ebalanceplus

Methodology for user engagement in energy literacy and flexibility

Disclaimer: This deliverable has not yet been approved by the European Commission and should be considered a draft

AUTHORS : JAROSŁAW KOWALSKI ; ZBIGNIEW BOHDANOWICZ ; PAWEL KOBYLINSKI ; BEATA ŁOPACIUK – GONCZARYK, CEZARY BIELE

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Introduction

This deliverable presents methodology and guidance for building engagement and energy literacy among end-users of the functionalities and technological solutions developed within the ebalance-plus project.

Some of the activities suggested within this project will require the active participation and consent of electricity consumers to the release of energy flexibility. This represents a change from the current pattern of electricity use; presently, electrical energy is perceived to be easily accessible commodity. Changes in energy-use habits could be met with resistance from end-users; without their active participation, the potential of the energy consumption flexibility concept cannot be fully realised.

In designing mechanisms to build engagement, we placed them in a broader context - psychological and sociological. The technology we are trying to encourage people to use is here an element of a broader system - intertwined with a network of social roles, values, needs and motivations of individual users and groups.

The deliverable commences by presenting knowledge attained by social psychology and experimental economics concerning motivation, decision making, and information processing mechanisms. It also offers a detailed description of the concept of engagement activities that can be performed on college and university campuses.

Next, these findings on energy users' motivations are supplemented by qualitative insights from three workshop sessions involving students and staff of demo site university campuses (in Malaga, Spain and Calabria, Italy) and with the expert knowledge of ebalance-plus project partners. Detailed descriptions are presented of electricity end-user personas and potential methods of engaging them when ebalance-plus solutions are being implemented on the market.

The content of this deliverable is also partially based on data collected during surveys conducted as part of the ebalance-plus project and the expert knowledge provided by the members of the ebalance-plus consortium. The participants included individual electricity consumers in France, Spain, Denmark, and Italy, as well as university facilities managers in France, Italy, and Spain. Based on this data, distinctive user groups were identified and described.

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1 Decision-making, motivation, and the formation of social behaviour

1.1 ebalance-plus functionalities from users' perspectives

The motivation and engagement of ebalance-plus users must be studied with consideration for their own perceptions of the system. The fundamental questions are: what is this system from the user perspective, and how do they perceive it?

For institutional stakeholders - such as distribution network operators, transmission system operators, and facilities managers—ebalance-plus is an innovation that carries the potential to increase revenue streams and to respond promptly to government and EU energy policy. For these stakeholder groups, the essence of the system lies in its technical performance, reliability, efficiency, and ability to meet the standards set. It should not be forgotten, however, that in addition to the user groups mentioned above, the operation of systems such as ebalance-plus also impact the end-users of electricity. In the case of university campuses, this group includes students, academics, and administrative staff.

For consumers, the system alters the experience of using electricity to some extent. In the classical paradigm, electricity is a background service that is used when needed. Reflexivity and reflection are scarcely present; in fact, they are limited to deciding whether or not to switch on particular appliances (and consume electricity). Systems in which consumers' decisions are based on flexibility allow a degree of autonomy to be enjoyed by digital devices. This serves to modify the paradigm of energy use. For some functionalities, end-users will have to decide whether or not to transfer autonomy to systems. Another decision pertains to the degree of autonomy to be delegated.

This change is relevant for users, as it may sometimes involve inconvenience (for instance, postponing power-consuming activities), or reduced comfort when autonomous systems reduce space heating or cooling to make more rational use of cheaper, greener, and more easily accessible energy.

In summary, the new paradigm of electricity use is a **change for consumers**: from a status quo in which calculating the benefits and optimality of decisions is unnecessary; to one in which decisions must be made actively and involve cognitive loads. It is also a change that can entail a decrease in comfort.

The default course of action is to continue operating within the established paradigm. This means that when faced with choices—such as whether to actively engage in a system like ebalance-plus, or whether to sacrifice some autonomy—users are likely to opt to maintain their old habits, as they are less cognitively burdening. When electricity is not noticeably less expensive, individuals must be motivated further and engaged to sacrifice some of their autonomy.

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1.2 Decision-making from a psychological perspective: System 1 and System 2

Humans encounter difficulties making decisions, as they always involve a cognitive load (Kahneman, 2011). ‘System 1’ and ‘System 2’ are the names given by psychologists to the primary methods that humans use to process cognitive loads (Stanovich & West, 2000).

System 1 operates outside of consciousness, and works rapidly. We use it when brushing our teeth in the mornings, selecting our favourite drinks from vending machines, or driving our children to school by the same route every day – we perform such tasks reflexively. System 1 works automatically, and does not require active mental effort. It is also rapid and low in energy cost (meaning that the brain burns less glucose). Additionally, it helps us to determine the emotions of our interlocutors: when they are angry, we recognise it immediately, and it is unnecessary to consciously analyse the tones of their voices or the shapes of their eyebrows. We utilise this type of thinking when swift decisions are necessary – for instance, we tend not to think whether we should stir cups of coffee clockwise or anticlockwise. System 1 is based on what we have done in the past – a set of rules for a simple game. If we have always done something in in a certain way, we will continue to do so until something in our environment necessitates a change.

Contrarily, System 2, comprises the reflective functions of our minds. It might be activated when performing calculations, learning to play new musical instruments, or memorising the capital cities of countries on other continents. System 2 is used when acting automatically is unviable, when previous ways of acting become inadequate, when conditions change, or when there is a need to make a ‘profit and cost’ analysis. It is used consciously, demanding concentration and time. It also consumes much more of the brain’s energy; the brain prefers, when possible, to utilise System 1 (Gailliot et al., 2007; Gailliot & Baumeister, 2007).

One consequence of this tendency is that some actions and activities, when repeated often, move from the area of conscious incompetence to that of unconscious competence. When we learn to drive, all of the activities it entails require high concentration (System 2); we later are able to do more of the activities automatically and unconsciously (System 1). Psychologists have identified many types of such ‘cognitive automatisms’ (heuristics), which are used by our cognitive apparatus to facilitate and accelerate choices. Below, we describe some of these, in the belief that they may prove useful in designing mechanisms to help engage users of the ebalance-plus system.

1.3 Priming

Priming is the phenomenon whereby increasing the cognitive accessibility of an idea increases the probability it being implemented in the near future. Priming has been observed by sociologists during pre-election research; merely asking whether individuals would go to the polls increased the probability that they would do so (Greenwald et al., 1987). This has been christened the mere-measurement effect: the measuring of a declaration increases the chances of that behaviour occurring (Morwitz et al., 1993).

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The same effect has been observed in other scenarios (Berger et al., 2008), including during a state referendum in which education funding issues were decided. Individuals from counties where polling stations were located in schools were systematically more likely to vote for increased funding.

Priming, then, is a phenomenon in which seemingly irrelevant details of the environment or the information one possesses increase the cognitive accessibility of other ideas. Studies demonstrate, for example, that priming the idea of money increases the probability of individualistic, selfish, and egoistic behaviour (Vohs et al., 2006). An offshoot of the priming mechanism is the phenomenon of **anchoring**. When making choices or estimating quantities, individuals do not operate in a cognitive vacuum; choices are always made in the context of other phenomena and ideas. In one experiment, visitors to a science centre were asked one of three variations of the same question, two of which contained anchors. In the first, the subjects were asked to estimate whether a sequoia tree was more or less than 365 metres high; the second version stated ‘more or less than 50 metres’; third group was asked to estimate the height of the tallest sequoia in the world without the presence of an anchor. It transpired that the high-anchored group estimated higher values on average, and the low-anchored group estimated lower ones (Jacowitz & Kahneman, 1995).

How these ideas can be implemented in ebalance-plus:
The action occurring on campus will prime ideas of education, community, youth, learning, and the future.
'Pro-environment', 'altruistic' messages have the potential to increase the probability of active participation in ebalance-plus, allowing the system increased flexibility.
In the design of interfaces, the context of the choices should be constructed in a manner that communicates the value of options that operate within an energy efficiency philosophy (ebalance-plus).

1.4 Framing

Scientific research demonstrates that language can influence individuals’ perceptions of reality and the decisions that they make. Amos Tversky and Daniel Kahneman called this effect ‘framing’ (Tversky & Kahneman, 1981). One example of this is when a doctor informs a patient of the risks associated with a particular therapy. The actual mortality rate (10%) can be communicated in two different ways (Kahneman, 2011):

The one-month survival rate is 90%.

There is a 10% mortality rate in the first month.

Despite both sentences being true and communicating the same information, their perception among patients differs considerably. The first sentence triggers associations with survival, recovery, and success; the second with death, endings, and defeat. Accordingly, patients are much more likely to opt for therapy if the information is presented in the form of the first sentence.

Another example of framing can be found in marketing communications. Pampers nappies were initially presented as a product that enabled parents to sleep comfortably and uninterrupted, thanks to the product’s absorption qualities. The

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product failed to sell well, as some mothers associated the benefit to themselves with selfishness and ensuring their own comfort at the expense of their children's. The communication framework was subsequently altered; the new message emphasised uninterrupted sleep for babies – which results in more energy for daytime play and faster development. The product gained a much larger consumer base (Neuhaus, 2013).

In the 1970s, when credit cards began to gain in popularity, many retailers charged higher prices for card than for cash transactions – owing to the additional costs they entailed. Card operators worked hard to ensure that retailers ceased this practice and that prices remained the same, regardless of the method of payment. If prices differed, the higher card price was to be the 'normal' price and the cash price the 'discounted' price. It was hoped that the change in perception would influence the frequency of card use. It was easier for consumers to forgo the discount than to opt for a higher price merely for paying by card (Thaler & Sunstein, 2009). These examples demonstrate that communicating the same feature in different ways can produce drastically different results.

How these ideas can be implemented in ebalance-plus: Consider how to frame the communication as a *profit* or a *benefit* (to the community, to the planet, to children in the future), instead of a *cost*.

1.5 Social scripts

1.5.1 Other people's behaviour as an information anchor

When faced with difficult choices, individuals often attempt to contextualise their options. They anchor their selections by relating them to other available information – sometimes following random cues.

With the intention of obtaining points of reference, individuals frequently observe how others have behaved in similar circumstances. In many cases, this heuristic 'social proof' is considered helpful. If one does not know what to do, a tip based on observing others' actions seems to be the right one. This heuristic is used particularly often when the dominant social norm is unknown, or when an individual engages in something new or unfamiliar (Cialdini, 1987).

There are myriad examples in psychology of how this heuristic works. One experiment examined how people behaved in areas where littering was prohibited – an injunctive norm. When the lawns around them were littered, they tended, in turn, to litter; whereas, when the lawns were clean, they refrained. It can be concluded that they tended to follow the observed norm (how people actually behaved) rather than the injunctive norm (how people should behave). Interestingly, it has been discovered that the greater the discrepancy between what should be (not littering) and what actually occurs (the factual degree of littering on the lawn), the greater the tendency to follow the latter. In other words, regardless of the categorical nature of formal bans, people tend to litter more in already-littered environments. This means that, as humans, we have a tendency built into our perceptual apparatus to follow others – regardless of what should be done (Cialdini et al., 1991).

In another experiment, on a university campus, the influences on individuals' choices to use lifts or stairs were investigated. Two types of intervention were tested:

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the first was a sign stating that most people used the stairs; the second stated that using the stairs was an effective form of exercise. Where the sign stating the descriptive standard was placed, the number who used the lift instead of the stairs fell 46% between weeks one and two; no change was observed either for the sign encouraging exercise or for the control group (which had been presented no information) (Burger & Shelton, 2011).

Information on others' behaviour, however, should be disseminated with caution, as the opposite of the intended effect can be produced. In an experiment conducted in California, 3,000 households were provided information on their average weekly electricity consumption. In most households, processes such as laundry occur in weekly cycles. This cycle includes both weekdays and weekends, which can differ significantly in power consumption. Additionally, each household was informed whether its average consumption was higher or lower than that of the local area. Those who had consumed more than the average reduced their consumption. Surprisingly, however, that knowledge also influenced those who had consumed less than the average; in these cases, consumption increased. Both groups started to conform to the average. The authors call this the 'boomerang effect' – those who used less electricity than their neighbours lost the motivation to continue being economical (Schultz et al., 2007).

The above scheme was later modified. In another study, those whose power consumption was above-average received bills containing 'unhappy faces'; those who consumed less received 'smiling faces'. In other words, an injunctive norm was added to the descriptive norm, providing information about what is desirable and what is not. Interestingly, this study failed to discover any evidence of the boomerang effect at work. Those who consumed more energy than the average of their local areas reduced their consumption, and those who consumed less continued to do so. This example illustrates the effective application of information that presents combinations of descriptive and prescriptive norms. One alternative involves informing only households that have above-average energy consumption of their status. This would likely lead to a reduction in the average.

How these ideas can be implemented in ebalance-plus:
Present messages (based on truth) that others are exhibiting the behaviour we wish to promote.
As initially, the public will be reluctant to use the system (as it is a new innovation), the process of building engagement should be divided into stages:
- In the first stage, it will be beneficial to communicate to prospective users that others are open to using the functionalities of ebalance-plus (this stage will require surveys to acquire actual percentages, and the information must be true);
- In subsequent stages, we must communicate the actual percentages of individuals on campuses using the functionalities.

It might be useful to encourage individuals to do 'something' and encourage them to 'brag' about it. This will make it more difficult to deny what we have revealed socially. This will allow the braggers' audience to see that this behaviour is occurring among others; thus, creating an anchor effect.

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1.5.2 Sense of being in social environments

Social influence can also manifest in other areas of human behaviour. For example, people might behave differently when they are with others to when they are alone. When we are with others, we take care to cultivate our images (Goffman & Others, 1978).

This begs the question: can inducing the impression in individuals that they are being observed alter their behaviour? The example of Woolwich, a suburb of London, illustrates this phenomenon at work. Vandalism was of great concern in Woolwich; at night, when the streets were empty, groups of vandals would damage parts of the district. In response, the municipality (with the help of an advertising agency) strategically placed murals depicting the faces of local children. It transpired that the mere presence of human faces significantly lowered both the number and frequency of vandalism incidents. Humans are inclined to behave according to social norms – even when they are in the company of mere depictions of others (Hooker, 2017).

Another example of how social influence can be stimulated was revealed by a psychological experiment conducted at a university in the United Kingdom. It was customary for university staff members who took advantage of tea and coffee at work to make voluntary contributions to a money box for future supplies. The experiment involved placing a poster near the money box: some weeks it depicted various flowers; on others, it depicted human eyes. The weeks in which the eyes were placed near the money box yielded greater contributions from the staff members. Stimulating the feeling that others are present increased the probability of pro-social behaviour (Bateson et al., 2006).

The examples above demonstrate that there is a filter built into our perceptual apparatus that makes us behave in a socially approved manner when we feel that other people are observing us. It is noteworthy, however, that social scripts can also operate through the other senses, such as hearing.

In one project conducted in Norway, IF INSURANCE utilised children's voices in GPS car navigation systems. When the cars entered areas where children might be present (such as those near schools and nurseries), the navigation messages (for instance, 'turn left' or 'go straight ahead') started to be delivered in a child's voice. As a result, the drivers drove more carefully and caused fewer accidents. The developers explained that humans have a default reflex to care for children and to behave carefully around them. This reflex can be triggered not only by the physical presence of a child, but also by stimulating the senses in such a way that mimics that presence. The effectiveness of the experiment was based upon this assumption (*IF INSURANCE 'Slow Down GPS',* 2016).

How these ideas can be implemented in ebalance-plus:

It is to be expected that when individuals are alone, they will tend to behave more selfishly. Placing social symbolism (human figures, faces, or eyes) near decision points (for instance, vehicle to grid (V2G) charging stations) can increase the probability of altruistic and ecological behaviours.

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1.6 Exposure effect

The research of Robert Zajonc established a relationship between the frequency of repetition of a stimulus and an increase in liking for that stimulus. Zajonc called this the mere exposure effect (Zajonc, 1968; Zajonc & Rajecki, 1969). In one of his studies, college newspapers displayed advertisements containing incomprehensible abstract words, which appeared with varying frequencies. Following their publication, a survey was conducted among students who had been shown the words. The students were asked whether they thought the words meant something positive or negative. Words that were 'tamer', or more cognitively accessible (those that appeared most frequently) were more often indicated by the students to have positive meanings. This experiment has been repeated many times by psychologists using other stimuli, such as drawings and Chinese ideograms, with similar results in each case. Individuals tend to view what they know, or what they have seen or heard before, more favourably.

How these ideas can be implemented in ebalance-plus:
Conduct an educational action on energy flexibility and the assumptions of the system. It is not necessary that the educational action be of an organised nature (lessons, lectures, and exams); it can adopt a more informal character, demonstrating the philosophy by example, or giving users opportunities to try some of its functionalities.

1.7 Heuristics of ease

Consciously processing information (and thus using System 2) is energy-consuming for the brain. This is why, for instance, when we ask somebody to make a challenging calculation while walking, that he/she usually comes to a halt. His/her brain is attempting to shift its cognitive resources to the task at hand, while interrupting the other activities and processes it is performing – even one as seemingly straightforward as walking. The phrase, 'to pay attention'– which implies that there is a specific currency (attention), the resources of which are finite – illustrates this process flawlessly. Since using System 2 is cognitively expensive, we have an innate tendency to take shortcuts in our perceptual apparatus; humans exploit these cognitive heuristics to conserve our precious attention currency.

The same process enables our brains to cope with messages and tasks that are structured to reduce cognitive effort. That is why simpler messages are easier to learn than complex ones. In one experiment, it was proven that easier-to-remember rhyming messages increased the probability of those messages being perceived as true (McGlone & Tofighbakhsh, 2000).

