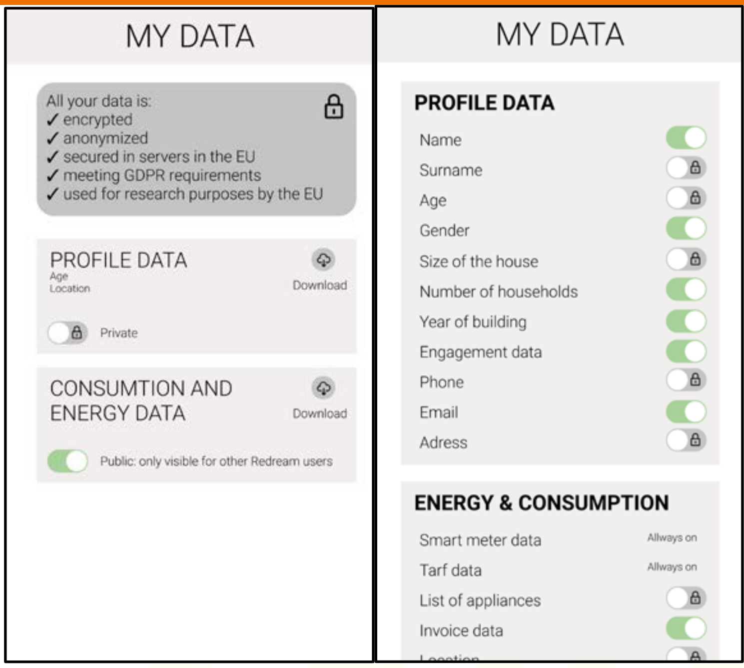
Functional requirements

1. Users will be able to choose which data will be used only for data visualization in the app and which data can be shared for other purposes (other purposes to be defined).
2. Users will be able to download their data.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. Table 42 shows an illustrative example for some of the functionalities described before.

Table 42 - Data & Privacy's illustrative examples

<table>
<tr><th>Screens</th><th>Comments</th></tr>
<tr><td>
</td><td>These are illustrative wireframes that show how we can provide information about the treatment of the data and give control over what they want to share and what they don't.

In validations, users were interested in being capable to share their data separately and in having the privacy policy easily explained.</td></tr>
</table>

6.5.4. F4.4 FAQ section / support forum

Purpose. A space for common doubts to be resolved and a forum where users can answer questions to each other.

Description. Users will have a space for FAQs where users can look for different answers to questions. We will have navigation with various levels of depth.

Users will also have a support forum where users can discuss different topics and give answers to each other (co-creation). In this support forum, users will have access to the public profile of other users (F4.1). The support forum will be taken to the main navigation screen of the application under the label "ReDREAM Community".

Master users will have a specific badge so that other users can identify them.

Functional requirements

1. We will need to have a browser for users to navigate through different FAQs.
2. We will have to have the FAQs organized in groups of information to ease navigation.
3. Each question of the FAQs will have its own page with the answer to the question: there can be different formats of answer (videos, text, images, etc.).
4. The support forum will have posts by themes and people will be able to participate in those forums.
5. We will need to have someone supervising the forums to ensure appropriate behaviour; it would be necessary that the forum manager also responds to the questions (like we did on community challenges F2).
6. We will include badges for the master users.

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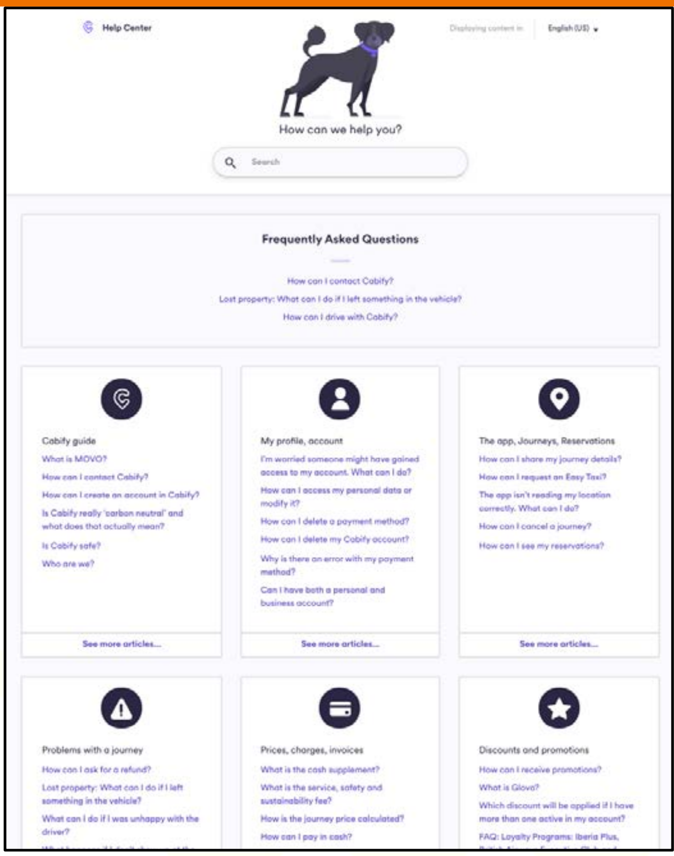
All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. Table 43 shows illustrative examples for some of the functionalities described before.

Table 43 - FAQ section / support forum's illustrative examples

<table>
<tr><th>Screens</th><th>Comments</th></tr>
<tr><td>
</td><td>This is an example of a page of FAQs of Cabify with a browser and questions grouped in themes.</td></tr>
</table>

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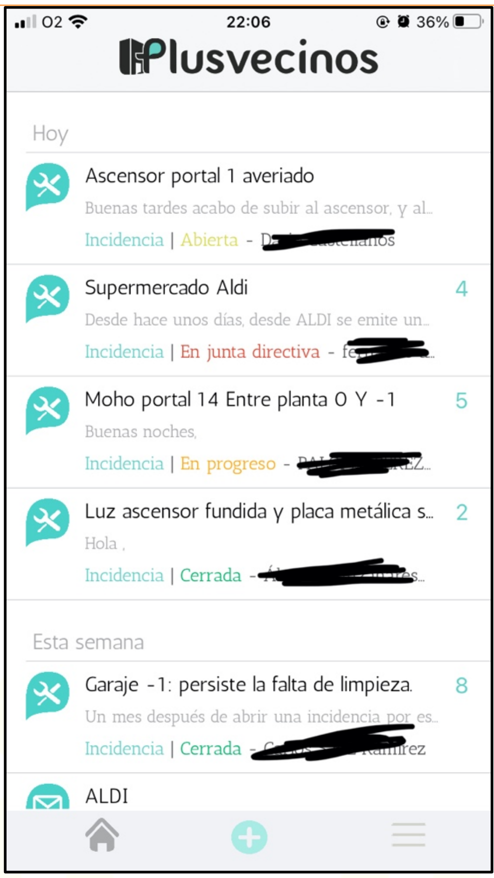

This is an example of a community forum from an app called Plusvecinos. The content of this forum is only accessible to members of the same block of flats[3].

[3] The content is in Spanish because we could not find an English version.

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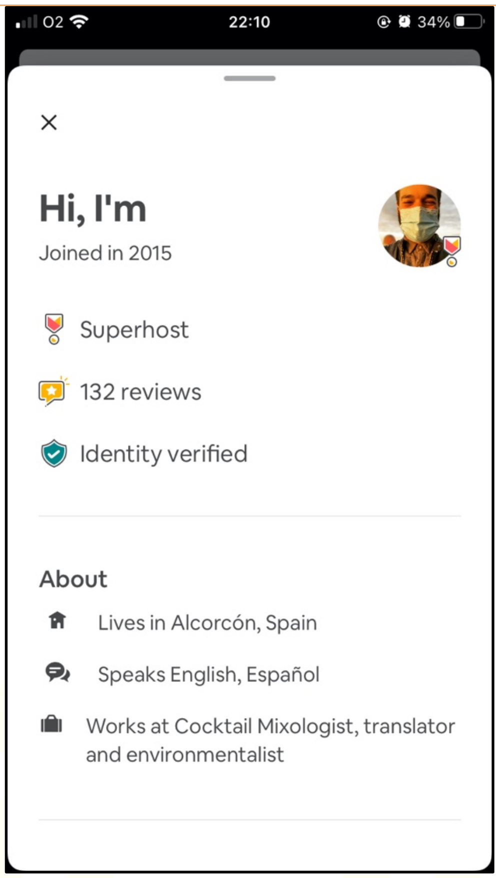	This is an example of the Airbnb app on how to create symbols that help users identify which kind of participants they are communicating with.

6.5.5. F4.5 Contact details and channels

Purpose. This functionality aims to give users contact facilities with a human perspective.

Description. We will introduce the concept of personal assistant making users see that they always talk to the same person or, if not, to a person related to their assistant. They will have access to that assistant's phone and mail.

We will also provide a 24/7 chat for any problem or query.

They will also have a link to invite other participants to the ecosystem.

Functional requirements

1. We need to have personal assistants for the participants to be in contact with.
2. We need people for the 24/7 chat.
3. The "invite others" link will send an invitation via email or SMS (the users can choose the way). The users that receive the email will arrive at the app registration and onboarding.

All of these are current requirements, in the future, we can add more or give more definition to those exposed in this document.

Illustrative examples. Table 44 shows illustrative examples for some of the functionalities described before.

