The character of eco-feedback systems for energy communities

Master Thesis

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Table of contents

Summary

Energy communities are organizations of people that aim to transition to an energy system where individuals or small organizations can take part on the production and distribution activities, with the purpose to move to a more sustainable energy system. Energy communities are still being studied, but it can be assumed that consumers will need a technology that helps them manage their clean energy to make the best use of it within the community.

One of the technologies that could be used for this purpose are eco-feedback systems. Eco-feedback systems provide consumers with their energy consumption data to influence a change in their everyday behaviour. What has been detected, is that most of studies related with eco-feedback systems have a focus on individuals. There are some eco-feedback systems that have had a focus on communities, but such systems still have a focus on the individual members of the community (for example, by comparing every member's consumption).

This project wants to study how an eco-feedback system could be designed with an energy community in mind, this has been summed up by finding a character that could identify such systems. To study different characters for eco-feedback systems for energy communities, two different artefacts have been developed. These artefacts have been designed for a neighbourhood community that lives in a building and decides to install solar panels on the rooftop to cover their consumption needs.

In order to generate a discussion with potential energy community members, both artefacts were materialised in a video where the context and the behaviour of the artefacts were explained. A focus group session with 5 participants provided opinion from potential users, who through a set of activities came up with a list of characteristics for each of the proposals. The list of characteristics was also used during the session to create a conversation between participants about energy communities and the artefacts themselves, providing information about how satisfied they were of the systems.

The knowledge generated during the focus group session was used to analyse the artefacts. The analysis resulted in the definition of a character for each of the designs, the two characters identified were the *intriguing* and the *committed.* Apart from the character, the properties obtained from the workshop showed that both artefacts had characteristic that could be related to eco-feedback properties, like those related to environment and learning from which consumers can make assumptions about their consumption. But it is interesting that they detected characteristics related to a community, like that the artefacts were *collective, accessible* or *inclusive*. To sum up, the analysis of the artefacts suggests that there are some characteristics that leverage eco-feedback systems to a community dimension, which potential energy community members appreciate and expect from a system that has to help them manage their clean energy within an energy community. The system has not only the function to give information to consumers but also it is the unifying tool for the community, with the purpose of having a better consumption together.

Future work should be focused on finding an energy community and installing the artefacts in their buildings, the artefacts should be tested during a period of time and feedback from members collected. It would be interesting to compare the characteristics for each of the artefacts that has been obtained in this project and the ones that could give energy community members who test the artefacts in a real-life scenario. It would also be interesting to see the influence of the artefacts within a community, and study if the community has an improvement on their energy management and if the artefacts have strengthened their community activities.

The character of eco-feedback systems for energy communities

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ABSTRACT

Energy communities are emerging around Europe with the purpose to transition to an energy system where individuals can also be energy producers. Although energy communities are still being studied, it seems that members of such organisations will need a tool to manage clean energy together. Eco-feedback appears to be an appropriate tool to fulfil this need. On the other hand, eco-feedback systems have had a focus on individual consumers, but systems with a community focus are missing. The research presented here aims to identify the character and characteristics of eco-feedback systems for energy communities might have. Two different artefacts have been developed and analysed on a focus group session with potential energy community members to find this character. The findings show that participants identified characteristics related to eco-feedback systems purposes, but they also came up with a set of properties related to the community. That proves that such a system can also be a cohesive tool for the community to have a sustainable lifestyle.

Author Keywords

Energy community; eco-feedback; concept-driven design; character of things.

INTRODUCTION

To reduce CO_2 emissions, the European Union is encouraging its countries to move to a more renewable energy system [11, 15]. Although nowadays, energy is generated by a centralised energy system, we are starting to move to a more decentralised system where smaller collectives or even individual citizens will also be energy producers [19]. The trends suggest that by 2050 almost half of the European households will produce energy [2].

Thanks to a decrease in the cost of solar panels and wind turbines, EU sees citizens as power actors in a future energy system, where they now have more chances to form energy communities [2]. The purpose of these emerging energy communities is to produce clean energy to consume or distribute it to the main grid or other households. Their participation can be from purchasing solar panels or wind turbines for self-consumption to investing in a project that aims to provide clean energy to the main grid. Although in a future these communities strive to be self-sufficient, nowadays most of them are supported by other institutions like local authorities and businesses or NGOs [4, 11, 14, 19, 22, 23].

To keep energy communities working, members have to put an effort on the management of all the activities that take part in the energy cycle (like production, distribution and consumption) [23]. One way of making this management easier for members of these communities might be informing them about how much energy they have and how it might be consumed.

A field studied for many in HCI research is eco-feedback, which have been used, among others, to inform households about their consumption activity. Eco-feedback technologies give information about energy consumption to families where the design is meant to cause a behaviour change on users' consumption, moving to a more sustainable lifestyle [17, 18, 27].

After an analysis of eco-feedback technologies with a focus on communities, there is evidence that eco-feedback studies so far focus on individuals [16, 28, 29]. Eco-feedback systems use comparisons with past consumption or even with other individuals to make consumers realise about their consumption. However, some studies prove that the results are not prolonged on time and that sometimes consumption is not reduced [16, 17, 27].

This study aims to research how an energy community in a city could manage their energy (both consumption and production), and how an eco-feedback system could help them track this management and reinforce their community sense. The purpose of the research is to define what characteristics work best when designing eco-feedback systems for energy communities. Two design proposals have been developed for a potential future energy community to get feedback from prospect users. The two design proposals were shown to prospective members of an energy community, who participated in a focus group workshop to get feedback on the artefacts. The impressions collected from the focus group resulted in a set of characteristics for community-focused eco-feedback systems that future designers can take into account.

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RELATED WORK

Energy communities

As a result of a literature review, energy communities were conceptualised and categorised according to how they produce clean energy (production), who is going to benefit from this energy and how (consumption), what are the motivations of joining an energy community (purpose) and which actors take part in the process (participants).

Walker and Devine-Wright developed a framework in which 'community renewables' can be organised [14]. One of the dimensions the authors came up with is the *process dimension,* which is about whom the project is developed for. 'Community renewables' can be positioned in a range from *open & participatory* to *closed & institutional* communities within the *process* dimension. The second dimension in the 'community renewables' framework is the *outcome* dimension; it defines who the project is for and ranges from *distant & private* to *local & collective* projects. The authors suggest that an 'ideal' community project is closer to the *open & participatory and* the *local & collective* dimensions [14].

Gui and MacGill established three typologies of future clean energy communities: centralised energy communities (1), distributed energy communities (2) and decentralised energy communities. The authors define centralised energy communities as "*a cohesive network of households and businesses that collectively own or participate in energy-related projects, […]*". Distributed energy communities are "*a network of households and businesses that generate or own distributed generation individually, connected through a controlling entity either physically or virtually, […]*" and decentralised communities are those in which "*a community of households, businesses or a municipality that generates and consumes energy locally for self-sufficiency that may or may not connect to the main grid*" [10].

Walker et al. and Gui et al. are some of the many studies which have tried to define how energy community could be or could organise their activities. Although there is research on the concept, it has been more challenging to find examples where these theories have been proved.

Here I present an overview of different projects that could be defined as energy communities: the Tidy Street project focused on visualising consumption between neighbours and comparing their activity publicly [16], the Tiree Energy Pulse uses forecast to predict energy production from wind turbines to inform citizens from an island about the energy availability they will have during the day [29], Francisco and Taylor designed a system to visualise energy consumption in a public building with a community focus [1], and a rural community in Germany that covers citizens' consumption needs with different energy generating technologies and help from institutions and the government [22].

What can be detected in all the examples above is that they are all very different, but at the same time, the authors consider them as energy communities. The variety of energy communities understanding demonstrates that theories around the topic still need to be evaluated in real scenarios, which would help settle on the different hypothesis.

Following Walker's et al. energy community's framework, this study will focus in an "ideal" community where members of a neighbourhood community (*open & participatory* process) install solar panels in their building to cover consumption needs (*local & collective* outcome). Here an "ideal" community is understood as what communities will look like in a future: individuals will gather together to transition to a self-supply or sharing energy project with renewables, and all the members will benefit from it.

Eco-feedback

Eco-feedback systems, among other purposes, aim to influence a behaviour change in consumers' everyday life. Such technologies inform consumers about their consumption and the benefits they are getting by making a few changes in their energy-consuming activities. The feedback given is shown by using different design principles with the purpose to motivate consumers to change their behaviour.

Eco-feedbacks lay on the hypothesis that technology can be used to inform consumers about their energy consumption, the awareness of energy activity in their everyday behaviour must influence a change in their habits and therefore have a more sustainable lifestyle [17, 18].

A design principle used by many designers and researchers in eco-feedback systems to influence a change is *comparison*. When talking about individual eco-feedback, the comparison is usually made between present data and past data to show a consumption reduction in the consumer's activity. When it comes to communities, the comparison has been used to contrast different consumers' consumption. For example, Bird and Rogers compared energy consumption between neighbours in Tidy Street to motivate residents to consume less energy than their neighbours [16]. Simm et al. designed a system to inform citizens on an island about energy forecast to synchronise energy consumption with supply [29].

Eco-feedback systems so far have used data visualisation to inform consumers about their energy activity. Kuijer studied different approaches about how design can be used to change consumers behaviour within the sustainable design field. The author discusses in her thesis different types of social doctrines, which are used to understand social behaviours. For this study, two of the theories mentioned by Kuijer have been chosen: the norm-oriented theory and the practice theory. Kuijer critiques norm-oriented theory because it gives information. However, it doesn't "interact" with users, which makes it challenging to create a connection between consumers and the eco-feedback system. At the same time, she believes that a practice-theory may involve consumers as

they will be challenged to participate somehow within the system [21].