In another experiment, respondents were asked to evaluate the growth prospects of various companies. They established their opinions on the basis of reports provided by brokerage houses (with specially constructed, fictitious names), which were not always consistent. It was concluded that the respondents placed more trust in reports presented by brokerage houses with easier-to-pronounce names. They preferred reports presented by 'Pera' or 'Dermond' over those of 'Sampiy' or 'Emniyet' (Shah & Oppenheimer, 2007).

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This example demonstrates clearly that even matters as serious as investing can be decided by side factors, such as the ease of pronouncing the names of the institutions. This influence can, in many cases, evade awareness. The decision to consider analyses more convincing than others can be secondarily rationalized: the participants were later asked why they had followed the recommendations of particular brokerage houses, or had trusted particular experts; many were convinced that they had relied solely on arguments of merit.

As the brain attempts constantly to minimise its workload, preferring to work in the less energy-intensive System 1, seemingly minor details can cause the frequency with which an option is selected to increase or decrease. One striking example of such impediments at work could be seen in a change to German law in the 1980s. In order to reduce the number of motorcycle accident victims who were hospitalised, it was made mandatory to wear a helmet while riding a motorcycle. An unintended consequence of the new law was a 60% decrease in motorcycle thefts. What exactly happened? Helmets are usually not left with parked motorcycles. It might seem that would-be thieves in this case should also consider having their own helmets. It emerged, however, that such a seemingly minor hindrance served to sufficiently discourage a large number of them (Mayhew et al., 1989).

Another example of how human brains 'take shortcuts' in decision-making can be seen in the default options in menus. Often, when presented with several choices, individuals will opt for a choice not presented in the menu: doing nothing. This is the least energy-intensive selection for our brains. The power of this phenomenon can be observed in the differences between European countries in their numbers of potential organ donors per capita. These differences can be significant: in an article that analysed the phenomenon in 2003, it was highlighted that in Austria, the percentage of potential donors was near 100%; while in Germany, it was 12%. Such a noticeable difference transpired as a result of a difference in the regulations of the two countries. Austria had adopted an 'opt-out' system – being a potential donor was the default option. Members of the public were required to actively unsubscribe from the donor list; in Germany, the opposite was true – citizens were non-donors by default (Johnson & Goldstein, 2003).

How these ideas can be implemented in ebalance-plus:
- messages should be worded in a way that precludes cognitive load
- messages should be clear and simple
- the system should have a name that is easy to pronounce
- in the application or on printed materials, the fonts should be clear and presented against light backgrounds
- in interfaces for energy flexibility-related functionalities, options that enable flexibility for end-users should be the default option.

1.8 The social vs the commercial world

From the perspective of end-users, (i.e. consumers of electricity), the application of a new paradigm of energy use means a change in their lives. Making such a change demands reasons or internal motivation.

In theoretical discussions, the economic element is frequently mentioned. Shifting demand, increasing users' flexibility, and using greener electricity is assumed to deliver economic benefits: users expect this electricity to be cheaper. This was

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illustrated to some extent in our own workshops (see page 46) in which financial motivators or incentives were frequently mentioned (in fact, they were the first benefits that the subjects discussed).

It remains unclear on the basis of the simulations performed, however, to what extent the flexibility or shifting of demand to different hours can be rewarded financially. Even if this affects the price, it is unknown whether the savings will be sufficiently attractive. It might also transpire that the financial benefits will be enjoyed primarily by institutional stakeholders, such as transmission system operators, distribution network operators, and the owners of buildings.

Communicating and emphasising the price differences to end-users while promoting the functionalities developed within ebalance-plus has another consequence that is worth highlighting: psychological research demonstrates that the **commercial and social worlds** are governed by different rules, according to their public perceptions. One prime example that illustrates these distinctions is a study that analysed the behaviour of the parents of children who attend nurseries (Gneezy & Rustichini, 2000). In one nursery, parents were frequently late to collect their children. This meant longer working hours and inconvenience for the staff. In response, a small fee was introduced for collecting children ten minutes or more after the designated time. Following the introduction of the fee, the frequency of late pickups actually increased.

The authors proffer that after the introduction of the fee, parents changed the context of their perception. Previously, they contextualised it socially. Delayed child pickups caused remorse – after all, the caregivers (who were known to both the children and the parents) were required to stay at work longer. These remorseful associations incentivised parents not to be late. An invisible psychological limiter was hardwired into their decisions. The introduction of fees moved the whole situation from a social domain to a market one, in which everything has a price. When goods or services are exchanged commercially for a price, neither buyers nor sellers can justifiably complain. As a result, parents stopped feeling guilty about inconveniencing their children's carers, and started to believe that they were paying a fair price for the overtime that caregivers worked.

Such a dynamic was the intention of neither the nursery staff nor the experimenters. After a handful of weeks, the penalties were abandoned. It was expected that the situation would return to the norm that dominated prior to the introduction of the fees; this, however, failed to materialise. This means that shifting the context of the situation from the **social world** to the **market world** succeeded only in one direction. When penalties were eliminated, a slight increase in latecomers was observed – an effect of the simultaneous abrogation of both norms.

This example demonstrates how the separation of market and social norms works. In everyday life, individuals are willing to perform a variety of tasks for free because they anchor their actions within social norms, in the qualities assigned to a given role. When someone close to us invites us to dinner, we do not assign a price to it, and nor do we hand him/her a banknote.

Intrinsically motivated individuals are able to achieve things that the market would value highly. An example of this lies in the hundreds of hours that the creators of open-source software, such as Linux or Wikipedia, work unpaid.

This mechanism was tested experimentally by James Heyman and Dan Ariely (Heyman & Ariely, 2004). They demonstrated that individuals were willing to work more efficiently when motivated solely by social factors (favours) than market ones (small fees). It might appear somewhat surprising that people are willing to do something for free, but not for a small fee. Objectively, it is better to do something and be paid than

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to do something and not be paid. Low remuneration, however has no motivating function – it discourages people from performing tasks. This is due to the change in context from a social one (‘I am doing someone a favour’; ‘I am doing something for my loved ones’; ’I am doing something for my community’; or ‘I am doing something for the world’) to a market one (‘I am doing something for my own benefit’). It exchanges intrinsic motivation (social) for extrinsic motivation (payment). As humans, we usually have individual ‘prices per working hour’, and a subjective sense of whether something is worthwhile to us or not.

The above considerations are crucial for the future of the energy market. If end-users must demonstrate active participation, how they are incentivised can make a remarkable difference. The above examples show that if financial incentives are small, they may even be counterproductive. Rooting the choice of ‘making your energy use more flexible *or* consuming energy in the old way’ firmly in the context of the market may cause users to continue acting as they always have, believing that since the market values their choice so lowly, exerting the necessary effort is unjustified.

How these ideas can be implemented in ebalance-plus:
All decisions pertaining to price differences between energy obtained in the old paradigm and the new should be made with thought and consideration.
Where possible, try to build **intrinsic motivation** based on values, and place flexibility in the context of social values. The opportunity to use electricity in a green way and to increase the flexibility of demand can be induced by communicating that:

- a large number of members of the university community are already doing so (accurate and specific percentages should be presented here);
- that it benefits the planet;
- that it benefits the university;
- that it benefits end-users’ departments and faculties.

Identity-building and ‘favour’ should be concentrated on the smallest possible groups. This means that using the phrase, ‘people from this dorm floor’ is better than ‘people at the university’; ‘people who study the same subject as you’ is better than ‘university students’. Similarly, using the phrase ‘people on this campus’ should yield better results than ‘students in this country’. By anchoring the message in a smaller slice of social reality, the ‘social frame’ effect is strengthened.

1.9 Motivation and self-identification

Different consumer behaviours can result from different motivations, which can, in turn, be categorised in a number of ways. One division that psychologists distinguish is that between intrinsic and extrinsic motivations. An extrinsic motivation might be, for instance, the desire to avoid a penalty or other negative stimulus (such as a higher fee). An extrinsic motivation can also serve as a tangible or intangible reward, such as social recognition. Intrinsic motivations are rooted in **consumers’ values and identities**.

Intrinsically motivated users engage in behaviours when they believe them to be right.

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Psychologists have noted that **intrinsic motivations** are much more useful in inducing behaviours. They are consistent, persistent, and manifest both in the presence and absence of external reward. Contrastingly, in the case of reward motivation, the behaviour lasts only as long as the rewards continue. It is widely believed that intrinsic motivation is a more stable source of sustainable energy-use behaviour.

1.10 Values

In the context of ecological behaviour, social scientists distinguish four main groups of values (Lindenberg & Steg, 2007; L. Steg et al., 2018; Linda Steg, 2016).

The first are **egoistic** values and motivations. They involve maximising individuals' resources, such as wealth or status. This group includes all kinds of monetary incentives, rewards, bonuses, and fees.

The second are **hedonistic** ones, which are concerned with individual comfort and convenience. Consumers driven by these values are reluctant to save on heating or to reduce their use of lighting, as it will potentially affect their well-being. Note that a hedonistically motivated individual is generally willing to pay higher prices because comfort is his/her top priority.

The third group of values are **altruistic** ones. Those for whom these values are important focus on the benefit of others – not only of individuals, but also of groups, such as families, cities, and states.

The last group are **biospheric** values. Consumers who possess such values consider how their lifestyles and consumption affect nature and the planet.

Hedonistic and egoistic values reflect an individual's focus on the self, while altruistic and biospheric values reflect ones focus on the external, on others.

It is not the case that every consumer is driven by a single type of motivation. In every individual, there is a mixture of values that manifest with varying intensities. It is also noteworthy that the same action can be motivated differently among different individuals. For example, for one person, choosing public transport over his/her own car might mean not having to worry about a parking space (a hedonistic value); another might do so to save money (an egoistic value); another might feel uneasy to contribute to traffic jams in the city (an altruistic value); and another might see it as a sacrifice they make for the good of the atmosphere and the planet (a biospheric value).

The extent to which individuals implement their values is influenced by the cost of the activities in question. Even if somebody enjoys cycling (a hedonistic value) he/she might prefer a shorter commute by car. Regardless of their values and motivations, there is a greater probability that consumers will engage in pro-environmental and ecological activities if they involve no effort, inconvenience, nor additional cost.

Linda Steg emphasises that contextual factors can act on the strength of individual motivations. This corresponds to the priming and framing processes discussed above. If symbols associated with particular values are present in the environment in which an individual operates, there is a greater probability that those values will manifest. For example, symbols associated with money, competition, and rankings will trigger associations with egoistic values; biospheric symbolism (greenery or ecological messages) will similarly trigger and reinforce biospheric values. This two-sided influence is worthy of emphasis. The internal values that individuals live by influence their actions. They, in turn, influence the external factors – the environment

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and the space in which the individuals act. Conversely, the environment can also shape individual values to some extent.

How these ideas can be implemented in ebalance-plus: Since there are few opportunities for campus employees and students to profit financially by increasing the flexibility of energy demand (the profit will be made by the institutions that own the buildings), we must install elements in campus environments that trigger biospheric and altruistic values. This might include symbolism related to nature, energy efficiency, and benefits for the planet and future generations. Symbolism can form part of buildings' design (action logos, action symbols, the colour green, trees, leaves, or the sun). The above activities can be supported by contacting students via a mobile application.

1.11 Self-identification

The nature of environmental influence on consumer behaviour can differ somewhat. Individuals often perceive themselves through the perspective of the groups with which they identify. If human identity is the answer to the question, 'who am I?', then a number of different factors influence the answer. According to the theory proposed by Tajfel and Turner, association with a particular group and knowledge of its values and beliefs can influence those of its members (Tajfel et al., 1979).

Van der Werff and his team examined whether this also applied to environmental values (van der Werff et al., 2021). The research examined whether the pro-environmental values and behaviours demonstrated by companies motivated their customers to behave similarly. Since in the cases of many companies, the same relationship may be present in reverse (in other words, individuals choose companies that share their own values), the analyses were conducted among those that serve captive markets – for instance, those that provide energy as monopolists in specific markets or geographical areas. The hypothesis that the values of institutions can influence those of the individuals with whom they associate was additionally tested by analysing the influence of the values espoused by national governments.

In each category of relationship (company/customer; company/employee; government/citizen), positive correlations were observed between pro-environmental values of institutions and individuals. The authors view this as evidence that supports their theory. The authors conclude by stating that their findings have deep implications for environmental policy. Institutions' communication of these values will influence the individuals with whom they associate. They continue by stating that environmental responsibility is more likely to influence individuals' behaviour when they identify with institutions, groups, and organisations that operate according to such values.

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How these ideas can be implemented in ebalance-plus:
Universities and colleges evoke exceptionally high identification among staff and students. Graduation from a particular university forms an important part of one's biography, and is included in one's CVs for life. Students tend to perceive themselves through the context of studying at a given university. The popularity of t-shirts and sweatshirts adorned with university emblems is a symbol of the power of this identity.
A university's communication of its commitment to ecological values has a chance of becoming a part of students' self-identification mechanisms, and of influencing their values, motivations, and attitudes:
'University X cares about the environment, so since I am a student at university X, I care about the environment as well'.

2 An example of a comprehensive system for increasing motivation, engagement, and energy literacy on university campuses

2.1 What should the change involve?

We assume that we want electricity users (specifically end-users: students, teaching staff, and administrative staff) to use flexible demand functionalities. Examples of such functionalities might include:

- Vehicle to Grid (V2G) charging: that is, allowing the system to draw energy from their car batteries;
- setting a range of temperatures in which the heating and air conditioning in their own rooms or dormitories can work, rather than rigidly adhering to a single temperature;
- setting temperature ranges at which the heating and air conditioning operate in shared, public areas of the campus, such as lecture theatres;
- active use of smart washing machines and dishwashers in dormitory rooms; in other words, setting a time range in which pre-loaded washing machines or dishwashers can be activated by the ebalance-plus system.

2.2 Why is the change difficult?

Currently, access to electricity is plentiful and requires no cognitive effort, as the system that provides it works reliably. The shift to a paradigm in which, to some extent, decision-making is delegated to automated external systems is cognitively burdensome. For ordinary users it is not entirely clear what this shift means, what advantages it might offer, and whether it will lead to decreases in users' comfort. It is

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reasonable to assume that prospective users are reluctant to diligently conduct cost-benefit analyses, and will refrain from making any selection. The least strain on the cognitive system is to do what has previously been done; thus, there is a risk that participants will not engage.

One method of encouraging users to participate actively in the programme involves educational campaigns. We assume here that by increasing energy literacy and raising awareness of the importance of pro-environmental behaviour and rational energy consumption when there is an excess of it in the network, we will encourage users to opt for specific choices. According to the results of the studies cited in Section 1, these assumptions are only partially true. Indeed, the more aware consumers are, the greater the probability that they will develop ecological behaviours; the difficulty lies in encouraging them to invest the time and energy necessary to become knowledgeable. Education means working with System 2, which is cognitively burdensome. While attraction methods, such as electronic applications and gamification, can be used to build knowledge, it must be remembered that there are thousands of activities (including other applications) that compete for users' attention. Merely convincing users to invest their time can prove a challenge.

This means that the application and educational methods alone (even if they are visually attractive and engaging) might prove inadequate. That is why we propose **surrounding the educational layer with other activities, utilising the achievements of behavioural economics, social psychology, and sociology.**

2.3 General principles

Globally, behavioural economics has been used successfully to effect social change. David Halpern lists four general characteristics of effective actions. The first letters of these characteristics form the acronym, EAST) (Halpern, 2016):

- **Easy** - for an action to be effective, it should be easy to understand. Instead of long lists of rational arguments, it is better to make the desired action as easy as possible, so that users can implement System 1 thinking.
- **Attract!** – when overwhelmed by a multitude of messages, we turn our attention to what catches it and stands out.
- **Social** - humans are social beings; in fact, everything we do has a social dimension. An effective action should not treat a person as an isolated individual but should account for the group perspective.
- **Timely** - incentives and motivators, as well as indirect cues, should be placed close to the decision – both temporally and spatially.

2.4 The campus as an environment for change

Before we consider how to design an engaging incentive system to encourage flexibility and pro-environmental behaviour, it is worth studying the university campus – a social environment that exhibits specific properties. In analysing the social landscape of the campus, we will notice that:

- there are **different groups of stakeholders** within campuses – including students, teaching staff, administrative staff, maintenance staff, and cleaning staff.

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- a hierarchy is organically built into the system. Students do not enjoy the same status as, for instance, teachers and lecturers. Members of the teaching staff also vary in status and prestige.

- an important characteristic of the campus is that it is a space of change. This can be justified in several ways:

  - campuses are spaces where **new ideas** are 'produced', where perspectives collide, where discussions take place, and where views change. This enables the easy introduction of new ideas into the campus space, compared to, for example, other public building complexes, such as hospitals or public administration buildings.

- The annual influx of **new people**. Part of the community is replaced annually, as incoming students take the places of outgoing ones. Every year, in social terms, the campus, as it were, 'becomes anew', and begins to exist with a different composition of individuals. It maintains continuity, while simultaneously evolving and developing.

The above characteristics imply that change is inscribed in the spirit of universities, that it is written in their social 'DNA'. The change embedded in the structure of universities can serve as a key ally in the wider mechanism that motivates increased flexibility in energy use. We know that changes in habits or lifestyles are easier to make when accompanied by other changes. Commencing higher education is an important milestone in an individual's life, and often works in tandem with other significant changes:

- new students' social circles change – as they get to know other people, relationships with older acquaintances might weaken.

- young people gain autonomy and can make decisions on more elements of their lives.

- the end of secondary school is often accompanied by further steps towards independence: meeting one's own expenses; moving out of the family home.