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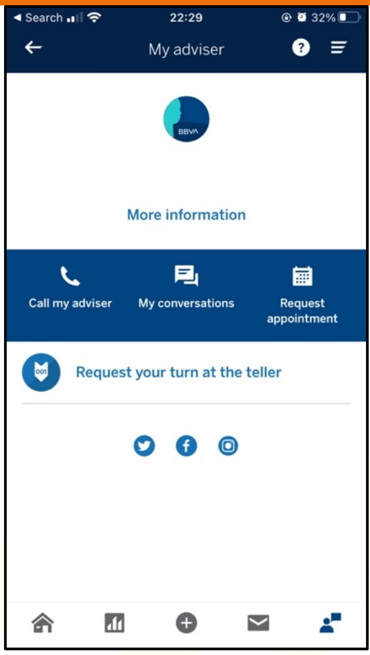
Table 44 - Contact details and channels' illustrative examples

Screens	Comments
	This is an example of a BBVA app designed for easy contact with personal assistance and a chat.

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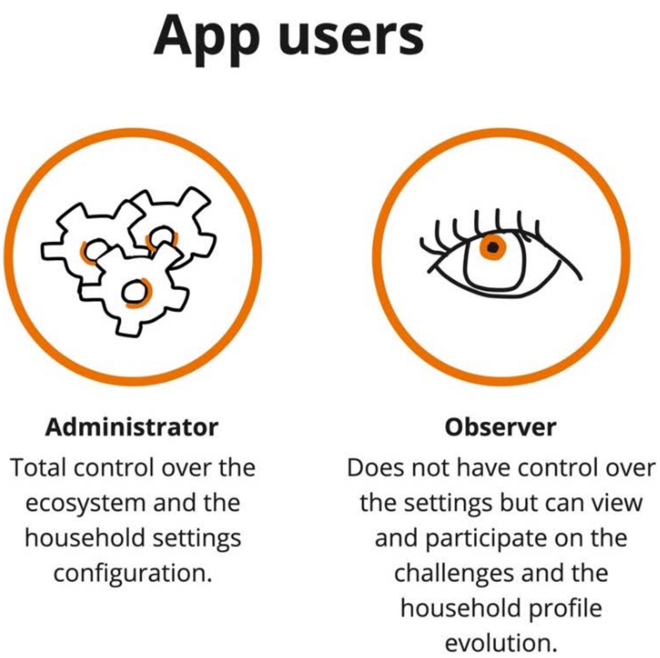
6.6 Management of different type of users

Each household or organization that enters the ecosystem will have a personalized application to manage and visualize the ecosystem. The same app can be used by different profiles of users within the same household/organization: administrator and observer's profiles (Figure 18).

Figure 18 - App users



Administrators have full management of the app; they can add new app users under the same household/organization and give them an administrator or observer profile. Usually, the person recruited to the pilot (signing the contract) will be considered the administrator. Once she/he downloads the app, she/he can add other users and define these users' profiles.

The administrator will have access to all the functionalities listed in the next section (list of functionalities) and all the functionalities described in sections. "F1. Dashboard", "F2. Challenges", "F3. Advisory Wall" and "F4. Settings". Observer permissions are described in Table 45. Administrators will have access to all the functionalities.

Table 45 - List of specifications for the observer users by functionality.

ID	Functionality Name	Observer's Specifications
F1	Dashboard	Depending on the functionality (detailed in the following)
F1.1	Consumption data	Full access.
F1.2	Comparison functionalities	Full access.
F1.3	Impact visualization	Full access.

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F1.4	Consumption per device	Full access.
F1.5	Virtualization	Full access.
F1.6	Self-Generation dashboard	Only access to the generation data: they won't be able to change the percentage dumped to the grid or choose whether they want to donate or receive a discount on the bill.
F2	Challenges	They will have only the challenges they can do with their profile. We could make specific challenges for them.
F3	Advisory Wall	Depending on the functionality (detailed in the following)
F3.1	Home/Building summary	They will be able to see the temperature of comfort and the calendar but not to change it. They will be able to decide on their own widgets.
F3.2	Advice wall	They will have their own advice, personalized for their users' specifications. They will decide with notifications/alerts they are going to see on the wall.
F4	Settings	Depending on the functionality (detailed in the following)
F4.1	My Profile	They will be able to change: - Profile configuration - Profile evolution - Public profile They won't be able to change, the only view: - Household configuration - Household inhabitants
F4.2	Alerts and Notifications	Full access.
F4.3	Data & Privacy	Full access to their own data configuration (not to the household).
F4.4	FAQ section / support forum	Full access.
F4.5	Contact details and channels	Full access.

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6.6.1 Awareness and set up

In this stage, we enrol the users, explain the ecosystem and set up the ecosystem in their household.

Web-based

- We explain the ecosystem and explain their expected involvement in the project.
- We explain the community they are embedded in.
- We ask them to fill up a survey with data about them and their household/organization.
- We set up the devices in their household/organization.

App

We do the onboarding

- We ask them to sign up an agreement so that we can connect the previous data with the app.
- We explain briefly the functionalities (namely, Dashboard, Challenges, Advisory Wall). We offer a brief tutorial on the first page of the app. The first three suggestions are given set up your temperature of comfort, fill up the calendar with your time at home and set up your privacy settings.

6.6.2. Visualization

This stage aims to make users aware of their starting point or baseline levels of consumption and impact. The app provides the information to make them aware with different functionalities, while simultaneously restricting other functionalities:

- In the Dashboard (F1): with the Consumption graphics (F1.1), the Impact visualization (F1.3) and the Consumption per device (F1.4).
- In the Challenges (F2): they will only have access to individual challenges about energy efficiency and non-energy.
- Advisory Wall (F3)
- In Settings (F4): My Profile (F4.1), expect the public profile, Alerts and Notifications (F4.2), Data & Privacy (F4.3), FAQ section (F4.4), except the support forum, and Contact details and channels (F4.5).

6.6.3. Improvement

Users enter this stage when they start progressing from their baseline measures to a more efficient and flexible relationship with energy. Once this occurs, users will see unlocked access to these other functionalities:

- In the Dashboard (F1): Comparison functionalities (F1.2), Virtualization (F1.5).
- In the Challenges (F2): they will have access to individual challenges about flexibility and all the community challenges.
- In Settings (F4): they will have access to the public profile (F4.1) and the support forum (F4.4).

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6.6.4. Participation

In this stage, users create content and actively participates in the ecosystem to a greater extent.

- They will unlock these functionalities:
    - In the Dashboard (F1): Self-Generation dashboard (F1.6)
- In the Challenges (F2): they will have the ability to create new community challenges for others to follow.
- In Settings (F4): they will have a special recognition when they participate in the support forum (F4.4)

The progress in the journey will be linked to the progress in the users' profile evolution (F4.1).

6.7 Adaptation to the archetypes

As we explained in 6.7 Adaptation to the users' journey, the goal of the ecosystem is to ease users go through a journey so that they end up mastering their relationship with energy. However, users differ in their starting point, value sought and relationship with technology. For this, we will personalize motivational communication adapting messages to the archetype with which they fit (archetypes explained in 4.6. A synthesis of findings of the exploratory stage: archetypes of users.)

The main personalization concerns the type of impact, followed by the challenges so that they provide the value they are seeking in the system. Concisely, these messages will be

- Non-conscious: save money
- Conscious: consume the right way
- Active: reduce the impact
- Participative: change the world

As we explained in 6.7. Adaptation o to the users' journey. We will know the archetype based on the profiling we will make on the onboarding.

6.8 Energy community app

In addition to the consumer-oriented solution, accessible from a smartphone app and web browser app, an energy community version is essential to monitor and control the aggregated consumer's base and help the energy community managers with decision making. This app should also comply with the design principles and guidelines previously defined and developed as a browser web app.

This energy community app will also serve during the deployment of the project to monitor the projects' progress and performance, control data flow, provide customer support, make decisions, optimize and iterate the ecosystem based on the analysis of results.

The energy community app is composed of the following functionalities described in Table 46.

Table 46 - Recommended aspects to cover in the ReDREAM project web app

DASHBOARD
Energy community dashboard
Consumer app dashboard
Third-party dashboard
CUSTOMER PORTAL
General communication portal
Customer support centre
EXPERIMENT HUB
Experiment builder
Experiment results dashboard
OPEN DATA PORTAL
SETTINGS

6.8.1 Dashboard

This functionality is a visualization in real-time, when possible, of the main KPIs and metrics related to the performance, engagement and flexibility capability of the energy community. Inside this dashboard, we differentiate three views:

1. **Energy community dashboard:** the managers will be able to monitor the general aspects form the energy community. Starting from the recruitment process of their consumer base, followed by engagement, flexibility capability, energy flows and other general KPIs related to performance. This section will help managers to provide better stability services to the grid and value to the consumers.
2. **Consumer app dashboard:** this view will allow monitoring all consumer app-related metrics, such as completion of challenges, use of the functionalities, interaction in the community challenges and forum, etc. This section will help the managers to make the most of the technology to understand and manage the consumers base in a highly personalized way.
3. **Third-party dashboard:** this view will gather key information of the third-party services (weather, market signals, prices, generation, etc.) so that energy community managers can cross-tabulate this information with user's behaviour.

6.8.2 Customer support and customer portal

It is crucial to provide excellent customer support to the participants if we want them to engage with the ReDREAM ecosystem. Therefore, answering their enquires and solving the problem quickly and

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effectively will ensure consumers loyalty. This is also critical for the deployment during the ReDREAM project, to collect enough consistent data and learnings.