In norm-oriented theories, the behaviour is explained through collective norms and structures. Social organisation is a result of normative consensus, and the units of analysis are normative structures, such as values and social rules [21]. On the other hand, Kuijer interprets practice theories as a *"set of design approaches, […], which explicitly take practices as their fundamental unit of analysis, and in fact, as a unit of design"* [21]. These theories can be a way to study different approaches that could be applied to eco-feedback systems for energy communities. Kuijer arguments may be a tool to try to prolong results over time apart from just making families aware of their consumption, as most of the eco-feedback systems have covered so far.

Eco-feedback systems and practice theories have always had a focus on individuals or families. Therefore, there is a need to research on how eco-feedback systems could be designed to cover energy communities' needs.

METHODOLOGY

Stolterman and Wiberg developed the concept-driven methodology, which intends to investigate an approach or argument that has been formulated and needs more research [12]. The concept-driven method explores future scenarios based on a theory that needs to be explored. The concept-driven methodology uses artefacts as a tool to express the idea. Stolterman and Wiberg believe that using a concept-driven approach as a complementary research method will strengthen the results in interaction research [12].

The concept-driven approach can be conducted following a set of methodological activities, which are very similar to any design process. The activities are *concept generation* (1)*, concept exploration* (2)*, internal concept critique* (3)*, design of artefacts, external concept critique* (4) which are presented in this section and *concept revisited* (5) and *concept contextualization* (6) which are shown in the *Discussion* [12]. Concept-driven methodological activities have been used to guide the process of the study presented here.

In the *Related Work* section, it has been demonstrated that the topic of energy communities is still being studied and needs further research. The concept-driven methodology fits with the purpose of this study as it is exploring a future scenario. Under the assumption that eco-feedback systems will be a tool that energy community members will use to manage their clean energy by developing some design proposals, it will be possible to study future energy communities.

Concept generation

Artefacts are used to present future realities based on a theoretical concept. Design concepts are not a prototype, but they are *probes* or *measuring instruments* that enable researchers to explore new ideas from the feedback users give [12]. Janlert and Stolterman suggest that artefacts can have a character: an artefact's character provides information about the whole object, it suggests what it can be used for or how it has to be used among others, it's a way to give an accurate description to the user through all its characteristics. Characteristics can be grouped in two different categories: 'manifest properties' which are related to physical characteristics like colours and shapes, and 'dispositional properties' that are characteristics associated to actions, feelings or interactions [20].

> Characters are important conceptual devices that reduce the mental effort involved in dealing with artifacts. In ascribing a certain character to an artifact we make a very simple, but powerful description that frequently will be accurate enough to help us to manage the task of handling the artifact and to appreciate the consequences of our interactions with it [20].

One of the main activities of energy community members is managing energy. It would be interesting to design an artefact that helps consumers perform their activities to explore their behaviour inside a community. Eco-feedback has been used so far to inform consumers about their consumption, and some researchers have also used it to forecast energy supply [29]. These energy management systems suggest that eco-feedback could be an appropriate tool to help energy community members have an overview of the availability of clean energy and how are they consuming it.

As described in the *Related Work* section, this project aims to study how eco-feedback systems with a focus on energy communities could be designed. In this study, I aim to define what character energy community eco-feedbacks may have, to establish characteristics that future designers could have in consideration when developing such systems.

Case study: An Energy Community in Spain

As a means to explore energy communities, the design artefacts that will be generated in this study will be contextualised in a possible energy community. The need for further research on the concept makes it difficult to design an artefact for any community as they are not yet concrete. That is why it seems necessary to define what kind of community we are studying to develop the artefacts according to their needs.

Energy communities usually use wind turbines or solar panels to produce their energy. The country's climate will determine which of the renewable energy technologies is more appropriate. This study has been conducted in Spain, one of the countries in Europe with more sun hours during the year, which makes it obvious to work with solar panels.

Until 2018, the Spanish government charged citizens who were self-supplying with solar panels with taxes, which made it more expensive to have clean energy rather than consuming from the main grid. For that reason, Spanish citizens have been reluctant to acquire solar panels [5]. After a law modification, this duty was eliminated but the Spanish

community still sees solar panels as an expensive technology and haven't started to install them. Energy communities could benefit from solar panels as the first investment would be divided between all the members of the community, and the benefits of it would be seen sooner. The example used in this study will be a neighbourhood association that collaborates on installing solar panels in the rooftop of the building to cover their consumption needs.

Concept exploration

To explore how eco-feedback systems could be designed for energy communities, research on different design theories has been done. As energy communities are still emerging and are not clearly defined yet, it has been challenging to come up with a single *character* for them. This lack of antecedents has led to the design of two different systems to explore how potential consumers perceive each proposal. Two different theories studied by Kuijer will be used to develop the artefacts: the norm-oriented theory and the practice theory [21].

Following the norm-oriented theory [21], an eco-feedback system for communities could inform consumers about clean energy availability and consumption data. This information's goal would be to make consumers aware of the use of clean energy the building has. The purpose of the first artefact proposal should aim to make consumers reflect on how, as a community, they can adapt everyday activities to balance their consumption needs to the energy supply.

In a practice theory framework, a community-centred eco-feedback may focus on how an everyday activity could be used to influence behaviour change in the community. A practice theory could help not only to get results caused by consumers' motivation at the beginning of the study [17, 25, 27] but also how this new behaviour can be prolonged in time [21].

Internal concept critique

Inspired by social theories [21], an initial design phase was elaborated. For the norm-oriented approach, a study of different materials and languages was done to find a visual way to represent consumption and production data. In the case of the practice theory framework, different formats of interaction activities were analysed (apps, websites, games, planning tools) to find an engaging artefact to help consumers organise laundries within the community. All the sketches and ideas were presented to different people during the design process to get feedback and iterate on the artefacts and concepts.

The design phase resulted in two proposals: the norm-oriented artefact displays real-time data about consumption and production to make consumers aware of the different peaks of energy supply and consumption. The 'practice theory' framework artefact consists of a wood game that forecasts energy production every day and that lets community members plan their laundry schedule for that day. The purpose of the game is motivating consumers to plan their laundries in those hours when more clean energy is available. Both artefacts are described in detail in next section.

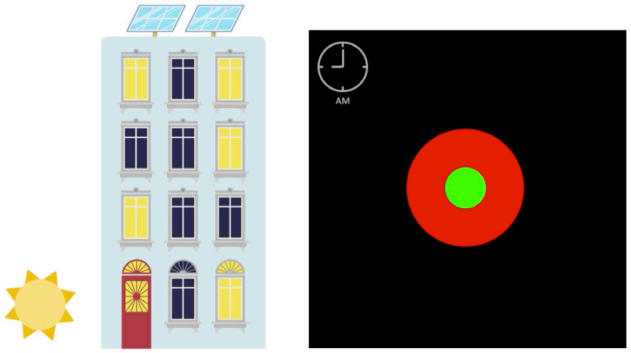

Figure 1. Data visualisation with an excess of consumption. Frame from video materialisation [6].

The fact that what is being explored is a future scenario, has made it difficult to find a real energy community similar to the one presented in this project. That is the reason why the designs developed have been materialised using videos. Videos give the chance to present a concept or idea even if it doesn't exist, which has been useful to present and describe the artefacts to potential future energy community members [6, 7, 8].

Design of artefacts

In this section, the two artefacts are presented. As mentioned in the *Concept Generation* part, both artefacts have been developed for the same community: a neighbourhood organisation that lives in the same building. As a community, they would install solar panels in the rooftop to cover their consumption needs.

The two artefacts developed, will be placed at the entrance of the building, where all the consumers will be able to see them every time they enter or leave the building. Another aspect that has been taken into account is that installing batteries to store energy is too expensive, and it is cheaper to use energy supply at the same time it is produced.

Artefact 1: Visualising data with lights

The first artefact, following the norm-oriented theory [21], aims to visualise real-time energy production from solar panels and the sum of consumption from all the consumers in the building. The objective of this artefact is to make community members aware of the difference between production peak hours and consumption peak hours to influence them to balance their consumption to the energy supply. If this change isn't applied, the energy not consumed at the moment will be sent to the main grid. Consumers would also need to pay for power from the main grid if there was a consumption excess compared to clean energy availability.

The artefact consists of a black wall and two spotlights pointing it. The red light represents consumption. It will be connected to a tool that measures consumption in the

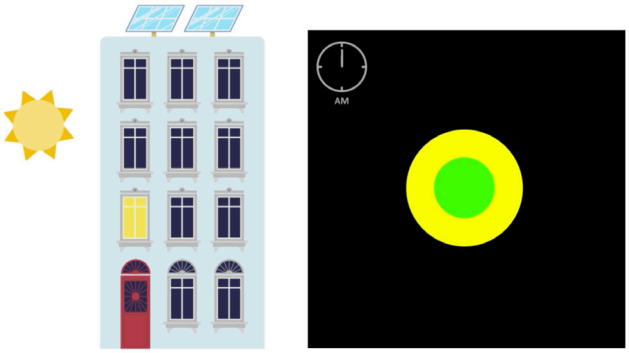

Figure 2. Data visualisation with higher production than consumption. Frame from video materialisation [6].

building, according to the Kw/h, the projected red light will change its size. If the consumption is high, the diameter of the red light will grow. If the consumption is low, the red light will reduce its size. The second light is yellow; it represents production. It will be connected to the solar panels to know the Kw/h that are being produced. The behaviour will be the same as the red light: according to Kw/h being produced, the yellow circle will reduce or increase its size.

The two lights will light up at the same point in the black wall; they will be overlapped. We have to take into account that the sum of light colours creates a third colour. According to the light colour theory, the addition of red and yellow results in green light.