This means that at the beginning of college or university, many changes simultaneously occur in students' lives. Moreover, they are changes that the students desire, and wish to adapt to as best they can and perform well in the new role of student. This creates opportunities to embed yet more changes – including in electricity use. The prerequisite is effective communication and execution of the process.

2.5 Campuses as spaces of personal identity and identification

University campuses have another feature that can prove helpful in designing a system to increase engagement: the **potential to build individuals' identity**.

A university is a symbol, a point of reference that can be (and usually is) a strong element in building an individual's identity. Students deepen their sense of belonging to a given university by adorning t-shirts and sweatshirts depicting its logo. When introducing themselves, their first and last names are often followed by 'I am a student of X at Y university'. The characteristics and values of the group with which individuals identify become those of the individual him/herself. This means that individuals will

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tend to more readily accept the values of the group with which they identify. This makes campuses a highly useful field – much more so in this respect than other potential demo sites, such as hospitals. It is much easier to imagine a student identifying with the values of their university than a patient accepting those of the hospital where they are being treated.

If communication is placed on campus that emphasises ecological and biospheric values, there is a high probability that those who identify with that university will acquire the same values; thus, increasing the probability of pro-environmental behaviour.

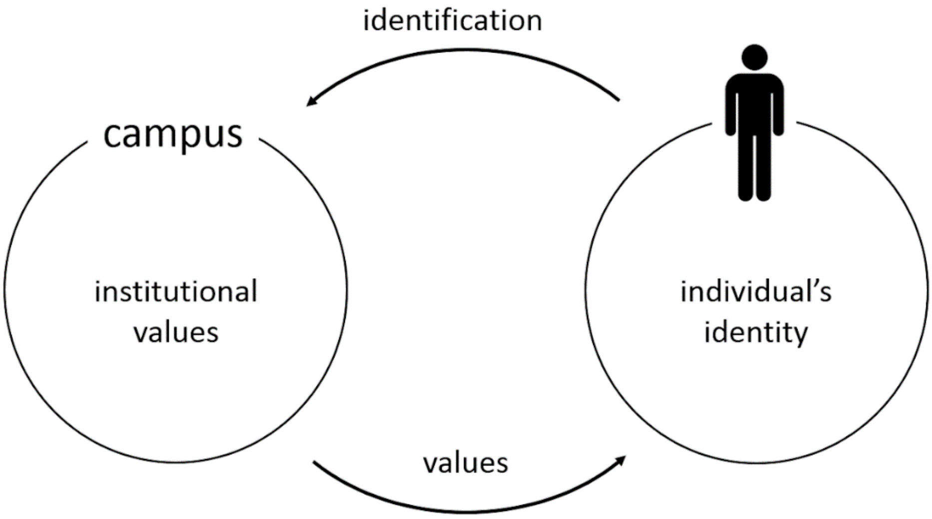

Figure 1: The value transfer scheme

It is also helpful that a young person becoming a first-year student at university usually has idea of how to behave in his/her role only to some extent. This is where the social scripts discussed earlier become relevant. Not knowing how to behave, he/she begins to search for hints in social ('how others behave') and institutional ('what hints does the environment give me') environments.

In order to increase the probability of pro-ecological behaviour and flexible use of electricity among students, one could saturate the university space with symbols and other materials that would communicate: 'students of this university support ecological values', or 'students of this university use energy consciously and rationally'.

2.6 Communication

One of the key challenges, therefore, will be the implementation of an information campaign, whose main goal is to create an image of the university as one that cares about ecology and is guided by biospheric values. It is worthy of emphasis that this cannot be a one-time action, lasting several weeks even months; it must serve as an additional layer in the space, one that is interwoven with others. This will allow for constant development of the values that guide a university.

Communications should comprise a variety of forms and be placed at various points around campuses.

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Messages should promote broad pro-environmental values and actions (in the context of the university's values), as well as information pertaining to specific actions and behaviours. In the case of responsible electricity use, messages should address the following:

- Explain terms such as energy efficiency, grid load variability, and peak load;
- Explain why the amount of energy produced and consumed must be balanced constantly;
- Explain the influence on load not only of the amount of energy consumed, but also the time at which consumption occurs;
- Explain what electricity demand elasticity is, addressing the lack of appropriately simple terms used in common language.

For example, energy consumption can be presented in a context of familiar objects and activities:

Q: Electrical energy is typically sold to consumers in kilowatt-hours. What can you do with one kWh of electricity?

- **light a room for 200 hours with a LED light bulb (5W)**
- **use a laptop computer for 20 hours (50W),**
- **use a small refrigerator for 2 days (energy class A, 180kWh per year)**
- **have your TV on stand-by for 20 days (2W)**

The messages might be presented in the form of:

- posters that encourage pro-environmental behaviour;
- posters that depict university students expressing their pro-environmental values;
- symbols associated with being environmentally friendly: the colour green, or symbols of leaves, trees, grass, the sun, and others.

In the case of universities, there is a possibility of contacting the administration that can help to design such an information campaign and integrate these activities with the rest of the communication to students.

The implementation of a wider action with its own logo and symbols that could be used in communication materials (both printed and electronic), is worthy of consideration. The action should have a simple, easily pronounceable name and a symbol that musters positive associations. The action symbol can then be used on materials around campuses, such as notebooks, binders, pens, backpacks, sweatshirts, and t-shirts. The presence of the logo and the name of the action on objects that belong to students will contribute to building the impression that the action has a wide reach and that the values it represents are shared by a large group of students. It will also utilise framing and priming heuristics. This impression will contribute to building the social norm, ‘students of University X care about environment’.

As stated above, the process of building such a norm cannot be limited to a deadline; rather, it should be an ongoing process. The arrival of new first-year students

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on campus is crucial for this process. This is the moment when many elements of their lives change, and when they seek external guidance to learn about the role of a student. The communication process should include profiled activities targeted at first-year students. A detailed list of such activities might include:

- together with introductory information on students' faculties and the campus (administrative issues; the campus plan; where and how to complete formalities) there could be an insert on the subject of pro-ecological values that are important for the university;
- information on the environmental achievements of the university and the students (for example those who live in dorms and use IoT devices for Demand-side management (DSM));
- if students receive a 'welcome pack':
    - pro-ecological information highlighting the environmental activities of the university should be a part of it;
    - such a pack could also include gadgets—such as wristbands, pins, caps, reusable water bottles, or lunchboxes—which, apart from the university emblem, depict those of pro-ecological actions – for instance, their logotypes and names.

An information process that is conducted effectively from the outset will increase the probability of message reception in later stages. Additionally, the current first-year students are the senior students of the future, and will create a reference point for those who follow in their footsteps. This means that the greatest exertions will probably be made at the beginning of the campaign – each subsequent year will become easier.

Communication activities should not be limited to first-year students, however. One element of the posters and symbols discussed earlier is information that provides knowledge on group norms. In order to achieve this, observations must be made and surveys conducted in advance, so that factually correct information on the desired behaviours can be presented. The following are examples of information that demonstrates the group norm in a manner that encourages imitation:

'Sixty-nine percent of students in this building choose to take the stairs instead of the elevator.'

'Eighty-two percent of those using this hall consider 22° C to be a comfortable temperature.'

'Seventy percent of users of this EV charging station choose the ECO option.'

The action of placing such communication can (and should) be spread over long periods. In essence, it involves 'catching' a particular group doing something that we wish to reinforce. The group is then informed of the desired action in the communication. After some time, when the communication has had an effect and the remainder of individuals who continue not to display the desired behaviour start conforming to the average, the effectiveness of the statements on promotional materials must be re-evaluated. The information should be true, meaning that it might

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be necessary to limit the process to simpler, more easily observable patterns in the early stages.

According to behavioural economics, the message should:

- state that a high percentage of individuals perform an activity (to inform the remainder that it is the social norm);
- focus on the desired behaviour (for instance, stating that 70% use the ECO option; not that 30% do not);
- focus on a group with which the recipient can identify (for instance, students living on the same floor);
- be located in a place and delivered at a time that is conducive to performing the given activity (for instance, if we wish to encourage students to use the stairs, the message should be placed somewhere close to the stairs and the elevator).

In addition to explicit messages, the communication process may also include elements that are implicit. Such elements might include green colour schemes, symbolism related to ecology, or sounds of the forest and the singing of birds in the canteen. This paves the way for priming decisions that influence energy saving and demand flexibility.

2.7 Green activities at universities

To credibly communicate pro-environmental values, universities must apply them to their own activities. It is crucial, therefore, that the activities are also evaluated in terms of these values, and that students are included in them. On the one hand, this offers a foundation for universities to serve as reliable sources of information on ecological values; on the other, it provides opportunities for students to learn these values not only theoretically, but also practically.

Performing an action increases the probability that the values associated with it will be internalised. The simplest (and least cognitively intensive for the participants) ideas are to enable support to be demonstrated via an imprint on social media. Students are able to show their circles of friends that they identify with the cause. Other activities might involve 'liking' a page or becoming a member of a group.

These forms of activism can be useful in convincing people of certain values—in this case, biospheric ones—as they allow individuals to inform others of their values. Contrarily, the relative ease of communicating these values (with no more than a click) can reduce the probability that individuals will exhibit behaviours consistent with these values in the physical world ('clicktivism').

To counter this difficulty, in addition to enabling students to communicate their values electronically, it is useful to establish actions in which students can participate. Although the specifics of these actions are to be determined later, their physical nature is essential. Such actions might include festivals, tree-planting events, picnics, and auctions to raise funds for activities that benefit the common good. All of these demand the active involvement of their participants.

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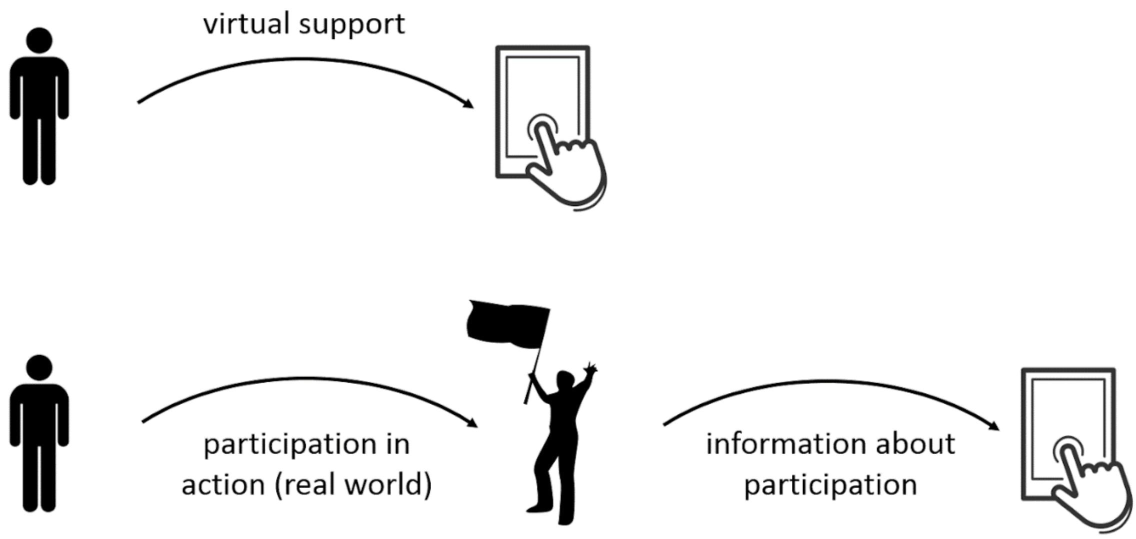

Figure 2: Virtual support versus virtual information about support in real world

2.8 The Application

The mobile application forms an important part of the ecosystem designed to engage electricity end-users on campuses to increase the flexibility of energy demand.

Smartphones have become a kind of meta-tool that accompanies us throughout the day. A multitude of achievements are possible using their applications. They are useful in increasing energy literacy, and in contributing to the development of environmental values. They can also serve as an element of direct communication, delivering messages at specific frequencies, as the recipients keep their smartphones close to hand.

Smartphones are capable, to some extent, of utilising the mechanisms described earlier in this deliverable, such as priming. The application could utilise built-in functions for sharing information and activities with others (through synchronisation with social networking functions).

A significant challenge lies in designing an application in such a way that ensures it is used eagerly. In many cases, a period of interest is proceeded by one in which an application stops being used (engagement burnout). A large part of the application's functionality will be contained in its energy literacy modules. These are educational by nature, and demand the use of System 2, which our brains use less willingly. We recommend that the application be constructed in such a way that it maintains significant value for its audience. On a university campus, it could assist with elements of broader student life: signing up for classes, exchanging notes, as well as receiving news on where classes are held, whether they have been rescheduled, and reading announcements.

Energy literacy messages will be embedded in an array of other functionalities. This has several implications:

- students will have valid reasons to use the app frequently;

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- energy education will occur alongside other functionalities; reluctance to burden the cognitive system would be limited;
- the risk that users will uninstall the application after a few days or weeks is reduced; students will not be eager uninstall an application that enables them to continue being students;
- the application will communicate indirectly that ecology is an integral part of being a student;
- the application will demonstrate that ecological values and the rational use of energy are part of the university's rules;
- the application will communicate that every student is part of a larger ecosystem in which the social, educational, technological, and ecological layers are closely connected.

The potential functionalities of such an application might include:

- messages that help users understand the new paradigm of energy production and consumption;
- messages on how users' own actions can contribute to green initiatives;
- news on new energy-saving technologies on campus (new features, how much has been saved, rankings of those with the highest numbers of points, and upcoming social actions);
- a display that shows the energy consumption of users' own rooms (for Internet of Things (IoT) features in dormitories) compared to the average values at their universities with information that it is 'OK' (consumption is lower than average) or 'not OK' (consumption is higher than average);
- data that shows the university's energy consumption and the impact of users' actions on this result;
- a V2G charging remote;
- an easy tool for social communication and informing others of users' participation in actions (utilising the social functions of popular social networking platforms, such as Facebook and Instagram). Facilitating the sharing of information on users' own pro-environmental actions has important implications. Bragging is highly engaging for the bragger – it is more difficult for us to reject a value that we have already revealed socially. Bragging also has an impact on the audience – it influences others through 'social proof' and contributes to the creation of social norms ('other people do this');
- an incentive system that rewards environmentally responsible behaviour.

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2.9 Interfaces of specific functionalities

The rules of behavioural economics can be applied in constructing the user experience when enhancing one's flexibility of energy demand. Below, we propose how they should be applied in the interfaces of two functionalities:

2.9.1 Vehicle to Grid (V2G) charging stations

We assume that the V2G charging station will offer a choice between the standard option (single-direction charging of car batteries) and an ECO one (bi-directional charging, with the option to partially discharge car batteries). We assume that we intend to encourage users to select the ECO option.

- V2G charging stations can be green in colour and contain symbols associated with ecology, such as leaves or grass;
- In the menu, the ECO option will be the default option;
- A graphic depicting a human face on the charging station or on its menu;
- A social norm message placed near charging stations – for instance, 'Sixty-five percent of people who have used this charging station selected the ECO option'. The information presented must be true;
- After selecting the ECO option, the interface can deliver a psychological reward – for instance, a sound associated with ecology, such as that of the forest or flowing water;
- Charging stations in which only the bidirectional charging option is available should be placed in more attractive locations – for instance, those closer to campuses.

2.9.2 Internet of Things (IoT) air conditioning in dormitory rooms

- The navigation menu should be clear and intuitive;
- By default, the flexibility-sharing option should be enabled, and the temperature defined as a range rather than a specific value;
- The control panel should contain information of the social norm – for instance, 'Seventy-two percent of the people who have used this system in this building set the range to ± 2° C'. This information should be true;
- Information framing the use of the system as a benefit to the user – for instance, 'thanks to the range setting, the system will automatically save electricity by reducing its consumption when energy is expensive and produced from non-ecological sources'.

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2.10 Summary

The ideas presented above form a proposal for how knowledge from the social sciences can be applied to encourage end-users to use electricity more flexibly. We have applied the achievements of behavioural economics, social psychology, and sociology in pursuit of this goal.

According to the literature, one important factor in the implementation of change using incentives from behavioural economics is their testing and verification in research and experiments. As part of the ebalance-plus project, selected solutions related to communication and functionality in the interfaces will be tested, and the results will be presented in Deliverable D2.3.

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3 Designing tools to support energy literacy and engagement in DSM

Examples of effective actions that modify social behaviour demonstrate that a multidimensional approach is necessary to change individuals' attitudes and actions in a lasting and significant way. Informing users about energy management and motivating them to adopt new behaviours should include the working or learning environment; the values used in the organization; easy-to-use, affordable and effective technology solutions. In this section, we will focus on an important element linking these activities - the mobile application, which is the key element integrating technological solutions and communication with the user. However, we need to remember that the application will be most effective if it constitutes part of a wider user motivation system, which influences users multi-dimensionally and utilises other means of communication (for instance, direct contact, printed information materials, information displayed visibly in public spaces) and methods of social influence (rules established within companies, universities, and other organisations; programmes that motivate users to perform specific actions).

Below, we present a framework to be considered when designing applications that aims to increase energy literacy among electricity users, to motivate them to reduce their energy consumption (particularly during peak load periods), and provide them with real-time data on their electricity consumption. A mobile application can be an effective tool for interaction between users and a system that manages the flexibility of electricity demand. An ideal application should not only provide information on energy consumption, but also increase energy literacy and motivate individuals to use electricity responsibly.

3.1 Setting goals

Before we commence the design stage of the tool for interaction with the energy user, it is important to determine what goals should be pursued – in other words, how it should serve its users, what information it should provide, and what actions it expects users to perform.