To avoid a bad customer support experience, a customer portal with a dedicated support tool is essential to help energy communities to deliver this service effectively and collect statistics of the common failures so that solutions can be put in place to iterate the product.

Hence, we identify two main functionalities that this customer portal should cover, which should work as a CRM (Customer Relationship Management).

1. **General communication portal:** it will help energy communities to contact the consumers, access their profile info and create personalized communications using other channels (e.g. sending e-mails, segmented by types of users or by archetypes).
2. **Customer support centre:** it will assist consumers with their inquiries, as all the previous conversations and activities are recorded so that the service is as much personalized as possible.

On the customer support aspect, it is needed to have dedicated people in charge of it that speak the local language. Technological solutions may have bugs and break downs. Providing quick, effective, and close/humane problem solving is crucial to maintain participants' initial engagement and do not lose their trust.

6.8.3 Experiment hub

As flexibility is an unknown concept for consumers and every location has a different reality, it is key for energy community managers to have the ability to run experiments or tests with consumers so that they can gain deeper knowledge on users' engagement. Energy regulation and technology are constantly evolving and being able to adapt the ecosystem and strategy to those changes increases the success opportunities and avoids obsolescence. Having the capability to test and optimize will facilitate making key decisions in this uncertain and new reality.

We envision then an input-output approach:

1. **Experiment builder:** a tool will be needed to prepare those experiments and select the sample of consumers that will take part. This will have the capacity, for example, to send specific notifications, create new challenges or change the visualization of the main interfaces of the ecosystem. Thus, we recommend building the customer smartphone app as a web app.
2. **Results dashboard:** a specific dashboard is needed to collect and analyse the results of all those experiments.

6.8.4 Open data portal

A data portal that collects valuable information about consumers engagement and behaviours will be open to all energy communities using the ReDREAM ecosystem and other not-for-profit entities with the purpose to foster the scaled adoption of energy flexibility and efficiency. This will help to understand new energy communities what works and not and why based on real data and make better deployment and management decisions.

A permission-based functionality would also be important to restrict access to confidential or sensitive information, in compliance with the GDPR requirements.

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6.8.5 Settings

A place where users can set their visualization, notification, sharing and permits preferences is obvious but not trivial because every energy communities will have a diverse approach to the ecosystem information and unique needs to be covered.

7 Minimum Viable Product (MVP)

An MVP ecosystem was developed to show the minimum required functionalities to satisfy initial customers so that based on functionalities feedback can be obtained for further ecosystem development. With this approach, we ensure that that it can rapidly be adapted to a fully marketable high-quality version. This approach has proven more effective than linear and conventional project methods where requirements are defined upfront. An MVP product is a product with only a basic set of functionalities enough to capture early adopters' attention and make the solution unique. Table 47 shows the phases in the proposed development with the corresponding functionalities to be developed/included at each phase in each of the modules.

Table 47 - Evolution roadmap for ReDREAM ecosystem: dashboard

DASHBOARD			
FUNCTIONALITIES	PHASE 1 (MVP)	PHASE 2 (EVOLUTION)	PHASE 3 (VISION)
General Consumption graphics	- Building consumption per days, weeks or years. - Comfort (temperature, air quality)		-Community consumption
Consumption per device	-Consumption per source of energy	- Possibility to add or erase devices/appliances - Consumption and impact per device - Access to individual challenges through the device/appliance section	- Access to community challenges
Comparison functionalities	- Comparison with historic consumption - Building graphics	Comparison with similar households	- Comparison with any other household and community
Impact visualization	-Basic information about the economic and environmental impact	Learn more about the impact	- Community impact

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Virtualization			- Virtualization of new energy devices or appliances
Self-Generation dashboard		Generation and self-consumption through hours, days, weeks and years	Choice to donate the surplus or obtain a discount on the bill

CHALLENGES			
FUNCTIONALITIES	PHASE 1 (MVP)	PHASE 2 (EVOLUTION)	PHASE 3 (VISION)
Challenges	N/A	- Individual challenges that sum up to the community (it can be related to the device, to the general consumption or the initial objective fixed). - Badges	- Community challenges - Community badges
ADVISORY WALL			
FUNCTIONALITIES	PHASE 1 (MVP)	PHASE 2 (EVOLUTION)	PHASE 3 (DREAM)
Advisory	Default advisory wall.	Customizable advisory wall (add or delete widgets).	
SETTINGS			
FUNCTIONALITIES	PHASE 1 (MVP)	PHASE 2 (EVOLUTION)	PHASE 3 (VISION)
My Profile	Basic profile settings.	Public profile editable.	
Alerts and notifications	Efficiency notifications & alerts.	-Notifications alerts -Flexibility-related notifications and alerts	Non-energy services notifications and alerts
Data & Privacy	Data privacy agreement.	Privacy settings for the public profile.	Advanced privacy settings and choice to download personal data.
FAQ Questions		Initial FAQ based on initial enquires reported to the customer support channels	Elaborated FAQ

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Support Forum			Support forum
Contact details and channels	Phone and e-mail	Chat	Chatbot

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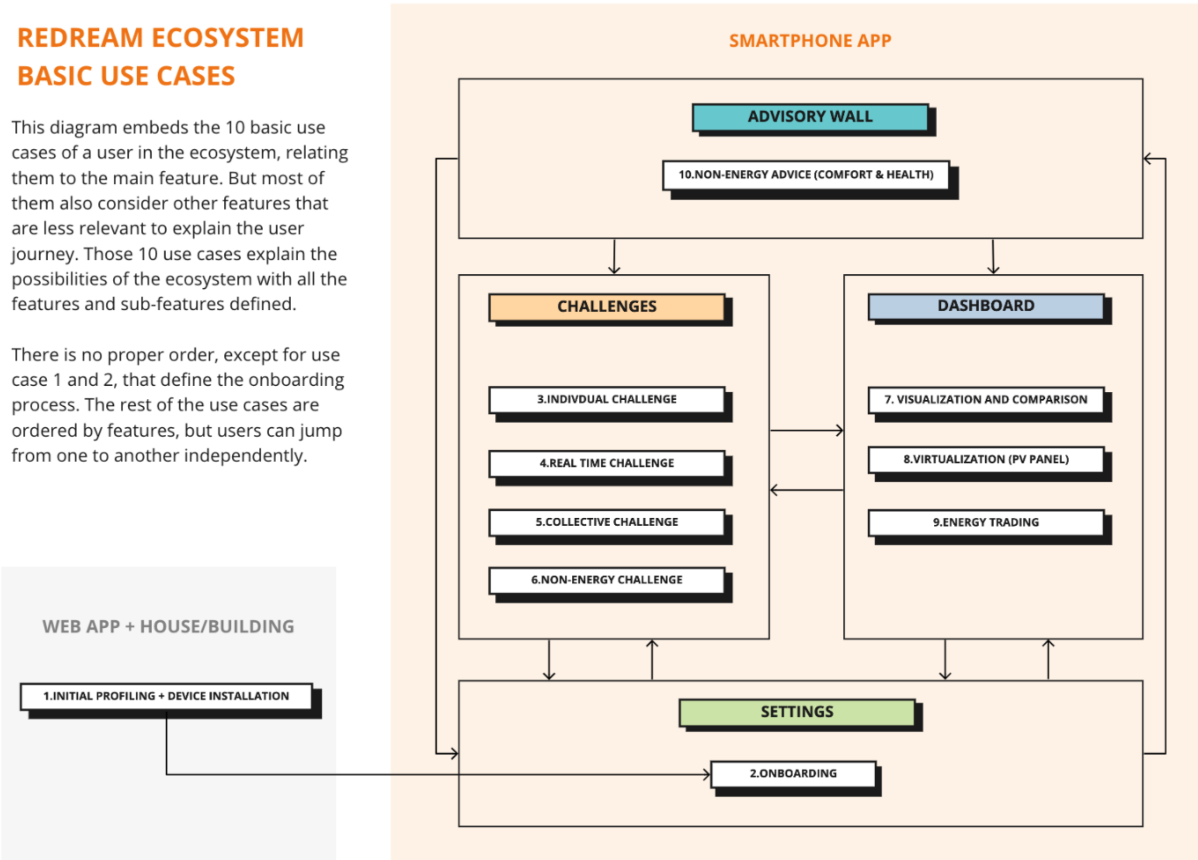
8 Use cases

This section explains the rationale followed for the use cases. The detailed use cases can be found in Annex 1. Use cases. We have developed some uses cases that try to make a first sketch of the experience of given users in the ecosystem. These use cases show the principal functionalities applied to the situation.

Figure 19 - Use cases diagram according to ecosystem main functionalities



For each use case, the name, description and the key functionalities that come into play are described. Additionally, the different phases are explained with this template:

- Action: what is actually happening.
- Ecosystem Functionality: on what part of the ecosystem is the action focused.
- Description: the description of the action.
- Personalization singularity per archetype: it shows how each functionality is adapted for the different archetypes.
- Design principle: which design principle guides that action.

If the line between the phases is dashed, it means users have to interact with things outside the ecosystem.

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Figure 21 shows an example of use case (the other collection of use cases can be found in Annex 1).

Figure 20 - Example of a use case

4.REAL TIME CHALLENGE

This use case explains how users flex their energy with a community approach through a common challenge.