When the two lights are overlapped, and they change their sizes, the superposition of them will create different colour combinations. In Figure 1, there is an example of how the data would be represented at 9 am. Let us then assume that consumption at morning would be higher than production; a big red light represents consumption, and a small green circle (created with the sum of red and yellow lights) represents the amount of consumption covered by clean energy. The red area represents the excess of consumption not covered by energy-supply from solar panels, and the community is using power from the main grid.

On the other hand, in Figure 2, information from noon is given. In this example, there is high production and low consumption. It results in a big yellow circle with a smaller green circle inside (created with the sum of yellow and red lights). The interpretation of this visualisation is that 100% of the consumption is covered by clean energy, but the community is "losing" the power from solar panels that has not been used.

Also, the artefact will have a dial that will allow consumers change the size of the red circle (consumption) to visualise what effect has a change in consumption activities related to the yellow circle (production).

Artefact 2: Laundry planning wood game

For the practice theory approach [21], a wood game for planning laundries has been developed. The purpose of the game is that consumers schedule their washing machines

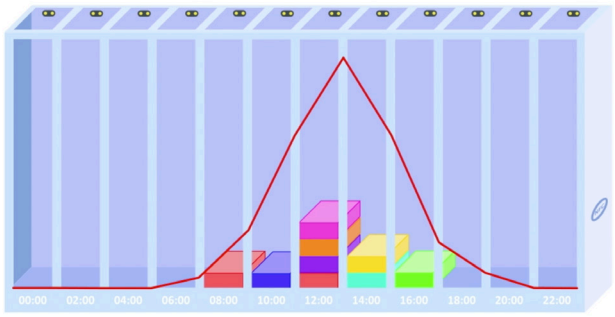

Figure 3. Laundry scheduling wood piece game with production forecast and booked laundries. Frame from video materialisation [8].

according to clean energy availability. By rescheduling the more consuming activities to the solar panel's peak hours, the community would be making better use of the technology. In consequence, they will have more sustainable behaviour.

The artefact consists of a box with twelve holes; each hole represents 2 hours. Every morning, according to forecast, a red thread will be placed in front of the box. The thread will represent the amount of energy that is being produced every hour of the day (Figure 3). Consumers will have to place wood pieces in the holes to schedule their laundries. To identify themselves, a colour will be assigned to each family. The size of the wood pieces will correspond to a 2 hours laundry, by dropping a piece in a hole, they will be planning a washing machine at the time corresponding to the hole.

Each wood piece will have an NFC sensor that will distinguish consumers. At one side of the box, there will be an NFC sensor, when a community member brings his/her wood piece to the sensor, it will identify the family. At the top of each hole, there will be a presence sensor; every time a consumer identifies himself/herself with the NFC chip, presence sensors will be activated. The presence sensor that presences a wood piece falling in front of it will send this information to the database, and a consumer will have scheduled a washing machine.

Consumers will be able to access the planning from any device to see the community's bookings. Also, washing machines will be blocked during that time that hasn't been scheduled, and consumers will have to follow their planning to use them. Every morning, the "game" will be restarted to start planning laundries again.

As seen in Figure 3, "good" behaviour would be that all the washing machines are done during those times when there is energy supply from solar panels. The size of the pieces will be proportional to the height of the thread, to have a realistic overview of the energy being produced and what amount of it will be consumed by washing machines.

Participants	Demographics	Building	Neighbourhood community
P1	P1: 29 years old, electrical engineer Flatmate: 29	Building with 3 apartments	There is a neighbourhood community in the building, they meet every 3 months and manage common areas, parking, cleaning… The community owns an outdoor patio that all households can use, if there is any misunderstanding, they try to approach it together. It is a small community and they don't have many conflicts.
P2	P2: 25, designer Parents: 59, 59 Sibling: 27	Building with 29 apartments	They do neighbourhood meetings quite often. There is mezzanine where the building doorman used to live, now it is owned by the community and they rent it. The money they get from the mezzanine is used to cover community expenses.
P3	P3: 57, retired personal trainer Partner: 60 Child: 23	Building with 7 apartments	The neighbourhood community meets at least once a year, and more often if it is needed where members can expose proposals. Families share a terrace that is managed together within the community.
P4, P5	P4: 23, teacher and physician P5: 30, developer	Building with 29 apartments	There is a neighbourhood community with which they meet quite often, there isn't anything owned by the community, they only manage together common areas (like the entrance or the stairs).

Table 1. Participants' demographics and their neighbourhood community characteristics

External design critique

To get feedback from the artefacts, a group of videos to explain the concepts and the artefacts were made. By materialising artefacts in videos, it has been possible to get critique from them. Artefacts have been the tool to motivate a reflection or discussion on the topic approached. The critique generated in a focus group has been the instrument used to create new knowledge [24]. Blythe arguments that when working with future realities, designers should not only focus on the design of the artefact but also in which scenario it will be placed and what users are going to use it. Therefore, artefacts haven't been used only to critique the design itself, but also to make a discussion about how potential energy community members could use such artefacts in an everyday life scenario.

Focus groups are a qualitative research method where collective discussion is generated to get knowledge from the opinion and experiences of participants [26]. Focus groups can be used as explorative research tools where a collective conversation generated knowledge. Although participants can have different opinions, they will try to get to a common understanding of the topic. The participants' discussion will result in a set of knowledge that can be analysed [26]. As the purpose of the research was to get insight from potential members of an energy community, a focus group session has enabled the generation of a discussion around the artefacts designed and the concepts being studied in this project where communities have an essential role in the research, which has been the way to get external design critique from potential users of eco-feedbacks for energy communities.

The focus group session was structured around five themes: *demographics and energy consumption awareness of the participants* (1)*, energy communities* (2)*, first artefact (visualising data with lights)* (3)*, second artefact (laundry planning wood game)* (4) and *design proposals character* (5). Different research questions emerged from these themes, which were used later to design the workshop guide (see Appendix II).

The participants that have taken part in the workshop are potential energy community members. Participants were recruited through a broadcast message; participants were required to live in a building where there was a neighbourhood community and that they were interested in sustainability or renewable energies. As can be seen in Table 1, five participants with different demographics were chosen. The characteristic that all the participants have in common is that they live in a building where a community like the one that has been used to develop the design proposals (described in *Concept Generation* section) could be formed.

Following the topics and the research questions from the guide designed, discussion about all the themes were conducted. At the beginning of the themes 2, 3 and 4 a video was showed to the participants: the first one was used to present the concept of energy communities and the example used for the research, the second and third videos were the artefacts' materialisation and description.

During the focus group, participants were asked to create a list of characteristics for each of the artefacts (manifest and dispositional properties were considered). After the visualisation of videos presenting the artefacts and a discussion about them, participants suggested a list of characteristics for both artefacts. This list was later used in the 5th theme of the focus group in which, through a card sorting activity [3], participants organised the characteristics

		Social			
		Learning		*Community*	
Environment	**Aesthetics**	*Positive*	*Negative*		*Logistics*
Sustainable[1]	Appealing[1]	Teaching[1,2]	Simple[1]	Unifying[1]	Demands material[1]
Artefact's consumption[1]	Visual[1]	Easy[2]	Unrealistic[2]	Committed[2]	Demands space[1]
Management[1]	Original[1,2]	Simple[1]	Impractical[2]	Awareness raising[1]	Collective[1]
Awareness raising[1]	Curious[1]	Educational[1,2]	Inconsistent in time[1]	Obligatory[2]	Accessible[2]
	Ground-braking[1]	Curious[1]	Limited[2]	Inclusive[2]	
	Funny[2]	Understandable[1,2]	Not very flexible[2]	Accessible[2]	
	Playful[2]	Funny[2]		Unfair[2]	
	Becomes out-of-date[1,2]	Present[2]		Playful[2]	
				Collective[1]	

Table 2. Card sorting categories. (1 = Data visualisation with lights; 2 = Laundry planning wood game)

identified. The card sorting activity consisted in giving participants 15 minutes to assemble the list of characteristics in different categories, they had the freedom to choose the categories and the number of groups, and they could use the same property in various categories. Through discussion, they had to agree on what was the best way to organise the characteristics, both debate and resulting categories can be used later for the analysis of the focus group session.

To measure the satisfaction of the artefacts' characteristics identified by participants, they were asked to answer a Kano Model questionnaire together [9, 13]. The Kano Model helped to determine the perception of each characteristic through the functional and dysfunctional questions and the evaluation table. For each characteristic of the artefact, participants have to answer if they like the property in the artefact (functional question) or if they would like the design if the artefact didn't have this characteristic (dysfunctional question). When the two questions are answered, the evaluation table determines the category (see Appendix VII) of each of the characteristics according to the users' satisfaction [9, 13]. During the focus group session, participants answered the functional and dysfunctional questions together; all of them had the chance to argue their satisfaction for each of the properties. The findings obtained from the focus group session are better described in the *Findings* section.

FINDINGS

An analysis through the perceptions and opinions around the two artefacts has provided clues to define two different characters for community focused eco-feedback systems. The card sorting activity allowed participants to organise the characteristics they had previously identified, and it also gave them the chance to discuss what properties identified an eco-feedback system for communities. Table 2 shows the result of the card sorting activity with the characteristics grouped under each category identified by participants. It is interesting that apart from groups of characteristics that defined eco-feedback systems like *environment* or *learning*, they also created a *community* category. The *community* classifier grouped properties that described a way to strengthen the community sense, and even the *logistics* to make possible an energy community was considered by participants.

The Kano Model questionnaire gave an idea of the satisfaction of the participants around the different characteristics identified. The survey also generated a debate between participants about the various aspects of the artefacts. The list of the characteristics and the categorisation resulted from the questionnaire can be seen in Figure 4. The evaluation table determines the category of each characteristic according to the functional and dysfunctional questions. Characteristics can be classified in 5 different categories: *must-be* properties (1); *performance* properties that are considered as necessary by users and will improve the satisfaction (2); *attractive* properties that are not essential but will get users' attention (3); *indifferent* properties that don't affect users' satisfaction (4); and *reverse* properties, that users would like to have the opposite property and it needs to be turned around to fulfil their satisfaction (5) [13].