With consideration for the knowledge obtained in our research and during workshops, we present the goals that are relevant to preparing electricity users for the changes associated with the upcoming transformation of the energy system – one which requires closer alignment than currently exists between electricity supply and demand. Two areas are particularly relevant here: increasing energy literacy and modifying behaviour to increase the elasticity of energy demand.

3.1.1 Energy literacy enhancement

Energy literacy is the provision of basic knowledge on the energy system. Through this measure, users know why a change in the way they use electricity is necessary and are aware of the changes that are expected in the energy system. The following are the main pieces of information that users should be familiar with.

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3.1.1.1 How can energy consumption be reduced effectively?

This goal refers to provision to the user of information about energy demand of various appliances and services, including refrigerators, televisions, computers, lighting, space and water heating, and air conditioning. Here also could be included suggestions on how specific types of energy consumption can be reduced.

Real time access to information on energy consumption builds awareness of the relationship between the use of specific devices or services and total energy consumption. Without this mechanism, users are unable to access the feedback loops that inform them of the nature of the relationship. The information on consumption that consumers receive in every electricity bill is insufficient to establish such links – owing to its distance from the moment in which the consumption occurred.

Consumers must understand how energy consumption is affected both by different types of appliance (the technology used, its size, and its parameters), and how they are used (for instance, the impact of defrosting a freezer on energy consumption).

3.1.1.2 What is energy efficiency?

In this section of the application, users learn the importance of the energy ratings of household appliances, the energy consumption of buildings, and the energy requirements of various modes of transport. They also learn how energy consumption can be influenced by improvements in the efficiency of household appliances, reductions in the energy intensity of occupied buildings, or the effects of switching modes of transport.

Examples that can be used to illustrate energy efficiency:

- Comparison between the energy demand of a low-insulated building heated with electric radiators and the same building following insulation using modern methods and the installation of a heat pump;
- The energy expenditure of transporting 10 kg of groceries from a supermarket to the user's home: on foot, by bike, by public transport, by city car, and by large car.

3.1.1.3 What is the elasticity of demand for electricity?

A noticeable obstacle to the enhancement of energy literacy is the absence of appropriate vocabulary to quickly and understandably describe the concept of demand flexibility as a route to responsible electricity use. Traditionally, each unit of energy is assumed to be of equal cost – both financially, and for nature and the climate.

By default, individuals refer to saving energy, reducing energy consumption, and using energy more efficiently; thus, the concept of flexible demand for energy continues to be poorly understood. How much energy we consume, and when this consumption occurs is not widely known, and European languages lack words to express these measurements concisely. It is important, in the context of low awareness of the importance of energy demand elasticity, to strengthen the public's knowledge that not only energy conservation is of relevance, but also shifting that consumption to different times of the day or week.

An example that illustrates flexible electricity demand:

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A comparison between the effect on the grid's energy load of a domestic hot water storage heater operating in standard mode, which switches on every time the water is consumed; and one that adjusts its periods of operation to current conditions on the grid, using hot water storage during peak hours and heating during off-peak hours.

3.1.1.4 Basic information on the energy market

It is difficult to understand the rationale for changes in how we use electricity without basic knowledge of the principles and limitations of the modern electricity production and distribution system. It is reasonable, therefore, for the application to provide information of the following concepts:

- The amount of energy produced and used must remain balanced at all times, since there is no energy storage capacity large enough to be relevant to the entire power system so far. Therefore, it is important to limit the variability of the load on the electricity grid.

- The energy system operates efficiently when the energy available from renewable sources is used when it is generated. Storing it significantly reduces efficiency; moreover, because of the limited capacity of energy storage, only a small portion of this excess energy can be used at other times.

- The price of energy is set in the market frequently (at least every hour), depending on current availability and demand. Most end-users are not directly affected by these prices, as they pay fixed prices per unit of energy. When prices in the energy markets permanently increase, however, these costs are ultimately passed on to consumers.

3.1.2 Engagement in energy saving and flexibility

This section discusses methods of motivating users to conserve energy, to reduce use at peak demand times, and to increase demand elasticity. The goal is to sustainably modify their behaviour, so as to relieve pressure on the power grid by better matching energy demand with supply, and by reducing energy consumption. This goal can be achieved through the following actions:

3.1.2.1 Establishing social norms for responsible energy use

An important role in the formation of these norms is played by an individual's direct surroundings, including his/her relatives and friends, and the culture of the organisation(s)—such as workplaces, universities, and associations—to which he/she belongs.

Compliance with social norms fails to result in direct benefits, but rather in their adoption as principles that we follow permanently, with the objective of living in a society based upon mutual respect. This is why, for instance, we behave respectfully in public places: taking care of our appearances and hygiene and cleaning after ourselves. Those who fail to respect such norms are considered to be 'badly behaved'. Accepting the principles of responsible energy use as a social norm implies that such behaviour is the result of internal needs, rather than of cost-benefit calculations.

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The establishment of social norms can be accomplished through activities such as:

- Communicating that others, similar to the user, have changed the way they use energy – that is, they save energy and offer flexibility to the energy system;

- Demonstrating that responsible use of electricity is consistent with the general principle of caring for the common welfare;

- Communicating values in a common space by sharing desirable actions with others – for instance, through Facebook overlays, LinkedIn, building a culture of 'being green', or distributing stickers that depict the logo of the project. Research suggests that by praising a desirable action, we increase the involvement of both the actor (the bragger), (as we identify with what we have been shown), and of the audience, (which succumbs to the effect of social proof) (Cialdini, 1987).

3.1.2.2 Maintaining visibility

High interest can be maintained by the provision of regular (but not overly frequent), user-tailored information on use of electricity. Such measures are most effective when supported by widespread information campaigns that are conducted outside the application, involving informational materials, posters, and events.

3.1.2.3 Maintaining motivation

Mechanisms exist that continuously maintain users' motivations to save energy and enable flexibility of demand through systems that reward such behaviour.

The basis for such a system might be point collection, in which points are awarded for responsible energy use, and spent on various benefits. Such a points-based mechanism can be flexibly adapted to specific activities, user groups, and projects. Its complexity can vary greatly and be tailored to the capacity and scale of the project to which it applies.

Social norms for environmentally responsible behaviour play an integral role in sustaining user engagement; they shape our attitudes and alter our preferences. For those operating under the norm of responsible energy use, an option that puts less strain on the environment and climate is likely to be the default one – even if it fails to benefit the user financially.

In addition, closely linking energy use with other activities performed within universities serves to familiarise mainstream audiences with the practice – for instance, by communicating these activities on university websites or class scheduling applications.

3.1 Meeting the user's needs

Users who decide to use an application to support them with energy management do so with specific expectations. They assume that an app will efficiently provide promised functions, and that it will work flawlessly – both technically and factually. If these expectations fail to be met, users will quickly abandon the application.

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Using an application should be easy and continue to be viable when the user is able to devote only limited time and attention to it. Presently, there are a plethora of information channels, mobile applications, and other forms of media competing for the public's attention. Users engage with the sources of information and mobile services that most effectively meet their needs.

An ideal application considers the needs of users in aspects such as:

3.1.1 Users' values and motivations

The application provides information relevant to users' needs and motivations. When the goal is to modify how energy is consumed, the effectiveness of the application can be increased by combining such a change with a user's transition to another stage of life – for instance, when he/she becomes a student, parent, or retiree; when he/she moves to a new home, city, or country; or when he/she changes jobs. At the moment of such changes, both openness to new knowledge and the likelihood of behaviour modification increase, as an individual's motivation is to adjust well to their new role or circumstances. Those entering university are at such a point in their lives, and are, thus, more open to change their behaviour in various aspects.

3.1.2 Users' technical competence

The application is tailored to the ability levels of its least advanced users. This ensures that we reach a wide audience, as the barrier of technical skill is effectively removed.

3.1.3 Users' merit competencies

The application is adapted to each user's knowledge of electricity. All concepts, data, and graphs should be understandable to the least knowledgeable of the target audience, or be explained in plain language. Simultaneously, care should be taken not to patronise users; overly extensive descriptions of concepts that are obvious to them can be as discouraging as content that is excessively complex.

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3.2 Example: design assumptions for an application that DSM and energy literacy

3.2.1 The goal of the application

The application's goal is to shift user demand for energy used by air conditioning systems from the peak load on the grid to other periods. The change should be long lasting.

The application is intended to educate its users on the elasticity of energy demand, as well as its impact on grid load, energy cost, and greenhouse gas emissions.

3.2.2 Basic functionalities

The application comprises of three modules:

- **Monitoring of electricity consumption** (individual consumption and comparison with a reference group).
- **An incentive system** in which by collecting points, users can obtain various benefits. Some of the rewards are material, such as vouchers, discounts, and access to tourist attractions; others take the form of social recognition, such as public awards; others allow users to support general initiatives within their universities.
- **Energy literacy module.** It provides information on electricity in the form of short, written with simple language articles on subjects such as the elasticity of electricity demand, energy efficiency, the balance of supply and demand for energy, the carbon intensity of electricity generation, the energy transition in the European Union, and more. Knowledge of these materials is rewarded with points in the incentive programme.

The following is a sample text designed for energy literacy enhancement, on the elasticity of energy demand:

Did you know that you can contribute to reducing greenhouse gas emissions from the energy sector not only by reducing the amount of energy you use, but also by adjusting the moment of energy usage?
Electricity demand varies throughout the day, with most energy needed in the evening when people return home and use multiple electrical appliances simultaneously. To ensure that energy is available during this period of increased demand, the power grid has to plan an increase of the amount of available energy in advance.
Even a partial shift in energy use from peak to off-peak hours is important for the cost effectiveness and efficiency of our power system. Such shifts in the periods we use electricity is known as the elasticity of electricity demand. This means that only to some extent can we match our energy needs with the capacity of the system.

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3.2.3 Tailoring the application's messages to users' needs.

Users are classified into groups, formulated on the basis of users' responses to a short survey, which collects basic socio-demographic information and users' motivations for using smart energy management devices.

As an alternative to the traditional survey, the questions that define users' categories may be asked in the form of interactive quizzes that help users learn more about their own energy consumption habits.

The following is an example of a user segmentation survey: 'What type of energy user are you?':

Welcome you to our application. Before we get started, we would like to ask you a few questions about the way you use energy. This will help us to better tailor our app to your needs, and you will learn what type of energy user you are.

To what extent do the following statements **describe you as a consumer of electricity**?

Please choose one answer in the row.

	Definitely not	Rather not	Rather yes	Definitely yes	Don't know / Hard to say
I can contribute to reducing energy consumption	○	○	○	○	○
I want to be an example to others on how to use energy responsibly	○	○	○	○	○
I feel morally obliged to save energy	○	○	○	○	○
People who are important in my personal life believe that I should save energy	○	○	○	○	○
I know how much energy my computer or laptop consumes	○	○	○	○	○
I know how much energy my heating/air conditioning system consumes	○	○	○	○	○
I know how much energy my lights consume	○	○	○	○	○
I feel jointly responsible for global warming	○	○	○	○	○
Not only the government and industry are responsible for high energy consumption levels, but me too	○	○	○	○	○

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To what extent do the following would encourage you to use smart energy management devices in your place of living?

Please choose one answer in the row.

	Definitely not	Rather not	Rather yes	Definitely yes	Don't know / Hard to say
Reduction of expenses for electricity	O	O	O	O	O
Free installation of the system	O	O	O	O	O
A reduction in my negative environmental impact	O	O	O	O	O
Reductions in CO2 emissions caused by my electricity consumption	O	O	O	O	O
Recommendations from my friends and family	O	O	O	O	O
More convenient use of home appliances	O	O	O	O	O
Better adaptation of electrical appliances to my habits and needs	O	O	O	O	O
The opportunity to analyse my own energy consumption profile	O	O	O	O	O
Automatic management of home electronic appliances	O	O	O	O	O
A safer and more stable energy grid; no outages or blackouts	O	O	O	O	O
Attractive hi-tech appliances in the system, such as touchscreens and voice recognition	O	O	O	O	O
Ease of use and no need to engage in maintenance of the system	O	O	O	O	O
Ease of adjusting the device to my own preferences and needs	O	O	O	O	O
The opportunity to impress my friends and relatives with a new solution	O	O	O	O	O

How many **people live in your household (including you)**?

- O 1 person (just myself)
- O 2 persons
- O 3 persons
- O 4 persons
- O 5 persons
- O 6 persons
- O 7 persons or more

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Please indicate all people in your household, except you:

- ☐ my husband/wife/partner
- ☐ my parents/the parents of my husband/wife/partner
- ☐ my children/children of my husband/wife/partner
- ☐ other adults
- ☐ other minors

Please, indicate the size of the place in which you currently live:

- ○ village
- ○ town up to 50 000 inhabitants
- ○ town from 50 001 to 100 000 inhabitants
- ○ town from 100 001 to 200 000 inhabitants
- ○ city from 200 001 to 500 000 inhabitants
- ○ city over 500 000 inhabitants

Q6. Please enter your age:

I am _ _ years old

Which of the following best describes the type of building in which you currently live?

- ☐ Detached house/villa
- ☐ Semi-detached house / Twin house
- ☐ Terraced house
- ☐ Residential apartment (block of flats)
- ☐ Other – please specify []

Please, indicate the size of the place in which you currently live:

- ○ Me/my family
- ○ Someone else (private landlord)
- ○ Someone else (public landlord)

Based on user categorisation performed on the basis of the data collected in the survey, profiled information that is tailored to the needs of particular user groups can be sent to the users. Financially motivated users receive information on benefits and discounts on various services. Environmentally motivated users receive information on the impact of their actions on reducing greenhouse gas emissions. Users for whom social recognition is of high value are notified that

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information on those who contribute most to reducing energy consumption and increasing flexibility will be disseminated, and that those individuals will be specially recognised. Individuals who use electricity responsibly can also support initiatives for the benefit of their universities, such as securing funding for scholarships. Also, the range of information presented can be tailored to a given category of users. However, the visual style of the application should be consistent for all users.

3.2.4 Evaluating the application's effectiveness

This is a crucial component of the process and should not be overlooked. Objective evaluation of the application's impact on users' attitudes and actions allows to assess its true effectiveness.
This can be performed with the use of measurements taken before and after use of the application – for example:

- Differences in knowledge of the meaning of energy demand flexibility (based on a survey);
- The energy demand generated by air conditioning systems during the evening peak (data from energy consumption meters);
- Users' values and extent of self-identification with efforts to decarbonise the energy sector.

The data can also be analysed with a view towards users' classification into specific groups. The data collected in the evaluation process should be analysed objectively to identify the strengths and weaknesses of the initiative, and to make recommendations for future action.

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4 Segmentation of electricity users

4.1 Methodology of qualitative personification

Segmentation was based on a quantitative survey conducted in four countries in Europe in June 2020 (Denmark, France, Italy and Spain, total n=3200). Based on this study, five internally consistent but different user segments were extracted through cluster analysis. Detailed information about the quantitative survey and segmentation analysis can be found in the appendix to this document.

In the next step, the quantitatively defined segments served as a basis for qualitative analysis and preparation of descriptive fictional portraits of characters who are typical representatives of each segment - personas. This method is used in qualitative research to accessibly present the characteristic features of the individuals who comprise a given user segment. The method seeks not to present detailed information on each segment, but to demonstrate their typical characteristics through portraits of fictional individuals.[1]

Subsequently, the portraits of energy users typical for each segment were used in workshops with energy users and energy experts. The workshop investigated methods of increasing motivation to use smart energy management solutions for users of the three selected segments.

Such approach serves two objectives. Firstly, it allows to better match the needs of specific user groups with the innovative solutions developed within the ebalance-plus project. Secondly, the solutions developed within ebalance-plus are intended to be available on the market for all users in the future. Therefore, understanding the structure of the user segments and their needs is very important and helps to design tailor-made solutions.

[1] Detailed segment profiles and socio-demographic characteristics are presented in Section 5 of this document.

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4.1.1 Persona for the Open and Modest segment (53% of the sample)

The Open and Modest segment, constituting 53% of the sample in the quantitative study, was distinguished by characteristics including: higher-than-average age; average levels of social activity; open attitudes to new technologies; low ownership of devices for energy production and storage; low use of electric and hybrid cars; lower-than-average energy consumption, lower-than-average income; residence in smaller towns and in relatively small households; and high environmental values.

General values for this segment are: sensitivity, cooperativeness, and fulfilment; its key motivations to save energy are financial and environmental.

Below is the persona which has been prepared to present the above characteristics of those belonging to this segment in the form of a description of a fictional character.


Marie and her husband, Gustave


Marie's house


One of many wineries in France (Marie's hobby)


Marie's car


Marie's husband's car

Marie Lempriere (50 years old)

Marie lives in the north of Brittany, in the small town of Lannion, where she works in the property department of the town hall.

Marie will retire in twelve years. She plans to spend more time doing what she loves most: visiting the countless wineries scattered across France. Marie's love of wine is shared by her husband Gustave, who works in the carpentry shop his grandfather founded in the early 20th century.

Marie's joy is her two children: son Pierre, 26, a lawyer who lives with his partner in Grenoble; and daughter Antoinette, 28, who lives with her husband and three children in Paris, where she works on temporary exhibitions for children at the Science and Industry Museum.

Marie and Gustave are content with their lives, are in good health, and appreciate small daily pleasures. At Christmas, their children and grandchildren visit them. They spend their holidays touring France by car.