Main features

CHALLENGES

ADVISORY WALL

	1	2	3	4
Action	**STATUS NOTIFICATION**	**FLEXIBILITY CHALLENGE EXPLANATION**	**THE USER AVOIDS CONSUMING**	**COMMON CHALLENGE STATUS**
Feature	ADVISORY WALL	CHALLENGES		ADVISORY WALL
Description	The user gets a notification, "We need your help to refrain from turning on a new thermal power plant." The user clicks the notification and is led to the challenge proposed.	The user reads the challenge proposed: *We need your help to avoid turning on a new thermal power plant.* *Please, avoid washing and/or cooking in the next 1h (dynamic countdown).* He/she can see that 35 other people already accepted the challenge, and, Despite s/he was planning to use the washing machine, s/he decides to postpone doing this chore. S/he decides to join the challenge and push the CTA button (JOIN).	The user avoids consuming after that hour.	The user receives a notification after explaining that thanks to his/her effort and the one from the other 122 participants, they have avoided the equivalent emissions to 340 cars driving during that our.
Personalization singularity per archetype	If it is a non-conscious user the message will emphasize cost saving			A more curious user, like a tech enthusiast, would have clicked on the notification to extend the info in the challenge section.
Design principles	**Personalisation** **Managed automation**	**Discoverability** **Visibility**		**Personalisation** **Visibility** **Simplicity**

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9 Social KPIs

This section explains the rationale followed for the identification of KPIs. The exhaustive list can be found in Annex 2. List of Social KPIs. An extensive list of social-related KPIs was defined with two aims: (1) project evaluation and (2) optimization so that ongoing analysis of performance can facilitate remediation actions on the functionalities. These KPIs would be also crucial for task 4.1, the UX audit, led by Comillas, in the WP4, when the ecosystem has been already deployed in the four demo locations. These KPIs should help to pivot and iterate the strategy and ecosystem, to meet the project goals.

We suggest that every KPI is broken down by:

- total of ReDREAM participants
- per demo location
- per consumer archetype
- per customer type (residential vs. commercial vs. industrial)
- per users' type (administrator vs. observer)
- per day
- per week
- per month
- per time of participation in the project
- per total duration of the project (36 months)
- in time (evolution)

Seven categories have been defined to structure the KPIs (Table 48 - List of social-related KPIs categories). Each KPI has an identifier (S.X), where "S" stands for social and X refers to the category number. Each KPI will therefore be identified with a specific number (Y) that will be added to the category identifier (S.X.Y).

Table 48 - List of social-related KPIs categories

#	Category	Description
S.1	General declared ecosystem KPIs	KPIs that have been tracked by the declaration of consumers via questionnaires related to the improvement of general topics of the ecosystem like engagement, participation, trust, awareness, comfort or community.
S.2	General measured ecosystem KPIs	KPIs that have been measured by data collected from the app related to the number and type of users, engagement, participation based on behavioural metrics.
S.3	Basic app KPIs	KIPs related to basic aspects like use and visualization times and preferences that can be applied to any section of the four functionalities.

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S.4	Onboarding KPIs	KPIs related to the onboarding process of the users including app downloads, preferences to set manual/automatic mode and completion timing and ratios.
S.5	Settings KPIs	KPIs related to the interaction with all the customer support, support and preferences related to data privacy, comfort temperature and energy trading.
S.6	Challenges KPIs	KPIs related to the number of challenges, ratios of acceptance, completion, abandonment, etc.; the scores assigned by users, timings, interaction with the community forum in the community challenges and the evolution of the users' profile.
S.7	Dashboard KPIs	KPIs related to the interaction with all the sections inside the Dashboard functionality

The list of KPIs includes the already defined KPIs in the grant agreement and for which there is an established target. All of them are included in the category S2 (Table 49 - List of social KPIs included in the grant *agreement*).

Table 49 - List of social KPIs included in the grant agreement

Grant Agreement KPI number	Social KPI number	Name of the KPI
KPI-2	S.2.1	No. of users involved through REDREAM
KPI-4	S.2.9	No. of users involved participating in the energy social network
KPI-5	S.2.10	No. of interactions to share best practices through the energy social network
KPI-8	S.2.11	No. of users up taking previous services

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10 Conclusions

Based on a deep understanding of users' needs, their context and value sought gained during the exploration stage, we can conclude that there are significant differences between the different consumer archetypes but are just little nuances between residential and non-residential customers (commercial or industrial). We identified four consumers' archetypes based on their energy awareness and participation and another four depending on their use of technology.

The users' requirements for participation in the service system were the foundation to establish a set of five design principles: personalization, visibility, simplicity, discoverability and managed automatization. These design principles were used as a compass for every decision made around the ecosystem. They should remain immutable across the entire project, while other aspects like functionalities or the content could change. The principles apply to all consumer archetypes and will ensure that the relationship between users and energy, facilitated by the ecosystem, is engaging and transformative.

The ReDREAM ecosystem aims to be the space where the users, which was traditionally passive, becomes an active and relevant actor in the energy service system. The ReDREAM ecosystem must ensure that all market actors, and especially users, co-create value to meet the decarbonization goals. For this, users' engagement with different energy services is fundamental. Prosumers should also be able to play an active role according to their resources, capacity and willingness. The ecosystem is designed to accompany users across the journey of their energy transition, helping them evolve by improving their efficiency and flexibility capability and reducing the negative impact of energy consumption on their pockets, on their communities and the environment.

The objective is to enable actors' contribution and participation, albeit different archetypes will have different engagement in the service system. Consequently, the ecosystem was designed to allow the users to perceive the value that the users seek and using the type of information and language that better meets their needs. We are confident that this personalized approach will strengthen the engagement for each type of user's archetype, customer type (residential, commercial or industrial) or type of users of the ecosystem (administrator or observer). All functionalities and content are to be adapted to the archetypes.

The ecosystem will provide the arena for a long-term relationship with users and the service system actors, especially DSOs and aggregators. The four countries where the exploration stage was conducted showed that this long-term relationship would occur if all the stakeholders obtain value and play an equal role in the ecosystem.

A fundamental requirement for value co-creation in the service system is trust among actors. Trust has been eroded for the historical power imbalance between producers and users, the market complexity and the lack of knowledge of how the energy market works. All these factors contributed to users' enduring mistrust and misgivings of users towards other market actors, notably utilities. The ReDREAM ecosystem aims to restore trust among actors by making the energy understandable for consumers; informed consumers are more empowered and able to adopt an active role in the system. Using a language that they can understand, providing accurate and transparent information about their consumption, and adapting to their daily routines so that users can achieve their goals is the starting point to rebuild that trust to empower users for the energy transition.

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After our field research, we can reaffirm that energy is an intangible resource that is perceived as an abstract and complex concept that is difficult to understand for most consumers. But we have also discovered how the physical interaction with the devices and appliances, accompanied by monitoring applications, facilitate game dynamics and discovery of consumption patterns that significantly ease their understanding of energy services and the energy market. We have also found the relevance of the social group as a driver of empowerment. Sharing information and experiences among peers seem to facilitate consumers' empowerment. Also, the activation of local and community energy goals is a means to trigger users' participation in the ecosystem.

That is why the gamification and social network dimensions, embedded in the challenge functionality, are the primary vehicle to make users more aware of their consumption, of their impact, and consequently, more active in the energy transition. We also expect that enhanced energy awareness implies an increase in sustainability awareness overall and a better understanding of the links between energy with health, environment and social issues.

We have provided a first version of the ReDREAM ecosystem that will be iterated to more evolved versions during the project. Throughout the iterations envisaged in the project, changes to the ecosystem functionalities will be carried out based on the consumers' behavioural data and interactions with demo managers. We also envisage that the evolution of European and national energy regulations may also influence some functionalities in the ecosystem.

Even acknowledging that the ecosystem is a work in progress, this document depicts the dream ecosystem so that all partners have a shared vision and work towards it.