Figure 4 shows the result of the analysis of the kano model questionnaire. It has been developed following the evaluation table that defines properties category according to functional and dysfunctional answers. In Figure 4, *reversed* properties have been modified and categorised according to the opposite property. Figure 4 is structured following the Kano model, where satisfaction increases from the bottom-left corner (*indifferent* properties) to the top-right corner (*performance* properties). If *attractive* and *must-be* characteristics are strengthened in future versions of the artefact, the satisfaction of the users will increase [9, 13].

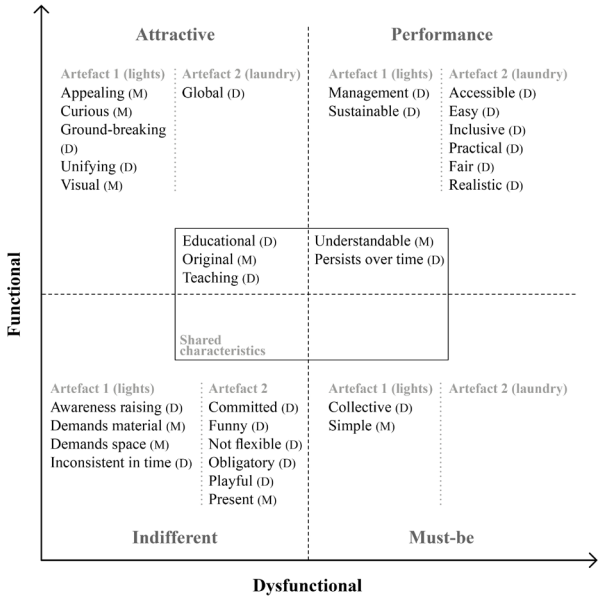

Figure 4. Artefacts' characteristics. (M = Manifest property; D = Dispositional property)

Analysis of characteristics and participants' perceptions resulted in a definition of the character for each of the artefacts. The data visualisation with lights artefact is characterised as the *sparkling*, as participants see it as a unique or attractive tool that also gives information. The laundry planning wood game can be defined as the *committed*; it demands a commitment from the consumers to the artefact but also between neighbours to make better use of renewable energy.

The sparkling

The first artefact (Figure 1 and Figure 2), was described by participants with many *aesthetical* properties. Consumers were surprised about the ground-breaking way of presenting data, which they had never seen before. At the same time, the artefact was easy to understand as it was very visual; participants saw these characteristics as attractive properties, which means that they increase participants' satisfaction:

> "The first thing I would say is that I like the system, I would have expected something more technical (like graphics), but it is very visual and easy to understand at first sight: it's simple: less green means you are doing better." (P5)

Another card that contained many of the properties given to this artefact was the *learning* category. Participants described the artefact as educational, teaching or even that it raised their awareness about building's consumption. At the same time, they thought it was inconsistent in time as they could only see real-time data when they were leaving or entering the building:

> "I think it would be optimal to give historical data to see what behaviour has been within the community on the last day, week or month. If you only see the system when you get into the building you don't know if your performance is affecting it, you don't know if you are having 'good' behaviour." (P5)

This lack of information about their consumption during the day, made them feel that the artefact wouldn't get their attention after some time:

> "Although at the beginning it is interesting because it is very visual, I only pass by through the entrance, and when I do it, I have my mind somewhere else. I feel that after some time, I would forget about the system, and my interest wouldn't be the same as it would in the first days." (P4)

Potential energy community members mentioned that the artefact would become out-of-date over time; they also categorised this property as a *reverse* one. If this characteristic is turned around, it means that participants expect that the artefact should persist over time to get better results within the community.

Participants saw the artefact as a tool "*to unify the community"* (P3), but at the same time, they would like to see how their behaviour is reflected in the lights:

> "I would like to know how my behaviour is affecting the community's behaviour, but if no one else is putting an effort on changing their everyday activities, it would be difficult to see changes on the lights." (P4)

Overall, participants agreed that they "*would change* (their) *habits for the community's good […]. But there are some disadvantages to take into account"* (P3) as sometimes it can be difficult to reconcile it with work life. What it is interesting about the *community* sense of the artefact is that participants see all the characteristics related to members as *performance* and *must-be* properties, which means that they think are essential characteristics for the eco-feedback, and they are already implemented and achieved. These characteristics are fulfilled, and consumers feel they have to be implemented in eco-feedback systems for communities, if the artefact didn't have such characteristics, they wouldn't like it.

To conclude, the first artefact can be characterised as the *sparkling* as it is visual and eye-catching, which results in getting the attention of consumers who quickly understand the meaning of the lights and have an overall idea of building's production and consumption. But although they think they would learn about which consumption activities consumers may change during the day, they believe it is missing historical and detailed information to have a better perception of the changes applied in their consumption activities. When talking about the community, participants felt that a way to see real-time data would help them adapt their activities to the needs of the community. In summary, they would like to know how their individual behaviour is affecting the community's energy to adapt their activities to

balance their consumption with the production for the community's benefit.

The committed

Participants saw the second artefact (Figure 3) as a tool that required consumers being committed to planning laundries together, make the community work as a team to make the best use of renewable energy, and it forced them to follow the schedule proposed in the wood game. All the characteristics related to the commitment of consumers have to do with the community behaviour and the commitment to consumers' demographics and teamwork.

Participants felt that the system was limited for two different reasons. The first one has to do with the information that it gives, as it only enables planning laundries, they thought it wasn't realistic because it is missing a lot of other activities that consume much energy:

> "It is limited because you have to organise your laundry, but it forgets about other consuming activities. I feel that even everyone is doing their best to do the laundry during peak production hours. There is a chance that they don't care about other consuming activities, and they do them when there is not clean energy availability. Data is not realistic in this system; it is limited because it only focuses on washing machines." (P4)

Another reason why participants felt the system is limited, is because if forces consumers plan their laundries daily, but it doesn't take into account unexpected events during the day, which may change their plan. Participants would prefer to book their washing machines weekly and with more flexibility when choosing the concrete hour during the day:

> "What I feel is that it is difficult to plan laundries daily, I plan my laundries weekly. For example, if instead of having a daily forecast, we had a weekly forecast, we could book laundries on Wednesday if it is sunny but not on the other days because it may be cloudy. I would prefer to have a weekly forecast because it would also be easier to organise laundries between neighbours." (P1)

Regardless, this limitation was also seen as a suitable property because "*it forces you to commit to it"* (P4), which can assure that results may be prolonged over time as consumers would have to use it to be able to use their washing machines:

> "I think that this limitation is what makes this system interesting. It is beneficial for the community because it makes people organise themselves and the parameters are very clear. If you do it, you will be able to use the washing machine, if you don't do it you won't be able to use it." (P5)

Another property that participants detected is accessibility. As most of them were young people, they agreed on that it would be easier to plan laundries on a digital platform because the artefact is generating digital data from wood pieces, which makes the process slower and more complicated. On the other hand, they realised that the fact that it is a physical object makes it more accessible to older people who usually don't use digital systems:

> "I also think that it is very accessible because it works with users of any age. For example, I have old neighbours, and it can be difficult for them to use a computer or maybe they don't even have a mobile phone. It is easier for them to use something like this system; it is also inclusive. It doesn't discriminate, and it doesn't make anyone use a technology that may not know how to use." (P3)

On the whole, participants felt that to get results using this artefact, they have to be very committed to the system, which can be a limitation because of the different lifestyle of members in the community but also it takes into consideration all kind of members within a community according to their technical skills, it is inclusive. But at the same time, they thought the system commits itself to the community as it can serve as a tool to help consumers work together. It can create dynamics between them, although they would prefer to plan laundries weekly instead of daily. To sum up, the system can be defined as a *committed* artefact as it establishes a commitment between the artefact and the community and also forces consumers to commit to renewable energy management.

DISCUSSION

Concept revisited

Eco-feedback systems use information awareness to influence a change in consumers everyday life [17, 18], which has been usually done through a norm-oriented framework that relies on society consensus from giving information to users [21]. As it is described in *Related Work*, eco-feedback systems have usually had a focus on individuals. However, a focus on a community has proved that the basis of eco-feedback systems is still giving data to consumers to raise their awareness of energy consumption. An artefact with a practice-theory approach has demonstrated that the use of a practice to influence a change can also achieve good results. At the same time, this practice is held around data that consumers will use.

Comparison has been used in eco-feedback systems for both individuals and communities. It has been proved that the use of comparison has led to undesirable results in eco-feedback projects focused in communities. That is the reason why it hasn't been used in any of the artefacts developed for this project. Instead, cooperation has been strengthened with characteristics like *collective, unifying, inclusive* and *accessible*. According to participants opinion, it looks like these characteristics may help energy community members work as a team, and results may be better as it wouldn't be a competition between consumers. Cooperation would help

consumers organise their activities around energy availability and members' everyday life.

Another thing that has been detected, is that the purposes of eco-feedbacks for individual consumers or energy community members have are different. While individual consumers want to improve their consumption by reducing it or changing their behaviour, energy community members aim to find a way to manage their clean energy availability and make the best use of it. Energy communities' purpose is to use most of the energy they have and not always depend on the main grid, especially during those hours when they have renewable energy supply.

On the other hand, the focus group discussion revealed some properties in both artefacts that were categorised through the Kano Model questionnaire as *reverse* characteristics. These properties didn't satisfy participants expectations for the eco-feedback systems, which suggests that such traits must be revisited to fulfil consumers satisfaction.