Marie lives in a small house on the edge of Lannion. She tries to live frugally and avoid major expenses. Her house was built in 1925. Since its renovation in 1986, it has been heated with a gas stove, which replaced the aging coal heating system. Marie tries to conserve energy by switching off lights when she leaves rooms, and by switching off electrical appliances that are not in use. She has heard about new solutions, such as heat pumps and photovoltaic panels, but she doesn't think she needs them. Both she and her husband own cars: Marie drives a nine-year-old Peugeot 207 and Gustave a 2008 Renault Laguna. Both cars have diesel engines, but Gustave plans that the next car he buys will have a modern hybrid drive.

Marie has a positive attitude towards the opportunities that new technology offers, but she only buys new equipment when convinced by her friends or children. A few years ago, her son bought her a tablet as a gift; after he explained how to use it, it has practically replaced Marie's computer.


Town Hall in Lannion, where Marie works


Lannion main square

Figure 3: Persona for the Open and Modest segment

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4.1.2 Persona for the Supporters segment (20% of the sample)

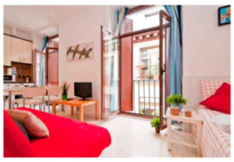
The Supporters segment, constituting 20% of the sample in the quantitative study, was distinguished by the following characteristics: high levels of energy literacy and intentions to save energy; average energy consumption; average ownership of equipment for energy production and storage; average age; high levels of social activity; relatively large households; average or lower income; environmental values; positive attitudes towards technology; average or higher education; and residence in medium-sized cities.

General values for this segment are: sensitivity, energy, positivity, and fulfilment; its key motivations to save energy are financial and environmental.

Below is the persona which has been prepared to present the above characteristics of those belonging to this segment in the form of a description of a fictional character.


Pedro at work


1st place in 2006 tournament


Inside the apartment


The townhouse, where Pedro lives with family

Care for energy efficiency at home


Pedro's and Gabriela's car


Cycling with family


On the way on vacation

Pedro Ortega (36 years old)

Pedro lives in Pamplona, in the north of Spain, with his wife Gabriela and their two children, twelve-year-old Maya and six-year-old Manuel. Pedro has been passionate about tennis since he was a child, when he started playing at primary school. Currently, he works as a tennis instructor. His wife is an administrative worker at an insurance company. Five years ago, the family moved to a larger apartment, in a building close to the city centre, to be closer to their workplaces and the children's schools. Pedro and Gabriela dedicate a lot of time to their family – including their parents, with whom they try to maintain close contact. During holidays, they try to visit new parts of the world; last year they visited Argentina, and this year they plan to visit Scotland.

Pedro tries to reduce his energy consumption for both financial and ecological reasons. When he renovated the family's apartment, he ensured that all appliances and lighting were energy efficient, and he teaches his children to use water and electricity responsibly and to segregate waste. Since they live close to the city centre, he and Gabriela decided that they no longer needed two cars. They were sold and replaced by a single new hybrid Toyota Corolla.

Pedro's home contains a lot of devices that use electricity. In addition to household appliances, they make frequent use of computers, a television, music equipment, and a games console. Although Pedro prefers that he and his family spend part of the day outside, he has noticed that everyone is using electronic forms of entertainment increasingly often. The change has been especially noticeable since the family gained access to a high-speed, fibre-optic internet connection, and since they have spent more time in the home due to the COVID-19 pandemic. Pedro has wondered how he could reduce the associated electricity consumption, but the installation of photovoltaic panels is difficult in his building due to its historic roof structure. He considered other solutions that could be applied, but failed to find any with noticeable benefits.

Figure 4: Persona for the Supporters segment

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4.1.3 Persona for the Sceptics segment (13% of the sample)

The Sceptics segment, constituting 13% of the sample in the quantitative study, was distinguished by the following characteristics: low intentions to save energy and low energy literacy; lower-than-average energy consumption; low ownership of equipment for energy production and storage; low ownership of electric and hybrid cars; average or higher age; low levels of social activity; average or lower income; low environmental values; lower-than-average education; and residence in smaller towns.

General values for this segment are: traditionalism, scepticism, and reserve; its key motivation to save energy is financial.

Below is the persona which has been prepared to present the above characteristics of those belonging to this segment in the form of a description of a fictional character.

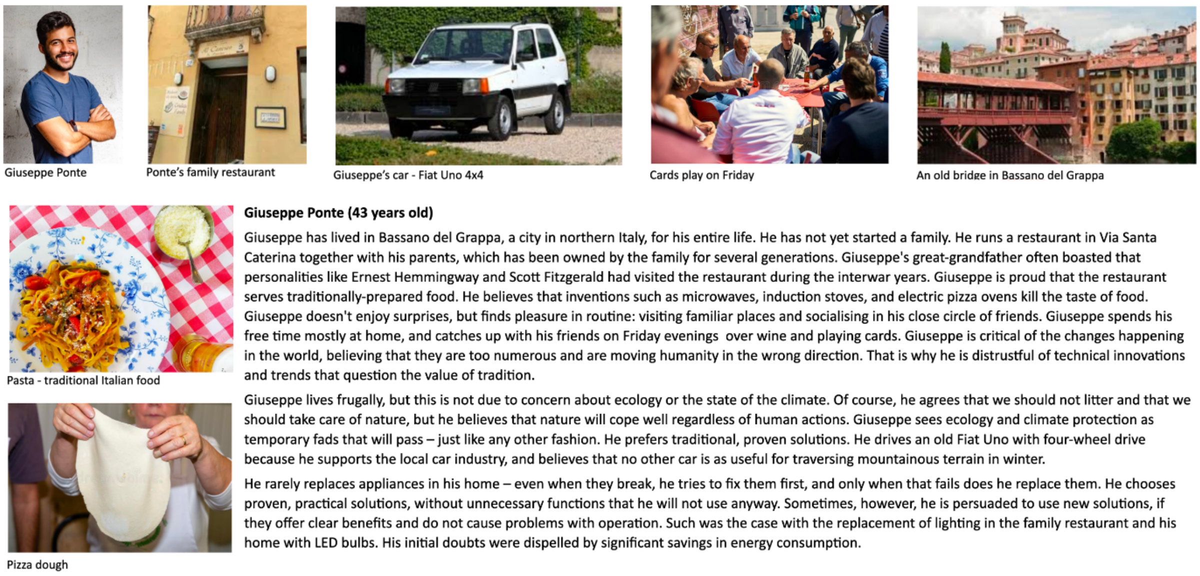

Figure 5: Persona for the Sceptics segment

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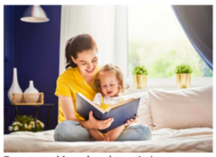
4.1.4 Persona for the Dynamic Traditionalists segment (12% of the sample)

The Dynamic Traditionalists segment, constituting 12% of the sample in the quantitative study, was distinguished by the following characteristics: average intentions to save energy; higher-than-average energy literacy; higher-than-average energy consumption; higher-than-average ownership of equipment for energy production and storage; relatively high ownership of electric and hybrid cars; lower-than-average age, high levels of social activity; relatively large households; higher-than-average incomes; low environmental values; positive attitudes towards new technologies; and residence in larger cities.

General values for this segment are: traditionalism, reserve, high activity, and dynamism; its key motivations to save energy are financial, interest in new technology, and environmental.

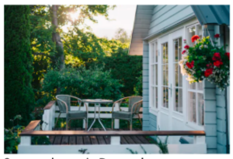
Below is the persona which has been prepared to present the above characteristics of those belonging to this segment in the form of a description of a fictional character.


Emma and her daughter, Anja

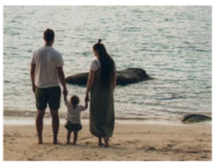

Cycling to work


Aarhus, waterfront


Andersen's family car


Summer house in Denmark


Andersen's family house


Weekend at the sea side

Emma Andersen (26 years old)

Emma lives in Aarhus, Denmark, with her husband and two-year-old daughter, Anja. She studied biology at the University of Copenhagen. She currently takes care of Anja and works part time as a Research Assistant at a pharmaceutical company. She has always wanted to have a large family, and wishes to have two more children. She believes that in the modern, increasingly unpredictable world, family and traditional values are a mainstay and should be respected. She has decided to take care of Anja herself as much as she can, and only uses the services of a babysitter for the part of the day when she is at work. Martin takes on many of the household chores – to the extent that his job allows.

The family lives in a terraced house close to the city centre. They use bikes to get around, and only use the car for weekend journeys or major shopping trips. They considered upgrading to an electric car due to favourable tax incentives and the low cost of charging, but decided that a car with an internal combustion engine would be more attractive.

They travel south once a year to warmer parts of the world, in addition to renting holiday homes in attractive locations in Denmark, Sweden, and Germany. Emma looks to the future with optimism. She is convinced that the development of modern technologies will provide her and her family a comfortable and safe life. She likes to use new technologies, and often buys new equipment out of curiosity. She has no difficulties operating new devices, and even offers advice to her friends and family. She is very satisfied with the smart home management system that the family installed last year. It automatically controls the lighting and heating, and allows voice control of multimedia.

Emma knows that much of Denmark's electricity is produced by wind turbines, so she feels that she no longer has to worry about environmental considerations when using it. When choosing new appliances for her home, she opts for ones that she finds attractive, convenient to use, and modern. The improved energy efficiency of the appliances is an added benefit that translates into lower bills.

Figure 6: Persona for the Dynamic Traditionalists segment

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4.1.5 Persona for the Affluent segment (3% of the sample)

The Affluent segment, constituting 3% of the sample in the quantitative study, was distinguished by the following characteristics: high intentions to save energy; high energy literacy; high energy consumption; high ownership of equipment for energy production and storage; high ownership of electric and hybrid cars; lower-than-average age; high social activity; average household size; high income; average environmental values; very positive attitudes towards technology; high levels of education; and residence in large cities.

General values for this segment are: high activity, ambition, open-mindedness, and the desire to stand out; its key motivations to save energy are financial, environmental, and interest in new technology.

Below is the persona which has been prepared to present the above characteristics of those belonging to this segment in the form of a description of a fictional character.

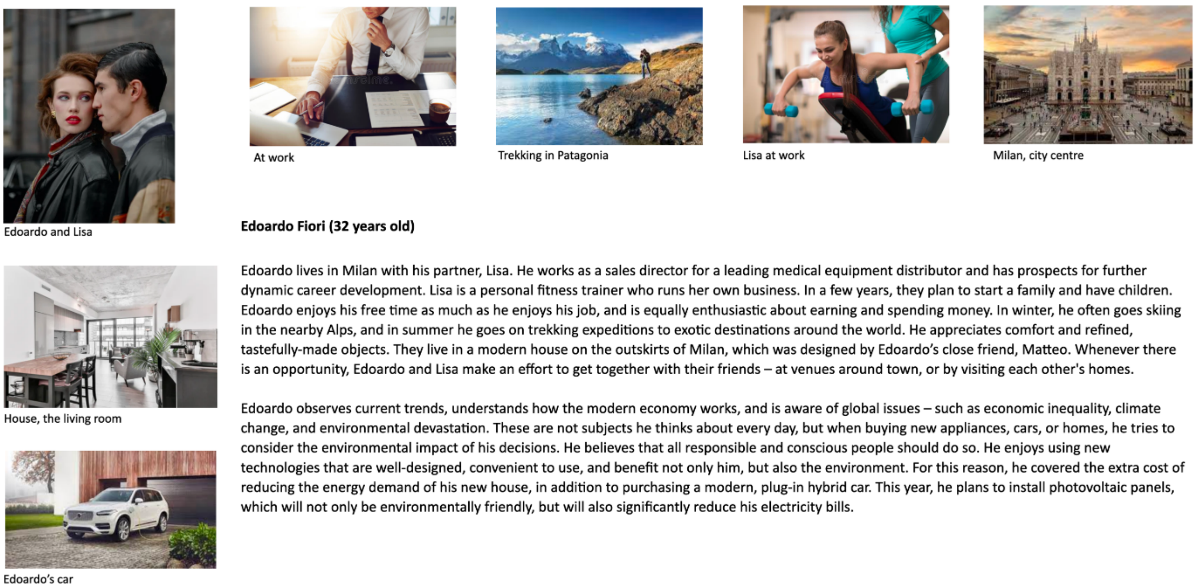

Figure 7: Persona for the Affluent segment

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4.2 Workshops on motivation building for energy demand flexibility

In May 2021, a series of three workshops was conducted with the intention of developing potential mechanisms to motivate individuals to use electricity demand flexibility solutions. One was conducted with experts who participated in the ebalance-plus project, and two involved students from the University of Calabria and University of Malaga – both of which are ebalance-plus project demo sites.

Workshops with experts

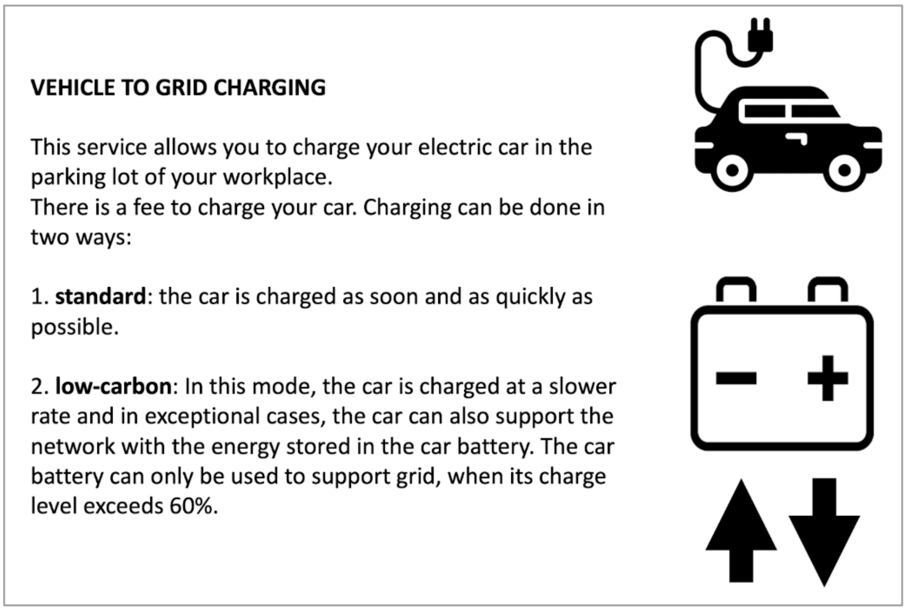
Eleven experts of the ebalance-plus project participated in the workshop, which was delivered via Zoom by moderators from the Polish National Information Processing Institute in Warsaw, Poland, and lasted three hours. The experts were split into three teams, each of which worked on motivation mechanisms for a specific segment of users (Open and Modest, Supporters, and Dynamic Traditionalists). These were defined by cluster analysis of the data from a quantitative survey conducted in 2020 as part of the ebalance-plus project (the survey results are described in D2.1, and the segmentation analysis is presented in the appendix to this deliverable, see page 53). In this group, solutions were developed for a wide range of potential users - not only in demo-sites.

Workshops with potential users in demos-sites

The students worked on solutions aimed at people like themselves – other students of their universities. They were divided into two groups, and each evaluated one of the innovations (V2G or IoT for air conditioning). The workshops each lasted three hours and were moderated by facilitators of the Polish National Information Processing Institute.

In all workshops, the participants worked on concepts pertaining to two solutions, and generated ideas for motivating electricity users to use them:

1. **V2G charging stations at workplaces**



VEHICLE TO GRID CHARGING

This service allows you to charge your electric car in the parking lot of your workplace.
There is a fee to charge your car. Charging can be done in two ways:

1. **standard**: the car is charged as soon and as quickly as possible.

2. **low-carbon**: In this mode, the car is charged at a slower rate and in exceptional cases, the car can also support the network with the energy stored in the car battery. The car battery can only be used to support grid, when its charge level exceeds 60%.

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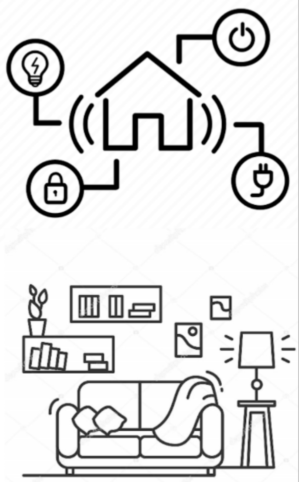
2. **IoT devices for smart management of air conditioning in homes**

AUTOMATIC HEATING / AIR CONDITIONING

At the dormitory room, the information regarding user's desired temperature range can be manually entered into the heating and air-conditioning system.

This allows the system to modify the temperature within a given range (eg + / 1.5 C). Thus, the system has a range of flexibility, and can reduce heating (or cooling) intensity during peak loads of the grid and use energy for heating (or cooling) at times when more energy is available.



4.2.1 Workshop results

The workshop results are presented according to the innovations evaluated: V2G and IoT devices for the management of air conditioning.

4.2.1.1 V2G charging stations

In the case of V2G technology, the following directions of motivation were distinguished:

A. **Benefit exchange**

As a reward for using V2G, one can access benefits, including:

- tokens or discounts for services, such as free parking and use of car washes;
- discounts for charging at commercial stations;
- tickets to cultural events, cinemas, or other attractions;
- access to more convenient parking spaces, such as those located close to entrances or in shaded areas, or those that can be entered more conveniently;
- monetary compensation for the energy ‘taken out’ of their car batteries.

This motivation was determined to align with all evaluated user segments.

An interesting method of motivating users involves providing access to local transport for the periods cars are connected to V2G. This might include public transport, or shared bikes and/or scooters. This idea is based on the observation that frequently, the routes from homes to places of work or study are long and require the use of cars. During the working day, however, cars are used to traverse shorter routes – for instance, to a restaurant for eating lunch. Providing alternative transport for these journeys in exchange for users connecting their cars to the V2G network can prove beneficial – both to the network and its users.