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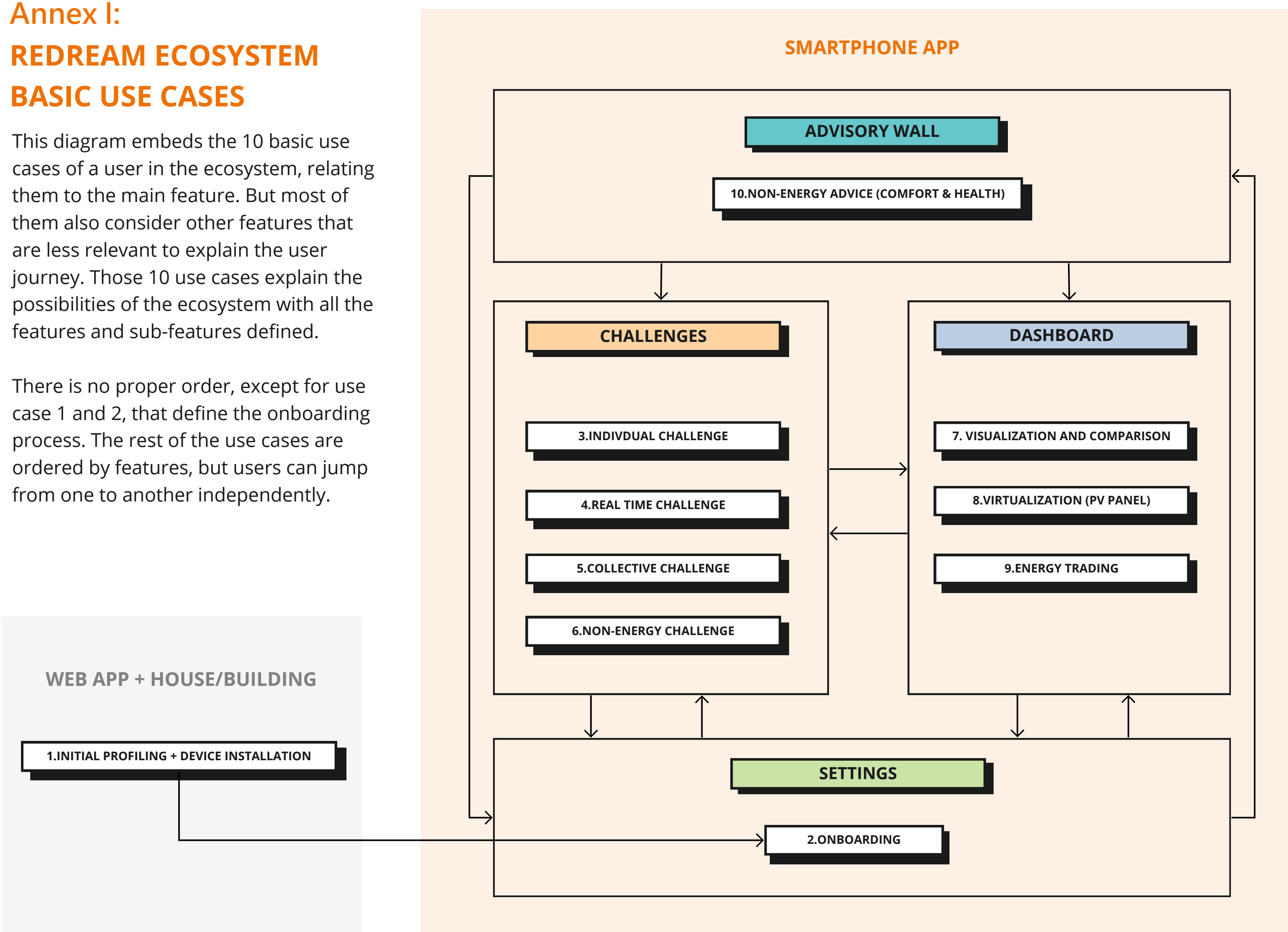
Annex I:

REDREAM ECOSYSTEM BASIC USE CASES

This diagram embeds the 10 basic use cases of a user in the ecosystem, relating them to the main feature. But most of them also consider other features that are less relevant to explain the user journey. Those 10 use cases explain the possibilities of the ecosystem with all the features and sub-features defined.

There is no proper order, except for use case 1 and 2, that define the onboarding process. The rest of the use cases are ordered by features, but users can jump from one to another independently.



1.INITIAL PROFILING (WEB APP) + DEVICE INSTALLATION

This use case shows the process of a user accessing for the first time the ecosystem to register and creating a profile of the house/building and its inhabitants.

	1	2	3	4	5	6	7
Action	**RECRUITED PROFILE RECEIVES A LINK TO REGISTER IN THE ECOSYSTEM**	**INTRODUCTION TO THE ECOSYSTEM**	**EXPLANATION OF THE QUESTIONNAIRE**	**QUESTIONS FOR HOME PROFILING**	**SCHEDULE DEVICE INSTALLATION AT HOME**	**INSTALLATION OF IoT DEVICES**	**CONNECTION CHECKING WITH THE APP**
Description	The responsible person of the cooperative/local community, after the recruitment process, will send the participant a link to finish the registration in the ecosystem.	The user clicks on the link and accesses the ecosystem web app. He/she will find a first introduction to the project and ecosystem explaining: • Why is it important to have him/her on board. • What is flexibility (video) • What we need from them in the next months • How the ecosystem works, both individually and collectively.	Before the user starts the questionnaire, it's explained what are we going to ask him/her during the questionnaire in different steps, the purpose of it and the expected duration.	On the second step, questions related to the house are asked like: • Estimated year of construction • Efficiency label • Appliances and devices list • Households • Number of rooms • Vehicle and/or garage • Etc. Every information required has a short explanation about the purpose and use of it.	After answering all the questions, the user selects a calendar for the right day and time for installing the ReDREAM devices. It also provides address, email and phone number. After confirming the meeting, he/she receives a confirmation email/SMS	The selected day a technician arrives at the house of the participant and installs all the devices.	The technician asks the participant to download the ReDREAM app and sets the house's energy installations, devices, and appliances with the installation.
Personalization singularity per archetype							
Design principle	**Visibility** **Personalization**	**Visibility** **Simplicity**	**Visibility**	**Visibility** **Personalization**	**Personalization**	**Simplicity**	**Simplicity** **Personalization**

2.ONBOARDING (SMARTPHONE APP)

This use case shows the process of any user when accessing for the first time the app creating a personal profile and setting the home screen (Advisory Wall) and data privacy settings.

Main features

- DASHBOARD
- CHALLENGES
- SETTINGS
- ADVISORY WALL

	1	2	3	4	5	6	7	8
Action	**PROFILE SETUP NOTIFICATION**	**LOG IN**	**PROFILING SET UP**	**ENERGY AWARENESS PROFILING**	**BASIC SETTINGS**	**NOTIFICATION SETTINGS**	**PUBLIC PROFILE SETTINGS**	**APP INTRO TUTORIAL**
Ecosystem feature	ALERT ADVISORY	SETTINGS	SETTINGS	SETTINGS	SETTINGS	SETTINGS	SETTINGS	ADVISORY WALL DASHBOARD CHALLENGES SETTINGS
Description	A welcome message pops up: "Thank you for joining ReDREAM; to help you be more efficient, we need you to give us some information about you and your consumption so we can personalise the most of your experience here."	User will be asked to log in, entering the address of the house/building and the family surname or entity legal name. If the house/building was already registered (web), it will appear so that the user can confirm it and get the initial settings and connect to the IoT devices.	The user will be asked some questions in order to indicate what type of user are we dealing with	User will indicate their energetic consumption type of profile.	The first step is to set the basic flexibility settings: • Comfort temperature • Calendar of stay at home A message will be displayed, explaining that the ecosystem will ensure this comfort temperature by efficiently managing the house. There is an option to set it in the manual.	In the second step, the user is invited to define the frequency, channel and type of notifications and alerts that the user wants to receive.	The third step explains the communal aspect of the project and its crucial for energy flexibility. It shows a preview of a public profile shared with the rest of the community: name (not surname), time enrolled in the project, and badges acquired. There is an option to disable the public profile.	After the first steps, the user will be guided by a tutorial that will show them where the main features (dashboard, challenges, an advisory wall and settings) are in the app and how to interact with them.
Personalization singularity per archetype					For tech agnostics or wary users, setting the comfort part in the manual mode is available by deselecting the automation mode.		A tech wary or agnostic user would probably disable the public profile.	
Design principle	**Visibility**	**Simplicity Personalization**	**Personalization**	**Visibility Personalization**	**Simplicity Personalization Managed automation**	**Personalisation Visbility**	**Personalisation**	**Visibility Managed automation**

3.INDIVDUAL CHALLENGE

This use case shows the way individual challenges work and the way people can be engaged and motivated through individual badges

Main features

DASHBOARD

CHALLENGES

SETTINGS

ADVISORY WALL

	1	2	3	4	5	6
Action	**STATUS NOTIFICATION**	**STATUS EXPLANATION**	**PERSONALIZED CHALLENGES**	**USER CHANGING THE LAUNDRY HABITS**	**BADGE NOTIFICATION**	**BADGE**
Feature	ALERT ADVISORY	DASHBOARD	CHALLENGES	CHALLENGES	ADVISORY WALL	SETTINGS
Description	The user receives a notification of his/her washing machine's consumption, explaining that it is much higher than the average. The user clicks the notification and is lead to the dashboard.	The user reviews the consumption and its impact for the last month and confirms that it is considerably higher than people with his/her similar profile. A message suggests him/her take a Challenge to efficient his/her use, and the user clicks on the link.	The user is taken to the challenge *Master your washing machine,* and he/she reads the information about the main goal and the steps the user needs to do to achieve it. It highlights that by accomplishing the challenge, he/she can obtain the badge of *"efficiency starter."* A "learn more" about efficiency appears where the user will read about the importance of the topic. The user accepts the challenge.	The user tries to change his/her laundry habits following the recommendations and steps of the challenge. The IoT device tracks the consumption data of the washing machine.	After a few weeks, the user receives a notification explaining that the challenge was accomplished, and therefore he/she has obtained the "efficiency starter" badge and clicks on it.	The user leads to the My Profile section, where he/she can see the badge acquired and explain it.
Personalization singularity per archetype	If it were a participative user, the first challenges would imply a community approach.	If it were a user worried about the impact it would show the washing machine impact on carbon footprint levels				
Design principles	**Personalisation**	**Discoverability**	**Personalisation** **Discoverability**	**Discoverability** **Managed automation**	**Visibility**	**Personalisation**

4.REAL TIME CHALLENGE

Main features

CHALLENGES

ADVISORY WALL

This use case explains how users flex their energy with a community approach through a common challenge.