Becomes out-of-date

The two artefacts presented to participants had in common that they were placed at the entrance of the building, where all the neighbours can see it every time they leave or enter the building. Participants perceived the artefact's location as an impediment to keep motivated on managing renewable energy. The artefact should be more present for them during the day, especially while they are consuming energy to see how their activities affect the community's energy consumption.

Impractical

Participants considered the *sparkling* artefact as impractical because it visualises real-time data, but consumers can only see it at the entrance of the building. Consumers would have preferred to see data from their apartment. Having real-time data more accessible might give more clues to consumers about instant energy availability and the community's behaviour, which would lead to better energy management.

Regarding the *committed* artefact, participants felt that having to plan laundries in the entrance of the building every morning was a barrier for them. Although participants characterised the artefact as accessible, most of them agreed on that it would be more practical to have a digital system, which would make it easier for them to change the laundry plan if they had any setbacks during the day.

Limited and unrealistic

Both artefacts were characterised as limited and unrealistic because they weren't giving all the information that participants would be satisfied with. One of the reasons why both artefacts were described as limited is because it only gives real-time or daily data, which participants agreed that it could be challenging to manage energy in such reduced information. Participants would prefer to have a more global idea of energy production and consumption within the community.

The artefact that visualises data with lights gave information of the whole community in real-time. This information makes it difficult to see the changes caused by individual behaviours; participants suggested that a historical summary would help them know the community's improvement and keep motivated on making more changes in their everyday activities.

The wood game artefact was only used for planning laundries, which participants felt wasn't representative enough for the community's consumption. Although there are some activities that are difficult to adapt to sun energy production, they would have liked to be able to plan their dryers, dishwashers or other high consuming household appliances to have a more realistic overview of the energy management.

Unfair

Participants assigned this property to the wood game artefact. They manifested that having to plan laundries in a physical object would be unfair for some of the consumers that may have difficulties in their schedule to book laundries or to schedule them during peak production hours.

All these *reverse* properties open opportunities to find those characteristics with which consumers would be satisfied and haven't been achieved on any of the eco-feedback proposals. Although they haven't fulfilled the participants' satisfaction, during the focus group were classified in the *learning* and *community* categories, which suggests that the artefacts are achieving the purpose of using an eco-feedback system for an energy community.

Concept contextualisation

Characteristics chosen and analysed by focus group participants have demonstrated that the two artefacts proposed to fit with eco-feedback motivations, proof of that is that in the card sorting activity participants came up with some categories including *environment* and *learning*. Eco-feedbacks give information about energy to consumers to influence a change in their everyday lives to have sustainable behaviour [17, 18, 27]. Another of the categories defined by participants was the *community* one, where properties like *unifying, inclusive, accessible* or *collective* were grouped. These properties ensure that both artefacts have a focus on an energy community where all the members have to work together to manage their renewable energy availability. Such features need to be reinforced when designing eco-feedback systems for communities because they are the ones that will make sure that the community works as a whole.

The first artefact presented in this project, the *sparkling*, focuses on giving information to consumers. It relies in a norm-oriented theory where "*social organisation is a result of normative consensus and the units of analysis are normative structures, such as values and social rules*" [21]. In this artefact consumers have to interpret the data given and change their behaviour to achieve a more sustainable consumption to work together with other community

members. The focus group proved that most of the properties assigned to this artefact are *attractive* properties grouped under the *aesthetics* category. Aesthetic properties may improve the performance of the system by getting consumers attention, but it is missing other properties that could have a more substantial influence on consumers' behaviour.

The *committed* artefact is focused on a practice theory [21], where the eco-feedback has been focused on changing consumers behaviour through the planning of washing machines activity. The participants' characterisation resulted in a group of properties that are considered as *performance* and *indifferent* characteristics by participants. What it is interesting about these traits is that participants grouped most of them under the *community* category, which proves that a practice approach could be beneficial for the community as it would help them manage together their renewable energy.

The set of characteristics collected in this project are the starting point for designing eco-feedbacks for energy communities. What should be done next is a formalisation of another artefact that takes into account the set of properties and its perception by participants. The findings of this study are limited by the fact that focus group participants were potential energy community members, it would be interesting to test the artefacts in an energy community and study their behaviour during a long period of time. Using the artefacts in everyday life might give influence the consumers in a different way than the assumed in this research, and therefore consumers might give different characteristics to the artefacts.

CONCLUSION

In this project, I have explored the character of two different eco-feedbacks for energy communities. Two artefacts were materialised in a video that was later used in a focus group to gather consumers' perception. Five potential energy community members participated in the group to critique the artefacts and come up with a list of characteristics for each of them. A discussion and an analysis of properties with participants resulted in a character definition for each of the artefacts: the sparkling and the committed.

The findings show that consumers expect that eco-feedback systems for communities have a focus on unifying community members and providing useful information to manage energy consumption together. Although participants appreciated aesthetic characteristics, they manifested that a system with a focus on community and educational properties would have better and longer results.

To conclude, this project establishes an initial set of characteristics that should be taken into account when designing eco-feedback systems for energy consumption, to give consumers the information necessary to manage their renewable energy. As the characteristics have been collected from a discussion with prospect energy community members, it would be needed to develop an artefact that gathers all the properties and analyse how a real community interacts with it to validate the findings of this project.

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Appendix I. Focus Group Research Questions

T1: Demographics and energy consumption	
RQ1: How is the household unit?	Q1: How many members live in the apartment?
	Q2: What is the relation between them?
	Q3: How old are they?
RQ2: How is the building they live in?	Q4: How many apartments are there in the building they live in?
	Q5: Is there a neighbour community in their building?
	Q6: What kind of activities/issues are discussed within this community?
	Q7: Is there something owned by the community? How do they manage it?
RQ3: What is their interest on energy consumption?	Q8: Who is responsible for tracking energy issues?
	Q9: Are they trying to reduce their consumption in any way right now? How?
	Q10: Do they have a system to measure their consumption?
	Q11: Is the system easy to understand and easily accessible? What do they like about it? What not?
	Q12: Have they noticed a change in their consumption since they got the system?
RQ4: Do they have / are they planning to have solar panels?	Q13: Do they have solar panels in their building?
	Q14: Who owns and benefits of them?
	Q15: If they don't have solar panels, would they like to have them?
	Q16: Why haven't they installed them?
	Q17: What do they think are the pros/cons of having solar panels?
T2: Energy Communities	
RQ5: Do they know anything similar to an energy community?	Q18: Have they ever heard about an EC or a similar community?
	Q19: What are its main activities and how they organize them?
	Q20: What is the relation between members within the community?
RQ6: Do they see energy communities as a viable future?	Q21: Would they like to become part of an EC? What would they benefit from joining it?
	Q22: What do they think are the pros/cons of an EC?
	Q23: Can they find other examples of future ECs? How do they think ECs could be organized between members and facilities?
	Q24: Do they think it is a soon future? Why? Why aren't there that much EC out there right now?
T3: Design Proposal – Visualising data with lights	
RQ7: What are the pros & cons of the system?	Q25: What things do they like of the systems?
	Q26: What things they don't like about the system?

RQ8: Do they think such a system could influence a change in their everyday activities?	Q27: Do they think the system can help them be aware of when it is best to consume renewable energy?
	Q28: Do they think the system will influence them to change their everyday habits in order to match their activities to production peaks?
	Q29: Do they think it can be done within a community? How could the community work together in order to get better results?
RQ9: What character identifies the system?	Q30: What do they think are the manifest characteristics (physical) of the eco-feedback?
	Q31: What do they think are the dispositional characteristics (ability or behaviour) of the eco-feedback?
T4: Design Proposal – Laundry planning wood game	
RQ10: What are the pros & cons of the system?	Q32: What things do they like of the systems?
	Q33: What things they don't like about the system?
RQ11: Do they think such a system could influence a change in their everyday activities?	Q34: Do they think the system can help them be aware of when it is best to consume renewable energy?
	Q35: Do they think the system will influence them to change their everyday habits in order to match their activities to production peaks?
	Q36: Do they think it can be done within a community? How could the community work together in order to get better results?
RQ12: What character identifies the system?	Q37: What do they think are the manifest characteristics (physical) of the eco-feedback?
	Q38: What do they think are the dispositional characteristics (abilities or behaviours) of the eco-feedback?
T5: Design proposals character	
RQ13: What characteristics difference the 2 proposals?	Q39: What groups of characteristics do they identify in the characters they have given to each proposal?
	Q40: For each group, what is the characteristic of each proposal?
	Q41: Do they identify more characteristics now for both proposals? Which are them? How can they group them?
RQ14: Which of them they think could influence them the most?	Q42: Which of the characteristics identify they think would influence more their everyday life? Why?
	Q43: Do they think the changes that they can cause will last or it will be also a motivation at the beginning?
	Q44: Are there any other characteristics they think could have a greater influence than the other found in the two design proposals?

Appendix II. Focus Group Guide

Presentation (10 min.)

At the beginning of the workshop it will be necessary to explain to the participants how it will work. Inform them that the workshop will be filmed and what is the purpose of the study. In order to conduct the workshop, participants will need access to internet and a google account to be able to perform some of the activities.

T1: Demographics & energy consumption (15 min.)

The first activity of the workshop will be an icebreaker to let all the participants meet each other and to collect demographic information about them, but also to find which is their interest in energy consumption and their actual activities around it.

- **Questionnaire:** to get all that information that is more personal (RQ1 and RQ2 from the table below), participants will have to fill a questionnaire. It will be a very simple questionnaire that will also help them start focusing on the workshop. The tool used to do the questionnaire will be Google Forms (5 min.).
- **Presentation**: each participant will have 2-3 minutes to introduce themselves and explain what their interest in energy and solar panels is (RQ3 and RQ4) (10 min.).

T2: Energy communities (20 min.)