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It is also becoming increasingly common for electric car users to bear the cost not only of charging their cars, but also for occupancy of the charging stations, as leaving a charged car at the station blocks access for subsequent vehicles. One motivation for using V2G is that vehicles are not billed for parking at charging stations. Not only does this facilitate monetary savings for users, but is also convenient, as it is unnecessary for them to move their cars after charging is completed to avoid the cost of parking.

B. Social recognition

V2G users can also be rewarded for responsible energy use through social recognition. Such rewards might include:

- special car stickers;
- personalised appreciation letters from local mayors or other prominent figures;
- invitations to cultural events or parties.

This motivation was rated to be particularly important by seniors, as there is a strong need in this group to be noticed, needed, and productive.

C. Modern, Efficient Technology

One attraction of V2G technology is the perception that it is a cutting-edge solution that is a precursor to future development. It is an example of a technology, available today that achieves high energy efficiency by intelligently connecting multiple devices into an efficient network.

V2G technology allows us to live, to some extent, in a future world in which we achieve energy and climate goals through modern technological solutions.

This motivation has been identified to fit the Supporters segment – individuals who are aware of present-day climate and environmental risks, but simultaneously live active, modern lifestyles, and are willing to capitalise on the benefits of up-to-date technology.

D. The impact of V2G on grid load

Users are informed on their personal grid loads and energy consumption. For some, it is important to know how much energy has been saved through technology and its impact on the overall outcome. They are curious about the broader effects of their actions.

E. V2G as support for energy generation and storage at home

Electric cars can be used as smart batteries that provide electricity to users' homes and enable monetary savings via the use of low-carbon electricity. V2G technology allows the electric car to be used as home energy storage, so that the user can also benefit from this functionality without investing in home batteries. Such solution also helps to protect the environment and supports grid security.

This use of V2G technology (in homes, rather than offices) might be easier to implement in practice, as most of the costs and benefits of using car batteries are borne by the same individuals. This means that such a system can work even without a reward mechanism for connecting cars to V2G.

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When car owners support their own electricity production and storage systems with their car batteries, they are the direct recipients of a significant share of the benefits, as they can reduce their own demand for electricity from the grid and use more of that generated by their own installations. The power system also benefits from reductions in peak energy demand. It remains unestablished whether and how this benefit should be valued and passed to the owners of V2G-connected cars.

Other comments regarding V2G technology:

It is noteworthy that during the workshops involving students, a pragmatic approach to the technology prevailed. Most of the participants expected benefits in the form of access to other services or financial remuneration in return for providing the car for charging. One participant said: 'no one would do this for fame or glory'.

Importantly, neither environmental motivations nor concern for the common good emerged as significant motivations. The dominant view was that the mere use of an electric car is a sign of concern for the state of the climate and the common good, and that incentives to select eco-friendly charging modes should work in other areas.

It was highlighted that V2G technologies should allow users to define the minimum battery charge level at which the system uses energy from car batteries. This instils confidence among users that despite giving energy back to the grid, the charge levels of their cars will not fall below a defined limit – for instance, 60%. Alternatively, the minimum charge level can be estimated based on analysis of user's driving habits.

The participants also mentioned the following barriers:

- Few people are concerned about emissions levels, and even fewer pay attention to the problem;
- Low financial benefits might be insufficient for building motivation;
- Few people own electric vehicles, so the potential of the system is limited.

4.2.1.2 IoT devices for air conditioning smart systems

In the case of IoT, the workshop identified several directions of motivation, relevant to specific groups, which differed significantly.

Construction of methods to **reach middle-aged and older users**, with average or lower-than-average incomes (described as 'Open and Modest at the beginning of this section) was based on the observation that it often includes seniors, who have specific needs related to their age and expected lifestyle changes following retirement. Individuals approaching the ends of their careers are aware that as they get older, they will gradually have less strength, and might find it increasingly difficult to adapt to new technologies. Three motivations for this group were subsequently identified:

A. Financial

It is important for this group to limit their spending in order to save for the future, to have the funds to fulfil their retirement dreams, or to pay for care when they suffer health issues. Having a supplementary budget is one way of increasing their sense of security – it serves as an insurance policy of sorts.

B. Security

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This need manifests quite literally, in the form of physical security. It is a fear, for example, of having one's home burgled during an extended absence. Systems could also detect whether a burner in the kitchen switched off (fire hazard), or signal the risk of flooding from a leaking water installation.

C. Convenience

As individuals age, it becomes more difficult for them to adapt to technological advances, and convenience becomes more important. A system that intelligently adapts to its owners' preferences and daily routines to effectively manage a home's ventilation, cooling, and heating could free homeowners from having to control the system themselves, in addition to providing thermal comfort with optimal energy use.

In summary, an IoT system that manages air conditioning systems for this audience should be designed in a way that targets its key motivations: the provision of noticeable financial savings, ease of use, and enhancement of security among homeowners. With these in mind, its operation should require minimal time – it should operate automatically and in the background, rather than allowing for the self-adjustment of a wide range of parameters. To increase users' sense of security, the system could, for example, additionally control the lighting in homes during their absence; thus, simulating that the home is occupied.

For working parents (the 'Dynamic Traditionalists' and 'Supporters' segments described in Chapter 1.), other motivations prove to be of higher importance. Their needs closely relate to their roles as parents who are concerned about the welfare of their children and wish to actively contribute to improving the state of the climate. Resultantly, the following motivations were identified for these users:

A. The future of children

Concern for the future of children can be expressed through concern for the state of climate and nature, in ensuring that the world in which future generations will reside is as healthy as possible. To address this need, systems can report on the climate benefits generated by their use (for instance, in stating the number of trees that have avoided being felled). Educating children through an application that offers advice on how to use energy responsibly can increase energy literacy – not only among children, but also their parents.

B. Energy Literacy

It is also important for this group to know the emissions generated by their households, and to have the ability to compare it to those of others living in their districts or households of similar sizes. It can also be motivating to know how much savings can be achieved by changing the temperature, and its relationship with perceived comfort.

C. Modern technology

Much of the attraction of new technology lies in its efficiency and the interoperability of multiple devices connected into larger, interactive networks. Using modern solutions to intelligently manage energy is firstly an expression of concern for

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the state of the planet, and secondly a lifestyle and method of cultivating one's social image. To address this need, communication to users should emphasise efficiency, modernity, and being in tune with current trends. Visible cues displaying the use of new technologies, such as solar panels on roofs, charging stations for cars, and other emblems or markings also contribute to satisfying this motivation.

D. Financial

Working parents are also sensitive to financial arguments – although the motivations above are comparable or more important.

Among students, the following motivations were considered to be most important:

A. Social recognition

This motivation was evaluated to be of most relevance to students. Suggestions include membership in some kind of organisation (i.e named 'The Green World Club') for those who use energy responsibly, and the personal recognition from universities of those who are most effective in reducing their consumption.

The exposure of efforts is also important. This might include public information containing rankings of the eco-friendliest users, or t-shirts that present information on actions. Such actions contribute to the dissemination of ecological values among student populations.

B. Energy Literacy

Energy literacy could be enhanced using an application that instructs users how to set the optimal temperature range in a particular room both to feel comfortable and to reduce energy consumption.

C. Financial

Ideas were also presented that involved rewarding the use of IoT devices for air conditioning systems with giveaways and other benefits. These were considered to be significantly less motivating than social recognition, however.

4.2.1.3 Barriers to the use of energy management systems

Designers of systems for energy management should be mindful of the following barriers that have the potential to stifle user motivation:

- system failure when the success of plans, or life and career goals depend on systems' operation: in the case of a car using V2G and remaining uncharged in an emergency situation, confidence can be eroded in the technology long afterwards;

- sense of social justice and equal treatment of all citizens: there is a risk that benefits for those who adopt new technological solutions will create a new, privileged social class, which, due to its ability to finance new solutions, will benefit from lower energy prices and from ownerships of their cars. When developing solutions, care should be taken that they are widely accessible.

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It seems that motivating individuals to use IoT devices for HVAC (Heat Ventilation and Air Conditioning) systems is easier than motivating them to use V2G. In the case of HVAC systems, the use of new solutions does not require noticeable changes in habits or routines, does not require significant compromises, and is relatively simple – after a system is installed, it should operate almost completely automatically, while simultaneously benefitting its owner.

More sacrifices are expected from users of V2G systems. The technology requires that users share access to their cars, agree to extend their cars' charging times, consent to use of their batteries (which may reduce the lifetime of a battery), and accept that car batteries might not charge fully. Convincing electric car users to adopt this technology will be more challenging and would require the delivery of meaningful, tailored benefits.

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5 Appendix – detailed description of segmentation analysis

5.1 Methodology of segmentation

Segmentation was performed by clustering – a quantitative, exploratory analytical technique. Its aim was to identify a number of groups (which are known as clusters) of similar objects – in this case, groups of the individuals surveyed. Such groups are defined firstly by the similarity of objects assigned to them, and secondly by the differences between them. In this case, the similarity can be found within the groups' responses to a set of questions, which were used as input for clustering. The following questions were used:

1. Which of installations / facilities listed below do you have at home?
2. Which of the following electronic devices, controlled by a smartphone, computer, or tablet, do you have in your household?
3. What is the primary source of heating in your home?
4. Which of the devices and installations listed below do you plan to buy in the next 12 months?
5. How many cars do you own?
6. What type of engine does your first car have?
7. What type of engine does your second car have?
8. Are you planning to buy a car within the next 2 years?
9. What type of engine does the car you are planning to buy have?
10. Why do you plan to buy this type of car? (please state up to 3 reasons)
11. Would you agree to pay the same amount for charging an electric car as for fuel for a standard petrol car?
12. Are renewable electricity production and storage facilities installed in the building where you work or study (in normal circumstances, not during the COVID-19 pandemic)?
13. Are you in favour of installing renewable energy production and storage devices at your place of work or study (in normal circumstances, not during the COVID-19 pandemic)?
14. Are you considering taking action to reduce cost of your energy consumption? If so, what?
15. Have you ever talked with other people about saving electricity?
16. Have you ever searched for information on how could you reduce your energy consumption?
17. Think of your experience with devices for the production of energy in your household. To what extent are you satisfied with these devices?
18. What are the most important benefits of using energy production facilities in the household that you see? (please state up to 3 answers)
19. Do you believe that installing renewable energy production and storage equipment can be economically justified?
20. Do you plan to add new equipment for energy production (for example, by adding new devices and functionalities)?
21. Are you planning to install energy production and storage devices in your home?
22. Why do you plan to buy new equipment for energy production?
23. Would you be interested in using such a system (evaluation of concepts: automatic lighting control in the home; external washing machine control; external charging control for an electric car)?

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The analysis included data collected on a sample of n=3200 individuals residing in France, Spain, Italy, and Denmark. The alternative, which we opted not to use, was to conduct four independent segmentations (one for each country). This decision resulted directly from the research objective, which was to empirically determine the divisions into groups that exist across national divisions. This approach did not exclude in advance that the empirical results would not demonstrate differences between the populations of the countries.

We utilised the hierarchical clustering method. This technique returns clusters in the form of a tree that connects individual objects in growing groups, from clusters containing single objects to one containing all objects. The researchers—after learning the structure of the tree, the parameters of divisions into smaller groups, and statistical descriptions of the responses offered to the questions within variously fragmented groups—decides on the final number of groups. As a result, unjustified *a priori* assumptions on the number and size of the clusters are avoided. Emphasis on the correct empirical result formed the basis of all of the analyst's technical decisions.

Aside from the selection of a clustering method, more detailed technical decisions were made, including the choice of metric (on the basis of which the distance matrix between the objects was calculated) and of the criterion to iteratively bind smaller groups into larger ones. These decisions, coupled with the data contained in the input, influence the final shape of the resulting cluster tree.

In our analysis, the elements of the square and symmetrical distance matrix (of size *n*, where *n* is equal to the number of questions that constituted the input for the analysis) were calculated using Gower's metric. Unlike the Euclidean metric (which is commonly used in clustering), Gower's metric is adapted to the questions posed on the interval scale, as well as the ordinal or nominal ones. Moreover, its use allows us to include variables containing data gaps in the responses. The input to our analysis contained such variables, as some of the questions were asked only when a specific answer to another question had been entered.

We opted to use Ward's minimum variance method as a binding technique – specifically, its special case. The method determines how to bind smaller clusters into larger ones based on optimisation of the objective function. This objective function is the criterion for tying clusters iteratively into larger groups. In the case of Ward's minimum variance method, optimisation involves minimising the squares of the distance between objects inside the clusters in each iteration.

The rationale for the decision to trim the cluster tree (and consequently, the final selection of the number of clusters to be further described) was the information contained in: 1) the settlement chart, on which the x-axis was marked by an increasing number of smaller clusters, and the y-axis by the quotient of the intra-cluster and inter-cluster variance; 2) variant charts (which were drawn for each consecutive number of clusters) of the scatterplot type, exhibiting objects grouped into clusters, placed on two dimensions determined by additional multidimensional scaling; and 3) variant sets (which were also constructed for each consecutive number of clusters) of heatmap charts comparing the conditional proportions of answers to individual questions, depending on the membership of a cluster. On this basis, the final number of clusters was established by an experienced researcher.

All analytical steps, including the construction of charts, were programmed in *R* by the analyst. The functions of analyst and researcher were divided between different people to minimise the unintended impact of research expectations on the shape of the empirical results.

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5.2 Characteristics of user segments

As a result of the analysis, five segments were identified, which are presented in the scatterplot diagram below. The numbers of individual segments are as follows: cluster 1 (n=1,681); cluster 2 (n=634); cluster 3 (n=410); cluster 4 (n=374); cluster 5 (n=101).

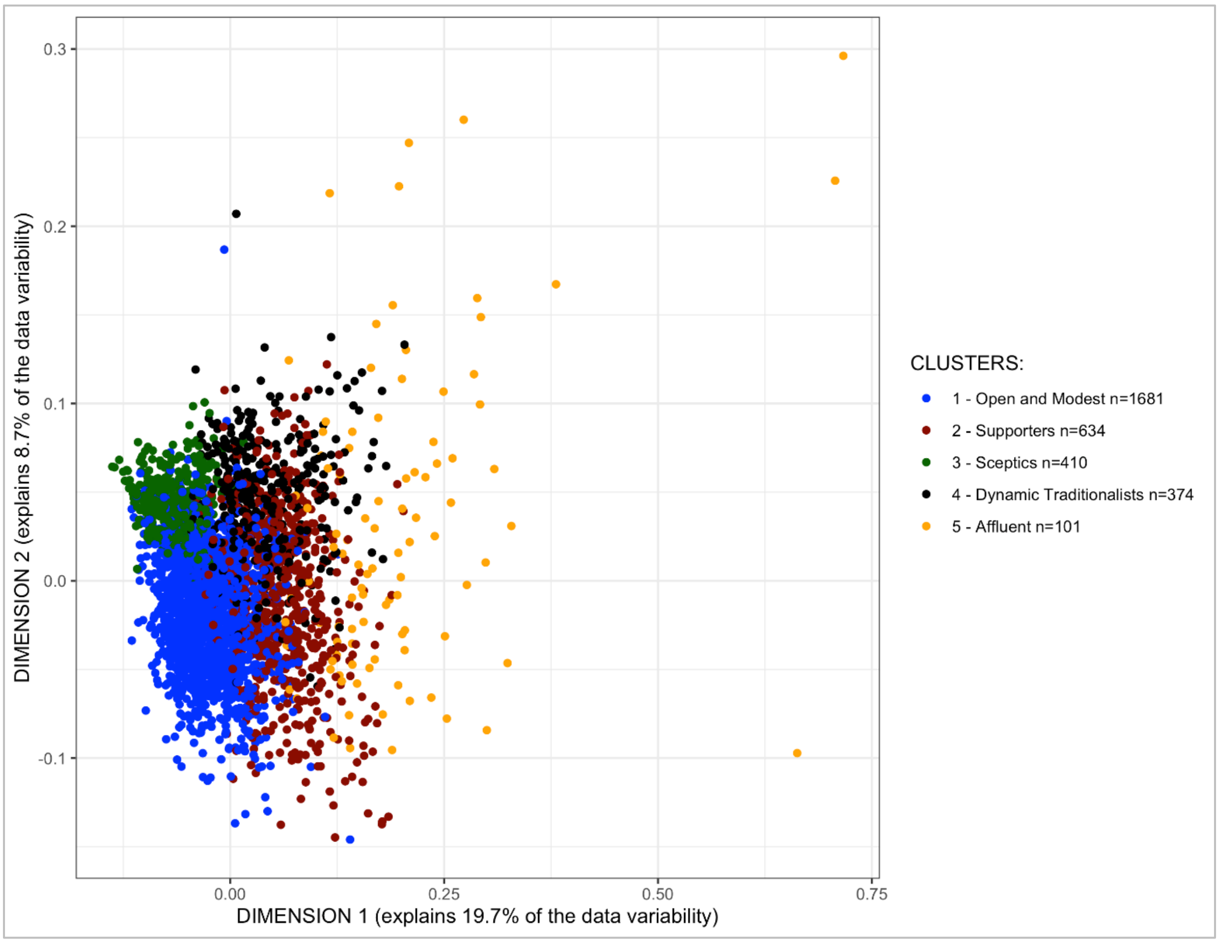

Figure 8: Scatterplot diagram displaying the five clusters identified in the analysis.

On the basis of analysis of the response profiles of individuals belonging to particular segments, we have distinguished the features that are characteristic for each of them. Recognition of a characteristic among a segment means that it is present at a higher intensity than in other segments.