	1	2	3	4
Action	**STATUS NOTIFICATION**	**FLEXIBILITY CHALLENGE EXPLANATION**	**THE USER AVOIDS CONSUMING**	**COMMON CHALLENGE STATUS**
Feature	ADVISORY WALL	CHALLENGES		ADVISORY WALL
Description	The user gets a notification, "We need your help to refrain from turning on a new thermal power plant." The user clicks the notification and is led to the challenge proposed.	The user reads the challenge proposed: *We need your help to avoid turning on a new thermal power plant.* *Please, avoid washing and/or cooking in the next 1h (dynamic countdown).* He/she can see that 35 other people already accepted the challenge, and, Despite s/he was planning to use the washing machine, s/he decides to postpone doing this chore. S/he decides to join the challenge and push the CTA button (JOIN).	The user avoids consuming after that hour.	The user receives a notification after explaining that thanks to his/her effort and the one from the other 122 participants, they have avoided the equivalent emissions to 340 cars driving during that hour.
Personalization singularity per archetype	If it is a non-conscious user the message will emphasize cost saving			A more curious user, like a tech enthusiast, would have clicked on the notification to extend the info in the challenge section.
Design principles	**Personalisation** **Managed automation**	**Discoverability** **Visibility**		**Personalisation** **Visibility** **Simplicity**

5.NON-ENERGY CHALLENGE (MOBILITY)

This use case explains how a user uses the mobility services integrated into the app by checking if he/she is eligible for an electric car and which is the impact of his/her mobility.

Main features

- DASHBOARD
- CHALLENGES
- SETTINGS
- ADVISORY WALL

	Action	Feature	Description	Personalization singularity per archetype	Design Principles
1	CHALLENGE ACCOMPLISHED AND LEVEL UPGRADE NOTIFICATION	NOTIFICATION - ADVISORY	The user receives a notification that he has accomplished one of the challenges. Due to this, he has got enough merits to upgrade a level, and therefore new challenges are released. There is a CTA button to drive the user to the profile status section, and the user clicks by curiosity.		Discoverability
2	CHECKING PROFILE STATUS	CHALLENGES	The user accesses the profile status section and checks the new profile level news. He(she carefully reads the new options, challenges and possibilities in this level and the challenge to check if he/she is eligible to acquire an electric car, which is one of the initial ones form this level that is not locked, caught his/her eye. He/she clicks on the challenge thumbnail.	This challenge is not shown for users that already have an electric car.	Visibility Simplicity Personalization
3	ACCEPTING THE ELECTRIC CAR CHALLENGE	CHALLENGES	The user takes a first overview of the challenge and then starts to read the steps carefully. The challenge asks to track the users commuting routine with the smartphone's GPS. It will also detect if it is riding a bike, a car o walking, depending on the path and velocity. It also highlights that the location data will only advise him/her if the commuting is suitable and worth for an electric car, and then the data will be deleted and the tracking stopped.		Visibility
4	ALLOWING TRACKING LOCATION OPTIONS IN THE SMARTPHONE	CHALLENGES ANOTIFICATION - ADVISORY	The user decides to accept the challenge by clicking on the CTA button. Immediately a notification appears explaining that he/she has to allow access to the location in the background to the ecosystem app. The user allows it in the smartphone settings and another notification explaining that the app started tracking and that he/she can forget about it until the app notifies him/her that the result is ready.	It is very important to manage expectations about route tracking with tech wary and tech agnostic users.	Visibility Managed automation
5	BEING TRACKED WHILE DRIVING DURING A ROUTINE DAY	-	The user keeps with his/her routine the day after while the app is tracking the movements in the background.		Simplicity Managed automation
6	CHECKING PROGRESS AND IMPACT OF MOBILITY	CHALLENGES	At the end of the day, the user is curious and wants to check how the challenge is going. He/she enters the challenges section and clicks on the electric car eligibility challenge. Then he/she can see a progress bar and read a message that explains that it still needs to collect more mobility data. There is also a message related to the impact of his/her mobility today that shows the number of trees needed to capture his/her emissions today.	A tech enthusiast and/or a Participative or Active user probably would click in the thumbnail to get more detail and, for example, the CO2 Kg in the Dashboard	Visibility Managed automation
7	RESULT OF THE CHALLENGE	NOTIFICATION - ADVISORY CHALLENGES	The users keep their daily routine when suddenly a notification explains that the challenge is done and the results that determine if he/she is eligible for an electric car are available. The user clicks a CTA button to check the results and is led to the challenge. A message is highlighted confirming that the user should upgrade to an electric car and explaining the benefits and impact from an economic (ROI and fuel-saving), environmental (GHG emissions reduction) and communal (reducing noise and improving air quality) perspective.		Managed automation Visibility Personalization
8	NEXT STEPS AND KNOW MORE	CHALLENGES	At the bottom of the challenge screen, there is a next septs section with a link to an article and a video, which provides advice and recommendations on choosing the right electric car and which should be criteria to make the decision.		Visibility
9	MOBILITY CARBON FOOTPRINT CHALLENGE	NOTIFICATION - ADVISORY CHALLENGES	A notification appears explaining to the user that a new challenge related to mobility has been unlocked and can do it.	The way we give the notifications will differ depending on the user notification settings.	Managed automation Visibility Personalization

6.VISUALIZATION AND COMPARISON

Main features

DASHBOARD

This use case explains how users will visualise their performance and compare it with others.

	1	2	3	4
Action	**USER GETS AN ALERT**	**ACCESS TO PERFORMANCE**	**PERFORMANCE & KPIS**	**KPIS BREAKDOWN**
Feature	ADVISORY	DASHBOARD	DASHBOARD	DASHBOARD
Description	The user gets a notification inviting them to see his last week performance.	User accesses his dashboard with his individual performance in energy production, energy consumption (last month specifically). A button of "compare" appears.	Users can choose what they want to be compared to: • Historical of themselves. • Their community. • Someone similar to them. Impact in economics, carbon footprint, or society displays comparing the three metrics between the user's variables. Button to click on a specific KPI	User can also click on an impact KPI and see the specific KPI data in a graphic way. Option to go back to the individual consumption data page
Personalization singularity per archetype	If its a participative, active or conscious user the notification would change "performance" vs "impact" or "carbon footprint"			
Design principles	**Personalisation** **Managed automation**	**Personalisation** **Discoverability**	**Personalisation**	**Personalisation**

7.VIRTUALIZATION (PV PANEL)

Main features

DASHBOARD

ADVISORY WALL

This use case explains how a user is curious about self-consumption and solar energy and wants to know if it is worth it for him to install PV solar panels in his/her house. A PV panel was taken as an example, but other possible appliances will follow a similar use case.

	1	2	3	4	5
Action	**INVITATION TO CHECK ELIGIBILITY FOR PV SOLAR ENERGY**	**CHECKING APPLIANCE CONSUMPTION**	**VIRTUALIZING**	**UNDERSTANDING VIRTUALIZED OUTPUTS**	**DEEPENING IN AN OPTION AND NEXTS STEPS**
Feature	ADVISORY WALL	DASHBOARD	DASHBOARD	DASHBOARD	DASHBOARD
Description	The user enters the ReDREAM app to make a quick check and then notices that a new recommendation has appeared in his/her advisory wall to check if his/her house is suitable to install solar panels, as the apps know that it has a single house. Driven by curiosity and willing to know more, he/she clicks in on the advice.	The user leads to the virtualization section of the dashboard, where the option of PV solar panels is highlighted, among others like different comfort temperature, heating system, etc. The user clicks on the PV solar panel option.	The user is led to a simple questionnaire, where he needs to the roof area of his/her house in a satellite vision of a map and answer some simple questions. In the end, a message pops up telling the user he/she is eligible for PV solar energy at home. The user clicks on a CTA button that leads him to a *know more* page.	The app shows three different options for the user: simple (mínimum installation to be worth), balanced (an installation that ensures full self-consumption on a sunny day based on his consumption) and complete (the balanced installation with battery). Each option shows the installation and maintenance costs, the ROI based on the house consumption of the previous year and the time needed. It also estimates the total carbon footprint, considering the emissions associated with the LCA of the solar panel and the once avoided by the generation of renewable energy.	The user clicks on the second option of getting more information. More detailed is given about the consumption and weather conditions of the past year and an estimation for the next year. He/she can also see the rate of self-consumption estimated by month. At the bottom, there is a CTA to contact the energy cooperative/local installer to get more information and a proper study and quote.
Personalization singularity per archetype					The conscious users (conscious, active and participative) or tech enthusiasts and/or wary would want to know also the environmental impact.
Design Principles	**Discoverability Visibility Personalization**	**Visibility Simplicity**	**Visibility Personalization**	**Visibility Personalization**	**Visibility Discoverability**

8. ENERGY TRADING

This use case explains the interaction and configuration of the energy trading option of a user that has PV panels and wants to increase the profit by taking advantage of ideal climate conditions.