We will start with the first video visualization in order to introduce participants to energy communities' concept and to help understand it better.

- **Discussion**: this time the activity will be an open discussion between participants in order to answer their questions and to reflect about the concept, see what their opinion about it is and if it they see it as a viable future (RQ5 and RQ6) (15 min.).

T3: Design proposal – Visualising data with lights (25 min.)

When they have understood what EC are, we can watch the first design proposal video.

- **Discussion**: we will start with a short open discussion to warm up and give the first thoughts of the topic (RQ7 and RQ8) (10 min.).
- **Character definition**: the participants will have to give characteristics to the design, they have to be manifest and dispositional characteristics (RQ9). The words they give will be written down for a later activity (10 min.).

T4: Design proposal – Laundry planning wood game (25 min.)

After the first design proposal activity we will do a similar process for the second design proposal.

- **Discussion**: we will start with a short open discussion to warm up and give the first thoughts of the topic (RQ10 and RQ11) (10 min.).
- **Character definition**: the participants will have to give characteristics to the design, they have to be manifest and dispositional characteristics (RQ12). The words they give will be written down for a later activity (10 min.).

T5: Design proposals character (25 min.)

Once a list of characteristics has been created for each design proposal, it is time to organize them. It is how I think we will be able to give value to these characters.

- **Card sorting**: although card sorting is usually used to define the architecture of websites, I think it can be a good technique to organize characteristics. Similar characteristics can be grouped under more general topics which will give us an idea of which are the different ways to design a part of the object we are working with (RQ13). The tool we are going to sort cards will be Google Slides by creating text boxes representing cards (15 min.).

- **Kano model**: Kano model is used to measure customer satisfaction taking into account design characteristics. I think it can be interesting to use a model like that to get feedback about what of the characteristics defined before are satisfying more the users (RQ14). In order to do it, it will be necessary to create a questionnaire (using Google Forms) where they will have to grade the different characteristics and the result will categorization of the characteristics according their satisfaction level, as a result we will have different groups of characteristics and they will be organized according to satisfaction. This activity will also serve as a closure activity as it can be a summary of the work done before (10 min.).

Appendix III. Participants

Participants	Demographics	Building	Neighbourhood community
P1	P1: 29 years old Electrical engineer Flatmate: 29	Building with 3 apartments	There is a neighbourhood community in the building, they meet every 3 months and manage common areas, parking, cleaning… The community owns an outdoor patio that all households can use, if there is any misunderstanding, they try to approach it together. It is a small community and they don't have many conflicts.
P2	P2: 25 Designer Parents: 59, 59 Sibling: 27	Building with 29 apartments	They do neighbourhood meetings quite often. There is mezzanine where the building doorman used to live, now it is owned by the community and they rent it. The money they get from the mezzanine is used to cover community expenses.
P3	P3: 57 Retired personal trainer Partner: 60 Child: 23	Building with 7 apartments	The neighbourhood community meets at least once a year, and more often if it is needed where members can expose proposals. Families share a terrace that is managed together within the community.
P4, P5	P4: 23 Teacher and physicist P5: 30 Developer (partners)	Building with 29 apartments	There is a neighbourhood community with which they meet quite often, there isn't anything owned by the community, they only manage together common areas (like the entrance or the stairs).

Appendix IV. Focus Group Transcription

T1: Demographics and energy consumption

M - RQ3: What is their interest on energy consumption?

M - RQ4: Do they have/are they planning to have solar panels?

P4 - I'm interested in renewable energy as I think it is important to change from the more "traditional" consumption system to a renewable energy system. I have never thought about installing solar panels in the building I live in, but I am really interested in the topic.

P5 - I'm not sure about what is my interest in renewable energies, but I do think it is a current topic or at least our society should be concerned about it.

P2- I am interested on the topic, but as I live in the centre of Barcelona, I have never thought about installing solar panels in the building I live in, because I think it is a bit complicated. I think there should be a general concerning within our society to move to a more sustainable energy system.

P1 - I am interested in renewable energy as I am an electrical engineer and I have been always interested on renewables. I think it is important to move to this reality in the future, and I think that it would be very interesting that every building could have its own solar panels as it would be a way to put such technology closer to the consumers. I think that the energy is starting to move to this direction, and we should work on it.

P3 - I used to work as a personal trainer (which has nothing to do with sustainability) but I am very interested in taking care of the environment, that is why I have an ecological garden. I am also interested in participating in activities concerning sustainability and I think renewable energy is one of those activities.

T2: Energy communities

M - RQ5: Do they know anything similar to an energy community?

M - RQ6: Do they see energy communities as a viable future?

P5 - I honestly think that the topic doesn't seem something very innovative or complicated but at the same time I don't know any project like that, where a community organize themselves to generate renewable energy. I do know individual people or companies who have solar panels, but I don't know any community

P3 - In my case, I don't know either any community, but it is something I would have within my neighbourhood community. On the other hand, I live in a 7 apartments building where some of the neighbours are resistant to changes, for example some time ago we wanted to install a lift and we couldn't agree on it, shared solar panels would be even more difficult to negotiate.

P4 - All the people I know that owns solar panels (which I understand is the easiest way to produce renewable energy in a city) live in a house, and they use it for their own consumption needs individually. Recently I realized that there are a lot of new buildings with solar panels in the city, which I think is because of law. From what I have heard, new buildings have to produce a minimum amount of renewable energy, although I am not sure how they use and manage this energy. About the pros and cons of such communities, I think that it is obvious that using solar panels benefits the environment. The cons I see in solar panels are that if you don't, we are not home during the more productive hours, we are "losing" this energy, and if we need energy at night, we have to pay for it from the main grid. I feel you have to do a big investment for the solar panels, but you can't use 100% of the energy you produce if you are not home during peak hours. From my point of view, it is more "comfortable" to pay for energy from the main grid and be sure that I can use it at any time.

P2 – As many of you have said, I also know individuals that own solar panels, and also some institution like a school, but never in an apartment block. I feel that it requires a big investment at the beginning and people

are reluctant to it right now, the benefits of such installations are long term benefits. What I think is not that good from solar panels is that the hours when we need more energy are not the same hours when solar panels are being more productive. I feel it can be a good investment, but small details make people reluctant to purchasing such energy systems.

P5 - About energy excess from solar panels, I understand that energy not consumed is sent to the main grid but probably you will get something back (which I don't know what it is). Knowing how electric companies work, I'm not sure if is there any benefit for individual renewable energy producers, it is probably complex.

P4 - I know that the company we have contracted is supposed to work with renewable energy. I am not sure if the energy we are consuming is renewable, but I know that they have committed to produce the same amount of clean energy as their customers consume. It is not an energy community, but it is a way for companies to make up for energy consumption.

P3 - The company I have contracted works with renewable energy. They use wind power, solar power and biomass to cover 63% of the energy they sell.

M - What do you think would be the benefits of doing that activities in a community?

P4 - In an apartment block I understand that the investment would be divided between neighbours and that there would be more surface to use for solar panels, and in consequence more clean energy production.

P5 - About sharing, it would not only be the initial investment but also there would be more chances to use that energy in different hours of the day. Resulting in more chances to use energy produced. If it was an individual installation, if the owners are not home at midday a lot of energy would be lost, but in a shared installation there are more chances that there will be people in the building during solar panel productive hours.

P3 - From my point of view, I feel that governments should promote such installations. For example, I have a friend from Switzerland who told me that in her country there are a lot of solar panels, and she is surprised that here in Spain we don't use them that much (taking into account that we have a lot of sun hours during the year). How is it possible that we have a lot of sun hours and hardly solar panels?

P1 – As an expert on the topic I would like to answer some of the questions generated. Until some months ago, in Spain there was a law that banned installation of solar panels for self-consumption. It is difficult to see solar panels in Spain because of that reason, but it wasn't forbidden by law in other countries like Holland. There was the "sun duty" which asked people who was connected to the main grid (obligatory by law) but who also had solar panels to pay an extra amount of money. Electrical companies were asking for that consumers to pay for a "transportation fee". This law is now out-dated, but it's being difficult for citizens to see the real benefits of self-producing clean energy. Apart from the initial investment, if they try to sell clean energy to the main grid, the money they get for it is very low and it is more profitable to use as much of the energy they produce as possible for it to be profitable. This is where I think communities could make a different, if you can't use energy while it is being produced maybe your neighbour will do it and this way you will be "saving money". At the same time, I think solar panels within communities could help to cover those energy used by all the community (like elevators, water pumps…), but I feel that the hours when we consume the most are at morning and at evening and it would be difficult to cover this energy demand with solar panels.

T3: Design Proposal – Visualising data with lights

M - RQ7: What are the pros & cons of the system?

M - RQ8: Do they think such a system could influence a change in their everyday activities?

P5 – The first thing I would say is that I like the system, I would have expected something more technical (like graphics), but it is very visual and easy to understand at first sight: it's simple, less green means you

are doing better. But I am not sure if I would pay it attention after some weeks because it looks interesting at the beginning but you only see it at the entrance of the building, I would like to see the information from my apartment too to see how my consumption affects to the consumption of the building.

P2 - I agree with P1 about that I would like to see the lights from my apartment, not only in the entrance of the building. Some questions have come to my mind while watching the video: can you see your own consumption or is it always the community's consumption? Can you see your behaviour reflected on it if you are having a "good" behaviour? (like cooking all the meals at midday or doing the laundry at noon). If I make a change in my behaviour, but my neighbours don't make it, I will still see the same lights but my performance won't be reflected. Another thing that comes to my mind is how would we divide monetary expenses between neighbours (talking about energy from the main grid), if I am adapting my schedule to consume during more productive hours but my neighbour can't do it because of his/her working hours, should we pay the same? I like the design itself because it is very easy to understand but there are these questions that emerge from it. How can I know if I'm doing the right changes? It has a very positive aspect because it helps people being conscious of the environment, which our society should be more concerned about. A system like that would help us having common objectives but each of us has different needs.