Based on the characteristics of the individual segments, we can observe that high scores on the horizontal axis of the scatterplot diagram (Dimension 1) are more common for households that are well equipped with installations for the production and efficient use of energy and smart electronic devices. These households more frequently own hybrid or electric cars. Electricity expenses are controlled, and efforts are made to reduce consumption.

From the psycho-demographic characteristics, which were not a criterion considered during segmentation, we can observe that high horizontal scores are more often attributed to young, economically active people who have higher incomes, reside

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in larger households (usually with children), freely use technology, are familiar with current technological trends, and demonstrate higher sensitivity to environmental problems. Conversely, low scores on Dimension 1 are more often attributed to people who are less wealthy, elderly, not employed, reside in smaller households (more often without children), and use technology less freely.

High performance on the vertical axis (Dimension 2) is dominated by people who are less supportive of the development of renewable energy sources, both at their places of work or study and in their households. They are less interested in saving energy, and are less convinced of the economic viability of renewable energy plants. The analysis of this group's psychographic profile, which was not included in the segmentation, exhibits high scores on the vertical axis (Dimension 2) for individuals who have more conservative, traditional views, and an unwillingness to adapt to new technologies. Additionally, this group is sceptical, has narrower social circles, and is less sensitive to environmental problems. Conversely, low scores on Dimension 2 are more often attributed to those who hold liberal views, are open to change and new knowledge, and have wider social circles.

Cluster 1. Open and Modest

This is the largest segment (n=1,681). It includes individuals who reside in households with few installations to produce and increase energy efficiency but exhibit positive attitudes towards the development of renewable energy, and declare a desire to save electricity. These individuals also do not have smart electronic devices or declare willingness to purchase them. They rarely own hybrid or electric cars, although half wish to do so in the future.

The psycho-demographic profile (which is not a segmentation criterion) demonstrates that there are individuals with liberal views in this segment, who are sensitive to the problems of others. They exhibit positive attitudes towards technology, although they sometimes need assistance in handling or learning new solutions. These individuals are slightly older than average, with longer professional experience, or are retired. They more often reside in smaller households. They prefer cooperation to competition. They are fulfilled in life, and their incomes are average or lower-than-average.

Cluster 2. Supporters

A large segment (n=634) that contains households that are well-equipped with both energy production and saving installations, and smart electronic devices. In these households, efforts are made to control and reduce energy consumption. Environmental considerations, in additional to financial ones, are a key motive for saving energy among this segment. Its members support the development of renewable energy, both at work and at home. They demonstrate good understanding of the concepts evaluated in the study and are interested in using such solutions.

The psycho-demographic profile shows that they are young, active people with higher-than-average incomes. Individuals in this segment more often live in larger households (with children) and maintain wide social circles. They are aware of the current state of the environment and are sensitive to these problems. They are energetic, fulfilled in life, and are positively oriented towards others and the world. They use new technologies easily and help others to use them.

Cluster 3. Sceptics

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This segment includes households that are poorly equipped with devices to produce and use energy efficiently, and do not own smart electronic devices. Its members have little desire to save electricity, and do not support the development of renewable energy. They own cars with traditional internal combustion engines and intend to continue buying them in the future. Frequently, they had problems understanding the concepts discussed, and were the least interested in using them.

On the basis of analysis of the segment's psycho-demographic profile, we can observe that individuals with traditional views stand out somewhat: they are sceptical of change and distrustful of new technologies. They reside in the smallest households and maintain the narrowest social circles – which are mostly limited to their families. In this group, there are many who deny the existence of environmental or climate change; therefore, they rarely make decisions based on ecological considerations. Members of this segment are relatively less educated and have lower incomes.

Cluster 4. Dynamic Traditionalists

Members of this segment live in well-equipped households, both in terms of appliances to produce and save energy and smart electronic devices.

These individuals monitor electricity consumption and take measures to reduce it, but do so primarily for financial, rather than environmental reasons. Relatively often they own hybrid or electric cars; nevertheless, in the future they would prefer to own cars with traditional internal combustion engines.

The psycho-demographic profile (not included in the segmentation process) shows that this segment possesses values similar to those of the Sceptics, but are younger, and more active. They often reside in larger households (with parents or children) and have significantly higher-than-average incomes. They adapt easily to technological novelties and are able to use them freely but are also suspicious of excessive dependence on it. They are not particularly concerned by environmental problems, and in climate change, they see opportunities and benefits rather than threats.

Cluster 5. Affluent

This is the smallest segment (n=101) and is markedly distinct from the others. Its members consume the highest amounts of electricity and take active steps to economise it. They support the development of renewable energy, have by far the largest number of power generation devices in their homes (54% vs. 8% of the entire sample), and use smart electronic devices. Most frequently among the segments surveyed, they own hybrid (26%), plug-in hybrid (9%), or fully electric cars (11%). In the future, they most often intend to own cars with hybrid (25%) or fully electric (24%) engines. Individuals in this segment are the most interested in the concepts assessed in the study and understand them well.

According to their psycho-demographic profile, they are relatively young people who have achieved considerable professional success. They often hold prestigious positions and have high incomes. They usually live with their partners and children in their own homes in larger cities. They are positive about the world, open-minded, aware of their success, and have a desire to stand out. They use technology very freely, and often serve as sources of information on new solutions.

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5.3 Household equipment

The Affluent segment, stating more than twice as frequently as other segments that they owned facilities for energy production and temperature management, is by far the best equipped. The fewest energy production and storage facilities can be found in the Sceptics and Open and Modest segments, while the Supporters and Dynamic Traditionalists have an average number.

Which of the installations / facilities listed below do you have at home?

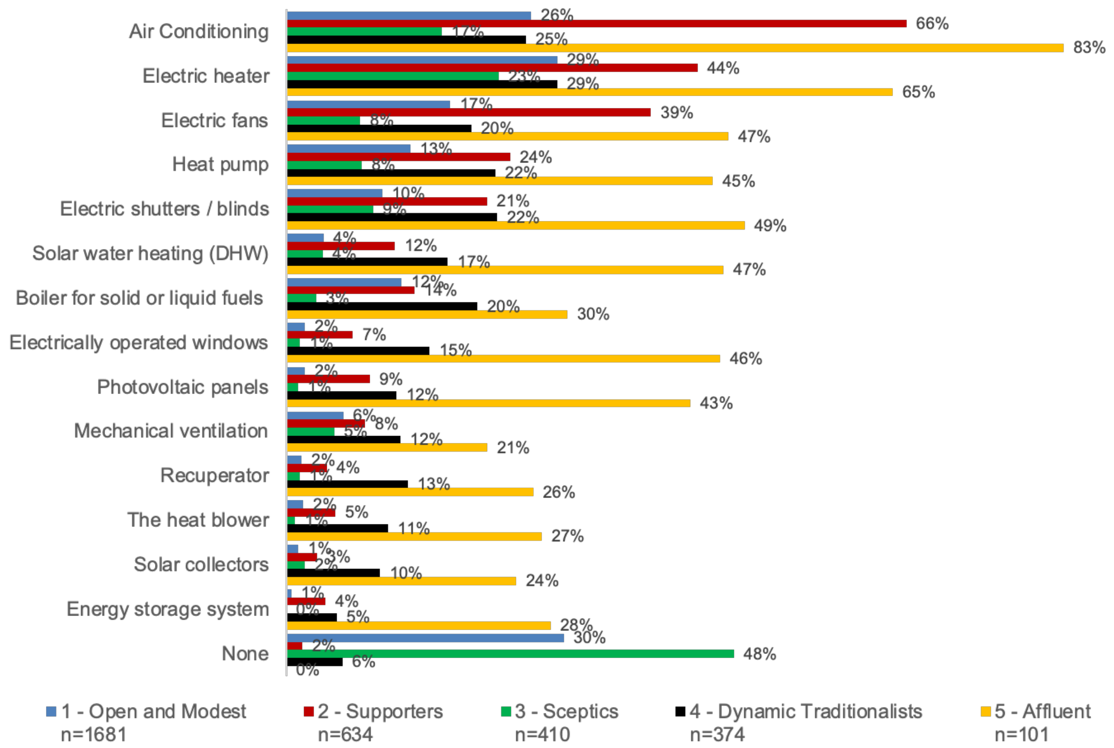

Figure 9: The installations / facilities in home

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A similar picture emerges around ownership of smart electronic devices. Those in the Sceptics and Open and Modest segments usually own no such devices; the Supporters and Dynamic Traditionalists segments are similarly equipped and straddle the average; by far the most are found under the ownership of members of the Affluent segment.

Which of the following electronic devices, controlled by a smartphone, computer, or tablet, do you have in your household?

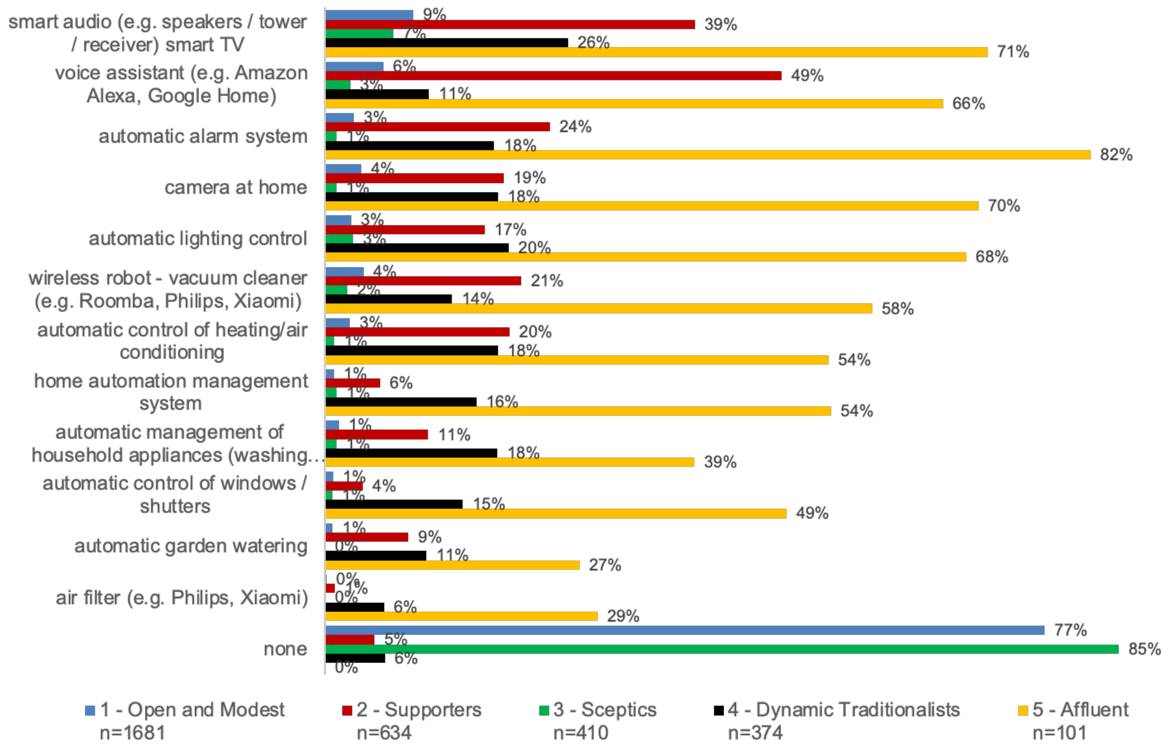

Figure 10: Electronic devices in home

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5.4 Car ownership

Ninety percent of the Supporters and Affluent segments, over 80% of the Open and Modest and Dynamic Traditionalists segments, and 68% of the Sceptics segment owned at least one car.

Car ownership by segments

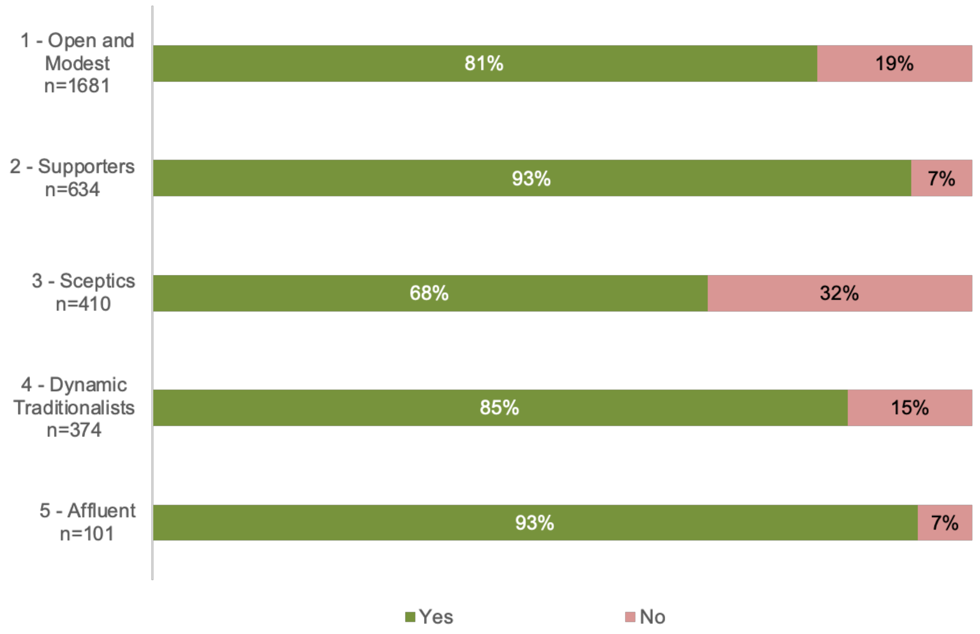

Figure 11: Car ownership

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We can observe that in the segments in which there are more young and active people, there are more cars with newer types of engines, such as hybrid, plug-in hybrid, and fully electric. Most of them belong to members of the Affluent segment. More broadly, however, the most frequently owned cars are those with traditional internal combustion engines that utilise petrol and diesel.

Type of engine in current car by segments (among car owners)

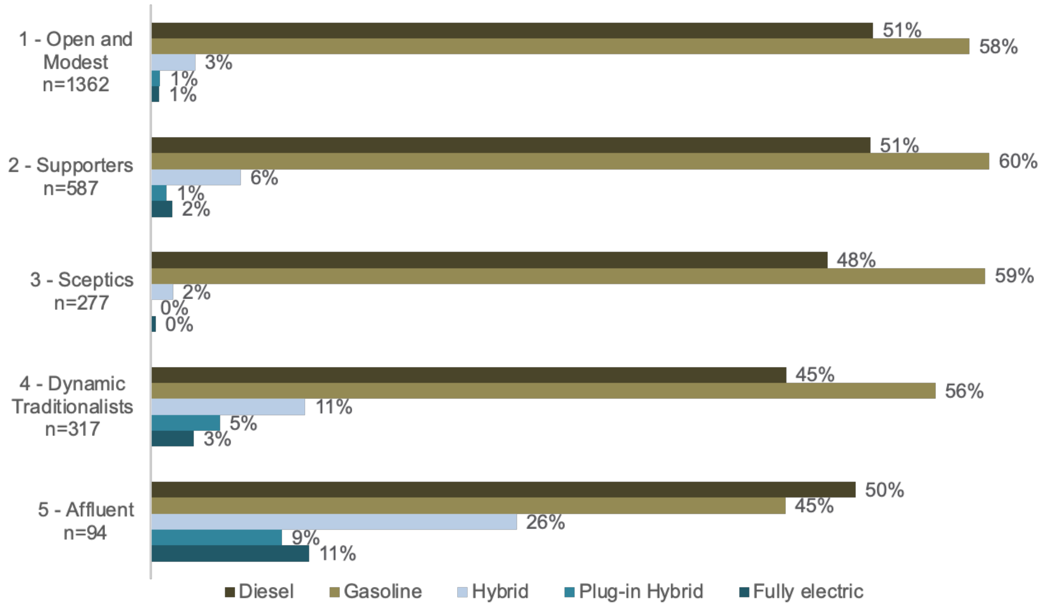

Figure 12: Type of engine in car

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The engine types of the cars that the respondents intended to buy differed from those in their current cars. In the Sceptics and Modern Traditionalists segments, respondents most often planned to buy cars with traditional petrol engines (33% and 26%, respectively). Even in these segments, however, a significant proportion of respondents intended to buy cars with hybrid engines.

In the Open and Modest and Supporters segments, respondents most often planned to buy cars with hybrid engines (29% and 33%, respectively), and relatively often planned to buy plug-in cars with hybrid engines (11% and 17%, respectively) or fully electric (9% and 11%, respectively). In the Affluent segment, the share of fully electric cars in planned purchases was by far the highest (24%), while the shares of hybrid cars (25%) and plug-in hybrid cars (14%) were also significant.