Main features

- DASHBOARD
- SETTINGS
- ADVISORY WALL

	1	2	3	4	5	6	7
Action	RECEIVING WEATHER NOTIFICATION	REVIEWING TRADING PREFERENCES	MODIFYNG PRICE PREFERENCES	SHOWING CONSEQUENCES OF MODIFYING PRICE	TRADING AUTOMATION OPTION	ACCEPTING TO AUTOMATE TRADING	CHECKING ENERGY TRADING PROFITS
Feature	ALERT - ADVISORY	DASHBOARD	DASHBOARD	DASHBOARD	NOTIFICATION - ADVISORY	SETTINGS	DASHBOARD
Description	The user receives a notification that the following week will be cold and very sunny. It argues that those conditions are ideal for solar energy generation and trading, not only because the PV panels are more efficient but because energy demand will be high due to the cold temperatures. The notification invites the user with a CTA to review its trading preferences in the *Settings*, and he/she clicks.	The user sees a graph with an estimated demand and prices curve for the next week. He/she can visually see where her/his price limit preferences are set and get more margin if he changes them.	The user modifies the price he/she is willing to sell by rising it. He/she knows that will earn more as the demand will rise and energy prices will be higher. He/she also sees that he/she can donate a percentage, so he/she decides to destinate a little bit of it into donations.	While he/she is modifying it, the impact of the decision is shown in realtime: Economic: forecast for profits Environmental: equivalent trees planted to the avoidance of CO_2 emitted Community: number of houses of the neighbourhood/town that will consume his/her energy.	A message pops up, giving the user the option to let the app automate this type of decisions, explaining that the software is learning form his/her decisions with AI. The message has a CTA button to accept it. This will avoid the hassle for the next time, but he/she had the opportunity to learn how the energy market and the ecosystem is working.	The user accepts that the app automates this flow by clicking the CTA button. Then he/she is taken to the previous settings screens and gives him/her the option to be notified (when and how) if the app changes the trading preferences based on his/her behaviour and previous decisions.	The following week, the sunny and cold one, the user checks, driven by curiosity, the profits from the energy trading in the dashboard. A trading widget shows the net profit with a simple visual number to provide the information at first sight. He/she clicks into the trading section to have a broader detail of the energy sold per day/hour and the net impact caused until today.
Personalization singularity per archetype							
Design Principles	**Discoverability**	**Visibility**	**Visibility** **Personalization**	**Visibility**	**Managed automation**	**Managed automation**	**Simplicity** **Visibility**

9.NON-ENERGY ADVICE (COMFORT & HEALTH)

Main features

DASHBOARD

SETTINGS

ADVISORY WALL

This use case shows how the ReDREAM ecosystem also veils for the comfort and health of the users by providing them with advice related to their energy efficiency.

	1	2	3	4
Action	**RECEIVING WEATHER NOTIFICATION**	**ADJUSTING COMFORT TEMPERATURE**	**RECEIVING FEEDBACK NOTIFICATION**	**CHECKING THE IMPACT**
Feature	ALERT - ADVISORY	SETTINGS	NOTIFICATION - ADVISORY	DASHBOARD
Description	The users receive a push-up notification informing them that the temperatures will considerably rise tomorrow and recommend low 2-3ºC comfort temperature at home. It explains that this is good for energy efficiency and ensures healthier conditions at home. A Learn More CTA button leads to an article explaining the relevance of interior temperature for healthy breathing.	The users navigate to the setting section and decrease the comfort temperature. At this right moment, a message is shown informing them that this decision could save him 15% per cent and reduce the environmental impact by 20%, which is the equivalent to new trees planted.	The week after, he/she receives a notification explaining the positive impact of lowering the temperature on their health and environmentally and economically.	Users click on the notification to lead to the dashboard and extend the information about the impact.
Personalization singularity per archetype		The conscious users (conscious, active and participative) or tech enthusiasts and/or wary would want to know the environmental costs or the info in kWh.		Conscious users (conscious, active and participative) or tech enthusiasts and/or wary would want to know the environmental costs or their info in kWh.
Design Principles	**Visibility**	**Visibility** **Personalization**	**Visibility**	**Visibility**

Annex II: SOCIAL KIPs

Disclaimer. Every KPI should be segmented by:

total Redream participants	Rows in yellow are social KIPs defined in the Grant Agreement
per demo location	Top 10 S6. Callenges KPIs are highlighted in **bold**
per consumer archetype	
per sector	
per customer type (residential vs. commercial vs. industrial)	
per user type (administrator vs. observer)	
per day	
per week	
per month	
per time of participation in the project	
per total duration of the project (36 months)	
in time (evolution)	

#	KPI	DESCRIPTION
S.1	**General declared ecosystem KPIs**	
S.1.1	Energy engagement improvement ratio	Difference between engagement with energy at the beginning and end of the participation on the project, based in a perception scale from 1-10 defined by a questionary that includes topics like awareness, activeness, participation and behaviours related with energy at home/business.
S.1.2	Energy market active participation improvement ratio	Difference between the perception of active participation in the energy market at the beginning and end of the participation on the project, based in a perception scale question from 1-10.
S.1.3	Energy empowerment improvement ratio	Difference between the perception of empowerment through energy at the beginning and end of the participation on the project, based in a perception scale question from 1-10.
S.1.4	Improvement ratio of trust in the energy market	Difference between the trust in the energy market resources at the beginning and end of the participation on the project, based in a perception scale question from 1-10, defined by a questionary that includes topics like trust in the different stakeholders and in the reliability of the system.
S.1.5	Sustainability & energy transition awareness improvement ratio	Difference between the of the sustainability & energy transition awareness at the beginning and end of the participation on the project, based in a perception scale question from 1-10, defined by a questionary that includes topics capability to drive change and create positive impact, reduce the negative impact and feeling of being part of a transition.
S.1.6	Home comfort perception improvement ratio	Difference between the perception of home comfort at the beginning and end of the participation on the project, based in a perception scale question from 1-10, defined by a questionary that includes topics like positive/negative feelings about temperature and air conditions at home.
S.1.7	Sense of community improvement ratio	Difference between the perception of sense of community around energy at the beginning and end of the participation on the project, based in a perception scale question from 1-10.

S.1.8	Ener-tech trust improvement ratio	Difference between the trust in technology to manage energy resources at the beginning and end of the participation on the project, based in a perception scale question from 1-10, defined by a questionary that includes topics like trust and perceived reliability in energetical devices (PV panels, smart thermostats, EV charging points, Stemy devices, etc.)

S.2	**General measured ecosystem KPIs**	
S.2.1	No. of users involved through REDREAM (KPI-2 in Grant Agreement)	No. of persons living and/or working in a building/household registered in the REDREAM ecosystem (S.2.6), whether they are registered users (S.2.2) or not.
S.2.2	No. of registered users directly benefited by REDREAM	Users that have been registered with a profile in the ecosystem through the web form and the app
S.2.3	No. of active users	No. of registered users (S.2.2) that opened the app at least once a month during at least 3 months.
S.2.4	Active users ratio	Active users (S.2.3) per registered users (S.2.2).
S.2.5	Engagement	Average monthly interaction in the ecosystem
S.2.6	Average participation rate	Average interactions in the ecosystem per user
S.2.7	No. of users involved participating in the energy social network (KPI-4 in Grant Agreement)	No. of active users in the support forum (S.5.12) and challenge forums (S.6.30)
S.2.8	No. of interactions to share best practices through the energy SN (KPI-5 in Grant Agreement)	No. of interactions in the support forum (S.5.17) and challenge forums (S.6.37)
S.2.9	Types of users registered in the ecosystem	Percentage of users per type: multisector (residential, third-sector, industrial) and by permits (admins, with change permits, viewers)
S.2.10	No. of buildings/households registered in the REDREAM ecosystem	No. of buildings/households registered in the REDREAM ecosystem with a building profile.
S.2.11	No. of users up taking of previous services (KPI-8 in Grant Agreement)	No. users participating in at least one challenge

S.3	**Basic app KPIs**	
S.3.1	Average app usage time	Average time a user spends in the app
S.3.2	Average app openings	Average number of times a user opens the app
S.3.3	No. of visualizations of each screen	Number of times a screen has been visualized more than 1s
S.3.4	Average page visualization time	Average time of visualizations of each page
S.3.5	Proactive openings ratio	No. of times a user opens the app spontaneously (without having received a notification/alert) per total of openings

	S.3.6	Reactive openings ratio	No. of times a user opens the app because of a notification/alert per total of openings
	S.3.7	Preferred day of the week and time for use	Day of the week and time slot the app is more used

	S.4	**Onboarding KPIs**	
	S.4.1	No. of downloads	Total number of downloads of the app, both in Google and Apple app store.
	S.4.2	Onboarding manual flexibility mode ratio	Number of users that set in manual mode the management of the automated flexibility during the onboarding process per total no. of active users (S.2.3).
	S.4.3	Onboarding public profile deleting ratio	No. of users that block their public profile (quit the social network) during the onboarding process per no. of registered users (S.2.2)
	S.4.4	Initial setup completion ratio	Number of users that complete the initial settings during the onboarding process per active users (S.2.3)
	S.4.5	App uninstall ratio	Number users that uninstall the app per total of downloads
	S.4.6	Average initial setup time	Average time that a user spends configuring initial settings in the onboarding process, also segmented by steps

	S.5	**Settings KPIs**	
	S.5.1	Social profile privacy settings ratio	Number of users that that change the default privacy settings for the social profile per total no. of active users (S.2.3).
Notifications	S.5.2	Notification activation ratio	No. of users that activate a specific type of notification per total no. of active users (S.2.3).
Notifications	S.5.3	Notification average frequency	Average frequency a specific type of notification is set
Notifications	S.5.4	Read notifications/alerts ratio	No. of notifications/alerts read per all notifications/alerts sent
Customer support	S.5.5	Customer support channel use ratio	Percentage of use of each customer support channel compared to all together
Customer support	S.5.6	No. of issues submitted	No. of issues submitted by channel and in general
Customer support	S.5.7	Average customer support response time	Average time users receive an answer in a specific customer support channel or in all together
Customer support	S.5.8	Solved issues ratio	No. of issues solved per total of issues submitted
Customer support	S.5.9	Average issue solving time	Average time an issue needs to be solved, also segmented by types of issues
Customer support	S.5.10	Satisfaction of the customer support	Average rating of 1-5 based on the satisfaction declared by a user that uses the customer support