P3 - On my case, I think I would change my habits for the community's good and I think I would pay a lot of attention to the eco-feedback. However, I see a handicap on it: it is very difficult to reconcile it with working life because, like me, if you have a strict schedule it is very difficult to change your everyday activities to match them to the solar panels' productive hours. I think it is a good idea for the community and for the environment but there are some handicaps to take into account.

P4 – This system makes me think of the faculty I studied in, there were solar panels installed in the building and at the entrance there was a small device that gave information about how much energy was being generated. The thing is that, although I studied there for 4 years, I only looked at this device twice. What I feel is that something similar would happen with this eco-feedback. Although at the beginning it is interesting because it is very visual, I only pass by through the entrance, and when I do it I have my mind somewhere else. I feel that after some time, I would forget about the system and my interest wouldn't be the same as it would in the first days. Graphically it is very clear because you can understand easily what is going on but after some time it would become unfashionable. I agree with P2 about the individual information, I would like to know how my behaviour is affecting the community's behaviour but if no one else is putting an effort on changing their everyday activities it would be difficult to see some changes.

P2 - I understand that lights represent real time data, but it would be interesting to have an individual follow up or some way to give tips to neighbours, like can you change some activities to have a more sustainable life-style or what activities can you move to adapt them to peak hours. I would like to see a list of proposals or helping guides to know how to make the best use of the solar panels. I also think that it could have a positive reinforcement to those people who are having a "good" behaviour, humans react to positive reinforcements and we are always challenged to have a better performance if we get something back from it (like a prize), it could be like a game where you go through different levels.

P5 - I think it would be optimal to give historical data to see what behaviour has been within the community on the last day, week or month. If you only see the system when you get into the building you don't know if your performance is affecting it, you don't know if you are having "good" behaviour.

P1 - Imagine that everyone gets back to the building at 3 pm and sees that there is a lot of energy to consume and all of them decide to use the laundry, that would be a problem of having real-time data and that is why I don't think it is a good idea for it to be instant. It is better to give information from the past to help neighbours plan their activities. It could be a planning between all the households, plan together how can they divide peak hours. At the end you would know if the community is having a good behaviour or not.

P4 - I understand that all the members of the community would be participating in the project, and that all of them would have the same awareness to environment and a common objective, then I think this system would help them because all of them would be working for the same purpose. The problem I see here is if some community members are less interested than the others, then it would be very difficult to see an improvement in the community consumption because not all the households will be having the same interest on it.

P5 - If all the community members have the same interest in the project, after listening to P1, I now see clearer what we have talked before: the coordination between members according to available data. Having historical data and more detailed data, households would be able to agree on how to manage the energy available to use as much as clean energy as possible and depend less on the main grid.

M - RQ9: What character identifies the system?

P4 - I'll start saying that it is easy to understand: it is **easy to understand**. On the same direction I would say it is **visual**, it catches your attention while there are other information systems that you can't even notice.

P5 - I would say it is **easy** to understand or **simple**.

P4 - I think that it is instant but I'm not sure if it is a positive thing because you see it at the moment but at the same time it is negative because you don't have a picture of the global consumption, I could say it is **inconsistent in time**.

P3 - For me it is also easy to use, understanding.

P2 - I'm trying to come up with physical properties, but what comes to my mind is that it needs a place where all the installation needs to be placed, it **demands a place** where all the **material** needs to be installed (focus, wall…), but I can't choose a word for it.

P4 - I'm now thinking that maybe it is not important, but if you have this system at the entrance of the building during all day (even at night), you are consuming energy that you haven't generated, **the artefact has its own consumption**. It is a bit contradictory here, if you need to project the lights at midday you will probably have enough clean energy for the system, but at night you will have an extra consuming activity.

P3 - At the same time, I think it is **sustainable**, as any other renewable energy systems pretend to be.

P4 - I think that we could also say that it aims to make people aware of their consumption, I can't come up with a word to describe it but we could say that it **raises awareness**.

P1 - A property I have come up with is that it is **collective**, it can be used by more than one person. There is something that a group of people needs to do together to use it.

P3 - I agree, it is another reason to **unify** the community, there are many neighbourhood communities that are not unified. However, in my community all the members are unified, but I think it could be another thing that would help us maintain this connection between us.

P5 - I'm not sure which word I could use (talking about physical properties) but I really liked the design, I think it is visual, striking… maybe **appealing** is the word.

P4 - About the dial that can be seen at the end of the video, I think it is ok to have it but I can't see the utility of it. It goes together with what I have said before, if you have it at the entrance of the building you will look at it the first two days, but on the third you will probably forget about it. I don't know if there is an adjective for it, but I think it **becomes out-of-date**. Getting used of it makes you forget about it.

P1 - Yes, I agree. I feel it can be like a picture that after some time you don't remember what red means, maybe you forget about the meaning of the colours, I am not sure how to explain it.

P3 - I think I wouldn't forget about the colour coding, everyone knows that red is a "bad" thing. I think colours make it easy to understand, they make it easy to understand.

P1 - Yes, that's true. We all know that green means "good".

P2 - I would like to add that it is teaching somehow.

P4 – Yes, this can be related what I said before with the dial, maybe I was looking at it on the negative opinion. It is "teaching" but I don't see the utility of the dial but probably you can get some knowledge from it as *P2* says.

P1 – I agree on that it is educational because it is somehow teaching people how to change their habits.

P4 – It is curious, I think that if you have that system at the entrance you will "forget" about it after some time, but if someone from outside the neighbourhood comes into the building and sees it, they might think it is curious and it could give ideas to them to bring something similar to their neighbourhood community.

P3 – Other properties we haven't mentioned could be ground-breaking and original.

T4: Design Proposal – Laundry planning wood game

M - RQ10: What are the pros & cons of the system?

M - RQ11: Do they think such a system could influence a change in their everyday activities?

P4 - What I think doesn't make much sense is that it is a digital system, but you have to put a wood piece in order to send the information the de DB. I think it would make more sense to make it all digital with an app without the need to use wood pieces. For example, you could have a forecast in your phone and through an app you could book your washing machines, it would be the same but digitally. I don't see the need to have something physical at the entrance of the building.

P2 - Another inconsistency I see on it is that because of the COVID-19 we can't go outside it would be annoying (now) to go to the entrance of the building to book a washing machine if you have the machine at your apartment. I understand that it is an unusual situation and that in a future it won't be like that anymore. Another thing is that I usually plan my laundries weekly because I only need to do one or two laundries every week. I would prefer to plan my laundries for a week other than every day, and maybe we could book the whole day instead of a concrete time in the day.

P4 - What I see is that laundry planning system is that when I have to do it, I haven't planned it previously, I just see that there are a lot of clothes that need to be cleaned. I don't plan it, and if sometimes I have done it, I usually forget about it. About planning, it can be a handicap although we have good intentions: for example sometimes I decide to go running at the afternoon and maybe I'll need to the laundry after that, but at morning when I planned the laundries I didn't think about going running and I haven't booked any washing machine today. It can be difficult to plan laundries because sometimes you don't plan your activities during the day. Another thing is that doing a washing machine takes some time: waiting for it to finish and then dry it, and if I want to have a "good" behaviour I should schedule my washing machine at midday because it is when there will be more clean energy, but maybe it is difficult for me to do it at midday because I'm working and I'll have to do it at evening when I'm back home and there is not renewable energy.

P5 - One of the inconvenient I see in this system is that all the neighbours have to agree and be open to organize washing machines together. It is difficult to be fair with everyone taking into account that each of us have different working schedules and it would be ideal to do the laundries at midday. As *P4* said, doing the laundry is a time-consuming activity and not everyone can change their schedules during the week to much peak energy production hours with their job. I feel that it is difficult to do laundries at midday because you need at least 1 or 2 hours, it would be easier with the dishwasher because you can start it and it doesn't matter if you empty it 8 hours later, dishes won't become stinky while clothes will.

P4 - What I am thinking now is that it was an app it would be possible to add the function to book dishwashers as it is also a high energy consuming activity.

P1 - What I feel is that it is difficult to plan laundries daily, I plan my laundries weekly. For example, if instead of having a daily forecast we had a weekly forecast, we could book laundries on Wednesday because it is sunny but not on the other days because it may be cloudy. I would prefer to have a weekly forecast because it would also be easier to organize laundries between neighbours. I also agree on that it would be easier to have an app instead of a wood game, but at the same time maybe there is someone in the community that because for some reason can't have an app. Having the Wood game would enable everyone planning laundries without the need of having a display or connection to the internet.

M - RQ12: What character identifies the system?

P2 - I think it is a **funny** system, it is very **playful** because you can play with the pieces and at the same time it is very **easy** to understand: you have you pieces, you identify yourself and they you put it in the time-slot you want to use your washing machine. You can see easily what hours are booked and which not.

P4 - On the other hand, I think that the fact that you have to use the wood pieces is **impractical**.

P3 - I think that as any other routine, you have to get used to it.

P1 - The fact that you have to use the pieces makes it affordable or it is something that you won't forget about because it will always be there, if it was an app it would be easier to forget about it. This system is more **present** because if you want to do the laundry you have to use it for sure.

P4 - I think that it is **limited** in the way that if you haven't booked a washing machine, you won't be able to do it. At the same time, maybe you booked a washing machine but because of some drawbacks during your day you "lose" your time slot and you have to book it on another time again. It is **limited.**

P5 - I can't come up with an adjective to describe it, but I think that this limitation is what makes this system interesting. It is beneficious for the community because it makes people organize themselves and the parameters are very clear: if you do it you will be able to use the washing machine, if you don't do it you won't be able to use it.