	S.5.11	Main issues/enquires raised in the customer support	Top ten 10 enquires submitted to the customer support ordered by no. of submissions.
support forum	S.5.12	No. active users support forum	No. users that visualized (S.5.14), posted (S.5.15), liked, rated or updated their profile, i.e. interacted with the support community interact
	S.5.13	support forum publishers ratio	No. of users that publish a post in the support forum ratio per total no. of active users (S.2.3).
	S.5.14	support forum readers ratio	No. of users that open the support forum and scroll and/or spend more than 10sec per total no. of active users (S.2.3), but never posted.
	S.5.15	No. of visualizations in the support forum	No. of times users have visualized the support forum for more than 3s
	S.5.16	No. of posts in the support forum	No. of times users have posted a topic, question or answer in the support forum
	S.5.17	No. of interactions in the support forum	No. of times users have visualized (S.5.15), posted (S.5.16), liked, rated, updated their profile in the support forum
Comfort temperature	S.5.18	Comfort temperature change ratio	No. of users that have change the temperature of comfort at least once a month per all active users (S.2.3)
	S.5.19	Average frequency of changing the comfort temperature	Average frequency active users (S.2.3) modify their comfort temperature
	S.5.20	Average comfort temperature	Average comfort temperature set by active users (S.2.3)
	S.5.21	Calendar modification ratio	No. of users that have change the *At Home* calendar at least once
	S.5.22	Average frequency of changing the calendar	Average frequency active users (S.2.3) modify the *At Home* calendar
	S.5.23	Manual comfort temperature mode ratio	Number of users that set in manual mode the management of the comfort temperature per total no. of active users (S.2.3).
Energy trading	S.5.24	No. of users trading with energy	No. of users that have trade (sold) or shared energy with the community at least once
	S.5.25	Average price limits set for energy trading	Average price limits set by active users (S.2.3) for energy trading
	S.5.26	Minimum share of energy set for self-consumption	Percentage of minimum of energy ensured for self-consumption set by active users (S.2.3)
	S.5.27	Energy donor ratio	No. of users that have donated at least 50% or more of the energy they have sold per no. of users trading with energy (S.5.24)
	S.5.28	Automatic energy trading ratio	No. of users that have set the trading options in automatic mode per no. of users trading with energy (S.5.24)

	S.6	**Challenges KPIs**	*The 10 most important Challenge KPIs are highlighted in* ***bold***
...nges	S.6.1	No. of challenges proposed	No. of challenges proposed to active participants (S.2.3)
	S.6.2	Average no. challenges proposed rate	Average no. challenges proposed to users

Amount of challe	S.6.3	No. of challenges visualized	No. of challenges proposed that have been visualized more than 5s, also segmented by types of challenges
	S.6.4	No. of challenges accepted	No. of challenges accepted, also segmented by types of challenges
	S.6.5	**No. of challenges accomplished**	**No. of accepted challenges that have been accomplished, also segmented by types of challenges**
	S.6.6	**No. of challenges uncompleted**	**No. of challenges that have been accepted but never accomplished, despite the progress achieved. Also segmented by types of challenges**
Challenges ratios	S.6.7	Challenge visualization ratio	No. of challenges visualized (S.6.2) per no. of challenges proposed (S.6.1), also segmented by types of challenges
	S.6.8	Average challenge visualization rate	Average challenge visualization per user, also segmented by types of challenges
	S.6.9	Challenge acceptance ratio	No. of challenges accepted (S.6.4) per no. of challenges proposed (S.6.1),also segmented by types of challenges
	S.6.10	Average challenge acceptance rate	Average challenge acceptance per user, also segmented by types of challenges
	S.6.11	**Challenge completion ratio**	**No. of challenges accomplished (S.6.5) per no. of challenges accepted (S.6.4), also segmented by types of challenges**
	S.6.12	Average challenge completion rate	Average challenge completion per user, also segmented by types of challenges
	S.6.13	Challenge abandonment ratio	No. of challenges uncompleted (S.6.6) per no. of challenges accepted (S.6.4), also segmented by types of challenges
	S.6.14	Average challenge abandonment rate	Average challenge abandonment per user, also segmented by types of challenges
	S.6.15	Average progress of the uncompleted challenges	Average progress achieved in the uncompleted challenges, also segmented by types of challenges
	S.6.16	Average progress of the uncompleted challenges rate	Average progress of the uncompleted challenges per user, also segmented by types of challenges
	S.6.17	User proposed challenges ratio	No. of allowed users (depending on level) that proposed at least one challenges per total no. of allowed users to propose a challenge
	S.6.18	Average User proposed challenges rate	Average proposed challenged per user, also segmented by types of challenges
	S.6.19	Challenge matching ratio	No. of challenges accepted (S.6.3) per no. of challenges proposed that related with the value declared by the user on the onboarding
	S.6.20	**Average Challenge matching rate**	**Average challenges matched (accepted challenges(S.6.3) per no. of challenges proposed that related with the value declared by the user on the onboarding) per user, also segmented by types of challenges**
	S.6.20	Extended content visualization rate	No. of visualizations of the challenge extended content (articles, videos, etc.) per no. of times the challenge has been accepted, segmented by types of challenges
	S.6.21	**Behavioural change ratio**	**No. of users that maintain the change of behaviour at least 3 months after the accomplishment of a challenge per all users that accept challenges. (Rebound or spill over)**
hallenge scores	S.6.22	Average difficulty score	Average difficulty declared by users in a rating from 1-3, also segmented by types of challenges
	S.6.23	Average usefulness score	Average usefulness declared by users in a rating from 1-3, also segmented by types of challenges

Ch...	**S.6.24**	**Average engagement score**	**Average engagement declared by users in a rating from 1-3, also segmented by types of challenges**
Challenge timings	**S.6.25**	**Challenge completion average time**	**Average time of completion by type of challenge since it is accepted**
	S.6.26	Challenge acceptance average time	Average time of acceptance by challenge since it is proposed
	S.6.27	Challenge abandonment average time	Average time of abandonment by challenge since it is accepted
Community forum in community challenges	S.6.28	Public profile deleting ratio	No. of users that block their public profile (quit the social network) per no. of active participants (S.2.3)
	S.6.29	Public profile update ratio	No. of users that update their public profile (quit the social network) per no. of active participants (S.2.3)
	S.6.30	**No. of active users in the community forum**	**No. of active users in the community forum that read, react, post or rate, in total and segmented by challenge**
	S.6.31	Community forum publishers ratio	No. of users that publish a post in the community forum ratio per total no. of active users (S.6.30).
	S.6.32	Community forum readers ratio	No. of users that open the community forum and scroll and/or spend more than 10sec per total no. of active users (S.6.30) but never posted.
	S.6.33	Community forum users ratio	No. of active users in the community forum (S.6.30) per no. of users with an accepted community challenge.
	S.6.34	No. of visualizations in the community forums	No. of times users have visualized (read) the challenge forums for more than 3s, also segmented by challenge
	S.6.35	No. of posts in the community forum	No. of times users have posted in to the challenge forums, also segmented by challenge
	S.6.36	No. reactions to the community forum	No. of times users have reacted (like) to the challenge forums posts, also segmented by challenge
	S.6.37	No. of interactions in the community forum	No. of times users have visualized (S.6.34), posted (S.6.35), reacted (S.6.36), updated their profile in the support forum
	S.6.38	No. of introductions in the community forum	No. of users that introduces him/herself in the community forum with a post
	S.6.39	**No. of interactions in the community forum**	**No. of times users have visualized (S.5.14), posted, liked, ratio, updated their profile in the challenge forums, also segmented by challenge**
Profile evolution	S.6.40	No. of badges	No. of total badges collected by active users (S.2.2), segmented also by type of badges
	S.6.41	Badges rate	Percentage of users in with each badge
	S.6.42	Average no. of badges	Average no. of badges a user holds
	S.6.43	No. of users in each level	No. of users that are in each performance level
	S.6.44	**Levels rate**	**Percentage of users in each performance level**
	S.6.45	Average level	Average performance level of all active users.

S.6.46	Average level upgrade time	Average time a user needs to upgrade form one performance level to another, segmented by level

S.7	**Dashboard KPIs**	
S.7.1	No. of interactions with the dashboard	No. of visualizations over 2s, clicks, swipes, etc. in the dashboard
S.7.2	No. of interactions with the each type of impact	No. of visualizations over 2s, clicks, swipes, etc. with the impact information, segmented by type of impact
S.7.3	Impact match ratio	No. of impact interactions (S.7.2) per no. of impact information items showed to the user based on the value declared by the user on the onboarding
S.7.4	Comparisons rate	No. of times a users compares his/her consumption and/or impact data per all active users (S.2.3)
S.7.5	Average comparison rate	Average number of comparison per user
S.7.6	Virtualizations rate	No. of times a users virtualises his/her consumption, new devices and/or impact data per all active users (S.2.3)
S.7.7	Average virtualization	Average number of virtualizations per user
S.7.8	Preferred visualization mode	Units, day/week/month/year that are more used in this case
S.7.9	Average visualization time	Average time per visualization in each dashboard section
S.7.10	No. of data downloads	No. of times a users download their consumption and impact data