P4 - Then we can say that we have to be **committed** to it. It forces you to have a commitment to it.

P3 - It is also **original**; I have never seen something that gives information about energy or washing machines at the entrance of a building. It is very creative.

P5 - I agree, the fact that it is not an app makes it **accessible** to all the members of the community.

P4 - As we have said before, it is **educational**. You can see the energy forecast every day and you can decide if you are going to do the laundry using clean energy or not, you learn how to manage the clean energy you have and the use you make of it. It is educational even if you get bored or tired of it, but it also can be educational for visitors to your building, they can also learn from it.

P2 - I also think it is accessible, but it has a negative side. Because of routines there will always be someone who is the first to book their washing machines, this person will always have the chance to book any time in the box, while the last one will have less chances to choose the time they prefer to do the laundry. Although neighbours talk between themselves about it, the system will always be "**unfair**" to someone. A possible way to solve this would be to do a weekly planning where neighbours can distribute better the washing machines and give the chance to everyone to use clean energy from solar panels.

P4 - I agree on that this could be solved with a weekly planning, washing machines would be organized better and all the neighbours could agree on this planning.

P3 - I also think it is very accessible because it works with users from any age. For example, I have old neighbours and it can be difficult for them to use a computer or maybe they don't even have a mobile

phone. It is **easier** for them to use something like this system, it is also **inclusive**. It doesn't discriminate and it doesn't make anyone use a technology that may not know how to use.

P1 - Another adjective I would give to it is that it is **obligatory**, the fact that you can't do the laundry if you haven't putted the piece, makes it obligatory in some way. If you had the chance to not follow your planning, after some time you might forget about it and you wouldn't make the best use of clean energy.

P4 – It is limited because you have to organize your laundry, but it forgets about other consuming activities. I feel that even everyone is doing their best to do the laundry during peak production hours, there is the chance that they don't care about other consuming activities and they do it when there is not clean energy availability. Data is **not realistic** in this system; it is limited because it only focuses in washing machines.

T5: Design proposals character

M - RQ13: What characteristics difference the 2 proposals?

P4 - Simple can be either a positive or a negative thing. For example, in the first design proposal we all agreed on that the lights were excessively simple and the information it gives is too limited, simplicity makes it very visual and easy to understand but it is too simple.

P5 - To sum up, it is a tool to educate in social values rather than energy consumption.

M - RQ14: Which of them they think could influence them the most?

Appealing

P4 - I can live with it if it is not appealing, I prefer if it is useful rather than if it is appealing.

P5 - I would say I don't care. For example, I wouldn't say a washing machine is appealing, but it does its function and I don't care if it is pretty or not.

P4 - What it is important is that it gives the information, I would say that if it isn't appealing, I don't like it.

P5 - It isn't the same that a washing machine is appealing or that an app or system is pretty. I wouldn't stop using something because it isn't "fashion".

P1 - But at the same time if you had to buy something very ugly you would consider not buying it for this reason.

P4 - If something isn't appealing it doesn't make it less useful.

Simple

P4 - It depends on what you are expecting from the system. For example, the light colours eco-feedback is "cool" and easy to understand, but at the same time it is too simple to give all the information and I would need more data to make a change and improve my consumption.

Collective

P4 - If it is not collective it doesn't make sense to talk about an eco-feedback for a neighbourhood community.

P1 - I agree, what is important here is that all the community members collaborate. Even if some members are not that interested as others, we should have the same goal.

Becomes out-of-date

P5 - I don't like it because you shouldn't forget about the system after some weeks, the system would be losing its functionality. I want it to remain interesting over time to have a better improvement in my behavior according to energy consumption.

Not very flexible

P5 - On the one hand I think it is something positive because it makes sure that it is working overtime, but on the other hand there are other ways that this could be done.

P1 - It can limit you but at the same time it is forcing you to make a change to a "better" behaviour.

Obligatory

P5 - For example, in the second design proposal it is obligatory to book a washing machine to use it. I think it is something positive because it forces the community to follow a plan that they have done together.

P2 - I also expect it to be obligatory because if you design something that people is not going to use after some weeks, I don't see the utility of it.

Easy

P3 - If it is something for a community, I think it has to be as easier to use as possible because not everyone has the same capacity to assimilate new knowledges. You have to think that there is people who will understand it at the first sight but others who won't, it can be a problem. I don't like things that are complicated to understand.

Unrealistic

P1 - The more realistic the better, because then you have a global understanding of the consumption and then you can make better improvements.

Funny

P5 - If it results that this system makes boring things funny (like laundry) it could help consumers be more interested on having a better behaviour around energy consumption and maybe this way they are interested on it during a long-term period.

P1 - At the same time, if it is obligatory, maybe it will be more boring.

Playful

P4 - When talking about playful and funny, I think they don't make sense if the system is not useful. They are conditioning the usability of the system.

Present

P4 - I'm quite neutral here, but it depends on the neighbourhood community and the resources of each of the members. It if is a community with older people who don't know how to use mobile phones, I think it is interesting that it is present. But if I'm thinking of myself using it I wouldn't care because I know how to use such technologies.

P1 - I think that if it is present every time you enter the building, it will make you remember about it and then you will use it for a longer period of time.

Committed

P1 – I think that it has to promote a commitment within community members because it is the way you will get engagement to the project.

P3 – I agree, but at the same time I think that there is people that although they would like to be committed it is difficult for them because of work schedules. Maybe they have the motivation, but it is complicated for them to collaborate and being committed to the project.

Appendix V. Design Proposals Characteristics

Design Proposal – Visualising data with lights

Manifest characteristics

- Appealing
- Understandable
- Curious
- Demands material
- Demands space
- Original
- Simple
- Visual

Dispositional characteristics

- Artefact's own consumption
- Awareness raising
- Becomes out-of-date
- Collective
- Educational
- Ground-breaking
- Inconsistent in time
- Management
- Sustainable
- Teaching
- Unifying

Design Proposal – Laundry planning wood game

Manifest characteristics

- Understandable
- Original
- Present

Dispositional characteristics

- Accessible
- Becomes out-of-date
- Committed
- Easy
- Educational
- Funny
- Impractical
- Inclusive
- Limited
- Not very flexible
- Obligatory
- Playful
- Teaching
- Unfair
- Unrealistic

Appendix VI. Card Sorting Result

Environment
- Artefact's own consumption - Awareness raising - Management - Sustainable

Aesthetics
- Appealing - Becomes out-of-date - Curious - Funny - Ground-breaking - Original - Playful - Visual

Social			
Learning		Community	
Positive	***Negative***	- Accessible - Awareness raising - Collective - Committed - Inclusive - Obligatory - Playful - Unfair - Unifying	***Logistics***
- Easy - Educational - Funny - Understandable - Curious - Present - Simple - Teaching	- Impractical - Inconsistent in time - Simple - Limited - Not very flexible - Unrealistic		- Accessible - Collective - Demands material - Demands space

Appendix VII. Kano Model Result

Evaluation Table

Functional (feature present) \ Dysfunctional (feature absent)	Like It	Expect It	Don't Care	Live With	Dislike
Like It	Questionable	Attractive	Attractive	Attractive	Performance
Expect It	Reverse	Questionable	Indifferent	Indifferent	Must-be
Don't Care	Reverse	Indifferent	Indifferent	Indifferent	Must-be
Live With	Reverse	Indifferent	Indifferent	Questionable	Must-be
Dislike	Reverse	Reverse	Reverse	Reverse	Questionable

Data obtained

Accessible		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Dislike	Performance
Artefact's own consumption		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Live With	Like It	Questionable
Appealing		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Live With	Attractive
Awareness raising		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Expect It	Don't Care	Indifferent
Becomes out-of-date (reversed: persists over time)		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Dislike	Like It	Reverse
Like It (reversed)	Dislike (reversed)	Performance
Collective		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Expect It	Dislike	Must-be
Committed		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Expect It	Don't Care	Indifferent

Curious		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Live With	Attractive
Demands material		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Live With	Don't Care	Indifferent
Demands space		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Live With	Don't Care	Indifferent
Easy		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Dislike	Performance
Educational		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Live With	Attractive
Funny		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Don't Care	Don't Care	Indifferent
Ground-breaking		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Don't Care	Attractive
Impractical (reversed: practical)		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Dislike	Like It	Reverse
Like It (reversed)	Dislike (reversed)	Performance
Inclusive		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Dislike	Performance
Inconsistent in time		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Live With	Expect It	Indifferent
Limited (reversed: global)		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**

Live With	Like It	Reverse
Like It (reversed)	Live With (reversed)	Attractive
Management		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Dislike	Performance
Not very flexible		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Don't Care	Don't Care	Indifferent
Obligatory		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Expect It	Live With	Indifferent
Original		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Don't Care	Attractive
Playful		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Don't Care	Don't Care	Indifferent
Present		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Expect It	Live With	Indifferent
Simple		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Expect It	Dislike	Must-be
Sustainable		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Dislike	Performance
Teaching		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Live With	Attractive
Clever		
Functional (feature present)	**Dysfunctional (feature absent)**	**Category**
Like It	Dislike	Performance
Unifying		

Functional (feature present)	Dysfunctional (feature absent)	Category
Like It	Live With	Attractive
Unfair (reversed: fair)		
Functional (feature present)	Dysfunctional (feature absent)	Category
Dislike	Like It	Reverse
Like It (reversed)	Dislike (reversed)	Performance
Unrealistic (reversed: realistic)		
Functional (feature present)	Dysfunctional (feature absent)	Category
Dislike	Like It	Reverse
Like It (reversed)	Dislike (reversed)	Performance
Visual		
Functional (feature present)	Dysfunctional (feature absent)	Category
Like It	Live With	Attractive

Categorisation plane