Type of engine desired in future car (answer: those who plan to buy cars)

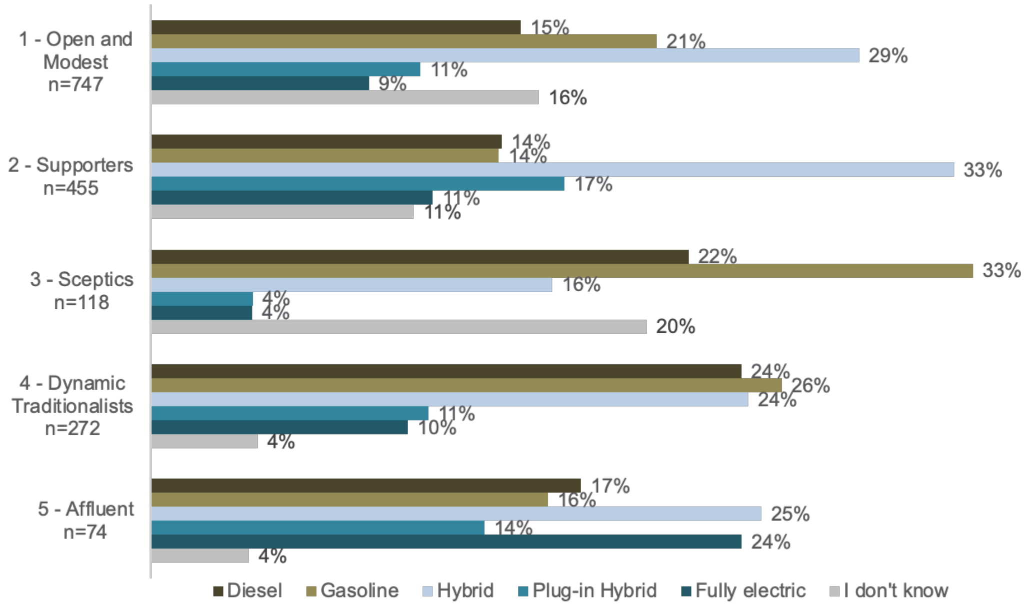

Figure 13: Type of engine in future car

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Environmental considerations are the most common justification for selection of a particular type of engine among all segments except the Sceptics – for which low operating costs, comfort, and failure-free operation were the most important. For Open and Modest, in addition to environmental arguments, practical considerations are also important – low running costs and range. Among the Dynamic Traditionalists, design and aesthetics also played important roles.

Why do you plan to purchase this type of car? (please mark up to 3 reasons)

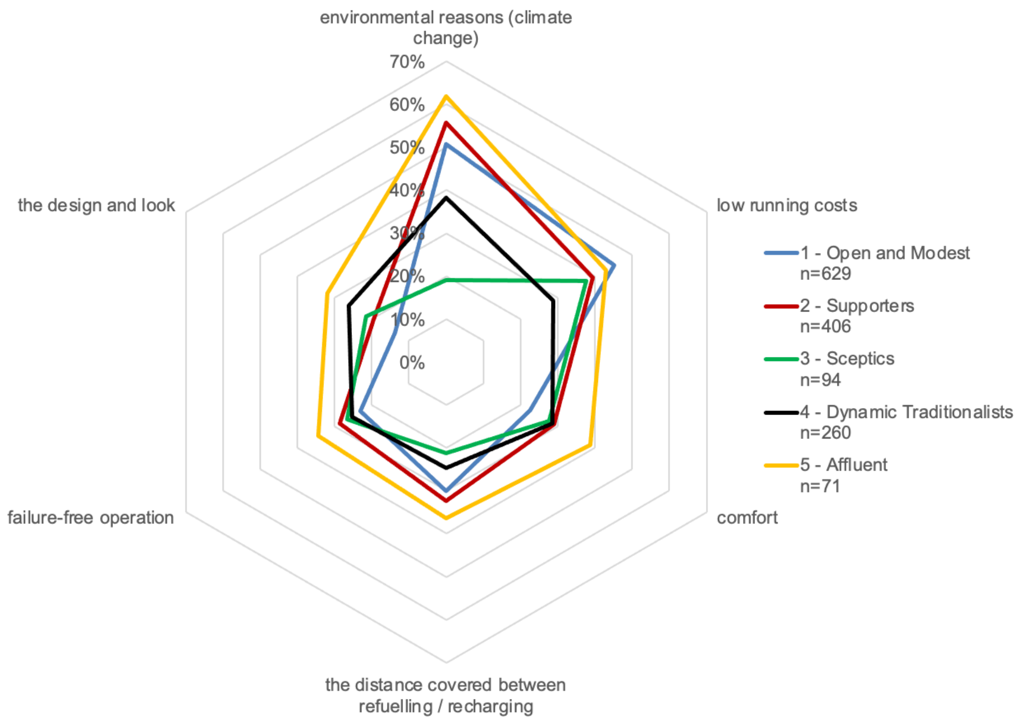

Figure 14: Reasons for buying a car of a particular engine type

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5.5 Facilities for renewable energy production and storage

Electricity generation and storage facilities are installed at the places of work or study of more than half of the Dynamic Traditionalists and Affluent segments, and 20% of the Supporters segment.

Members of the Open and Modest and Sceptics segments are often unaware whether such installations are installed at their places of work or study, or the question is inapplicable to them as they are retired, or, for other reasons, do not work or study.

Are renewable electricity production and storage facilities installed in the building where you work or study (in normal circumstances, not during the COVID-19 pandemic)?

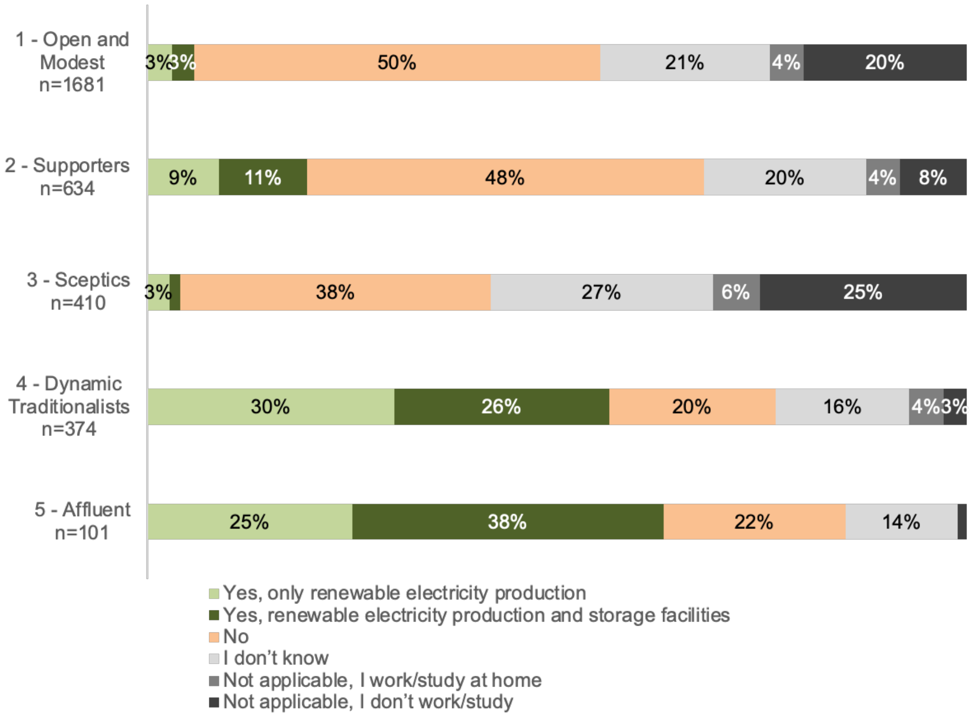

Figure 15: Renewable electricity production and storage facilities in building

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The most ardent supporters of the installation of energy production equipment are members of the Affluent and Supporters segments. Also, the majority of individuals representing the Open and Modest and Dynamic Traditionalists segments support the installation of such devices in their places of work or study.

The least support is expressed by the Sceptics – only 35% of whom support the installation of energy production and storage devices.

Are you in favour of the installation of renewable energy production and storage devices at your place of work or study (in normal circumstances, not during the COVID-19 pandemic)?

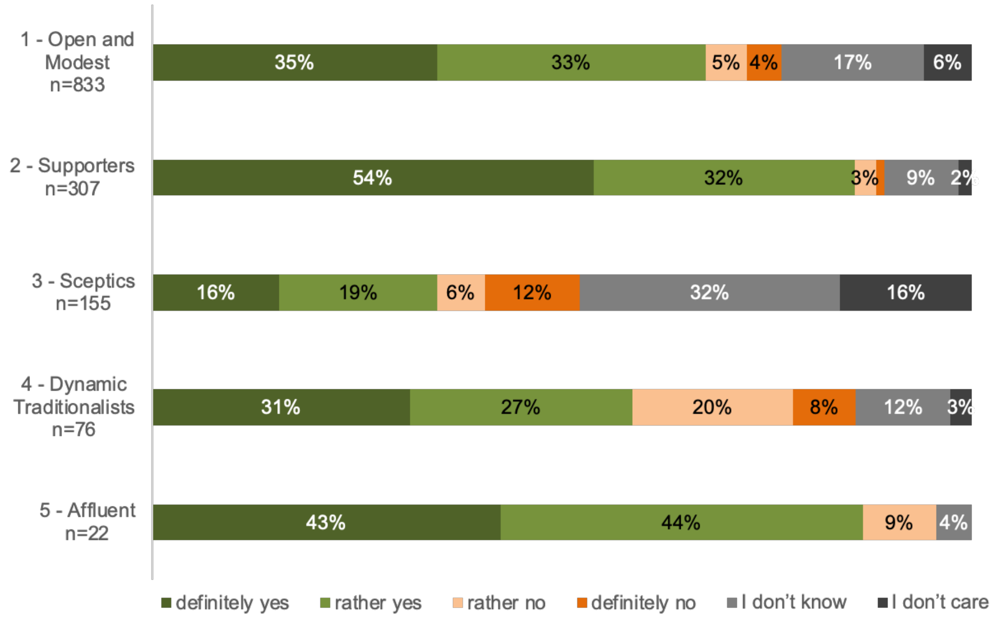

Figure 16: Support for the installation of renewable energy production and storage devices

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5.6 Energy Saving

The Sceptics segment is outstanding since as many as 91% of its members do not intend to take any action to reduce their energy consumption.

Members of the Open and Modest segment wish to reduce their consumption by simple methods, such as switching off unused devices, less intensive use of equipment, and the purchase of energy-efficient devices. In the Dynamic Traditionalists segment, energy saving through investments in home insulation, recuperation, photovoltaic panels, or replacement of existing devices with energy-efficient ones is pursued relatively frequently.

Members of the Supporters and Affluent segments are eagerly willing to save energy, and intend to do so in a variety of ways – most often by reducing the energy consumption of their equipment, and by the planning of major renovations and installations.

Do you consider taking action to reduce cost of your energy consumption? If so, what?

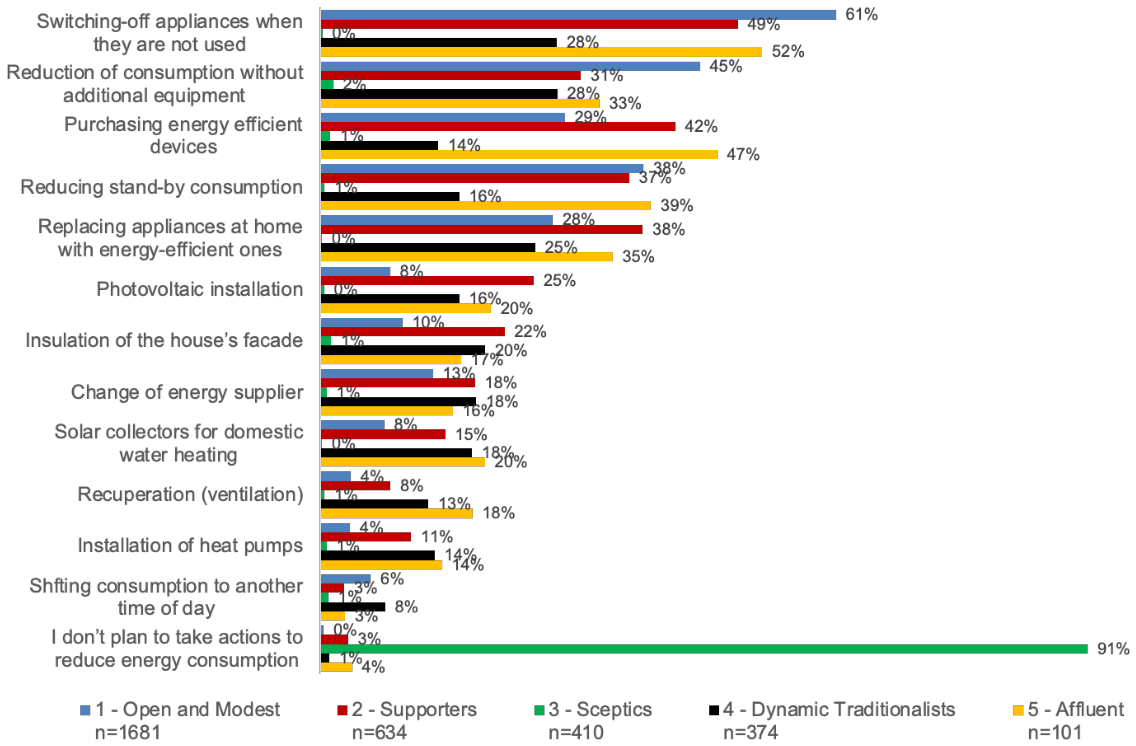

Figure 17: Considered actions for reducing electric energy consumption

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In the Sceptics segment, more than half of respondents state they do not talk about saving energy. In the other segments, the vast majority talk about it – most frequently in the Supporters (80%) and Affluent (91%) segments.

Have you ever talked about saving electricity with others?

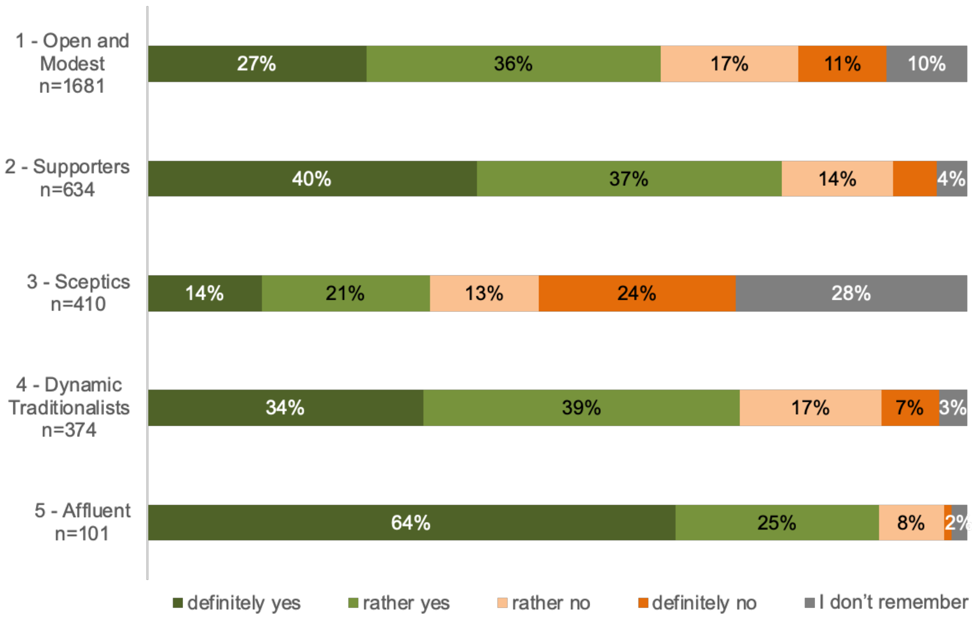

Figure 18: Talking with others about saving electricity

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The majority of individuals representing the Affluent, Supporters, and Dynamic Traditionalists segments have searched for information on energy-saving opportunities. Less than half of the Open and Modest segment and only 17% of the Sceptics did so.

Have you searched for information on how could you reduce your energy consumption?

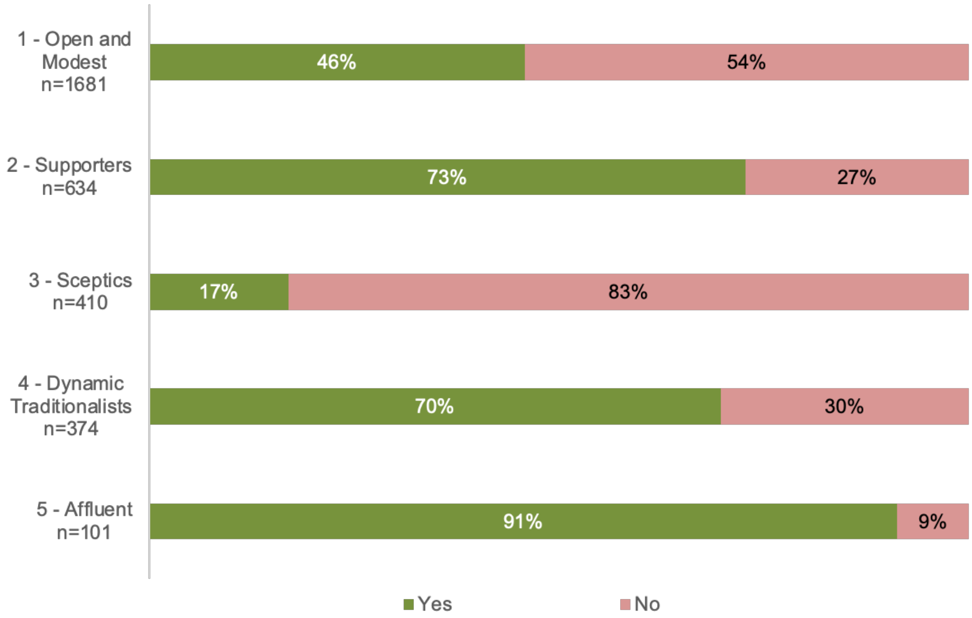

Figure 19: Searching for information about reducing energy consumption

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5.7 Devices for energy production and storage

For members of the Open and Modest, Affluent, and Supporters segments, the greatest advantages of using power generation equipment are savings on electricity bills, environmental benefits, and less dependence on external energy sources. The Sceptics segment considers the same benefits to be of most importance, but to a far lesser extent.

Among the Dynamic Traditionalists, the key benefit is the opportunity for financial gain on energy production, although reductions in bills and environmental benefits are also relevant.

What are the greatest benefits of using energy production facilities in the household that you see? (please state up to 3 answers)

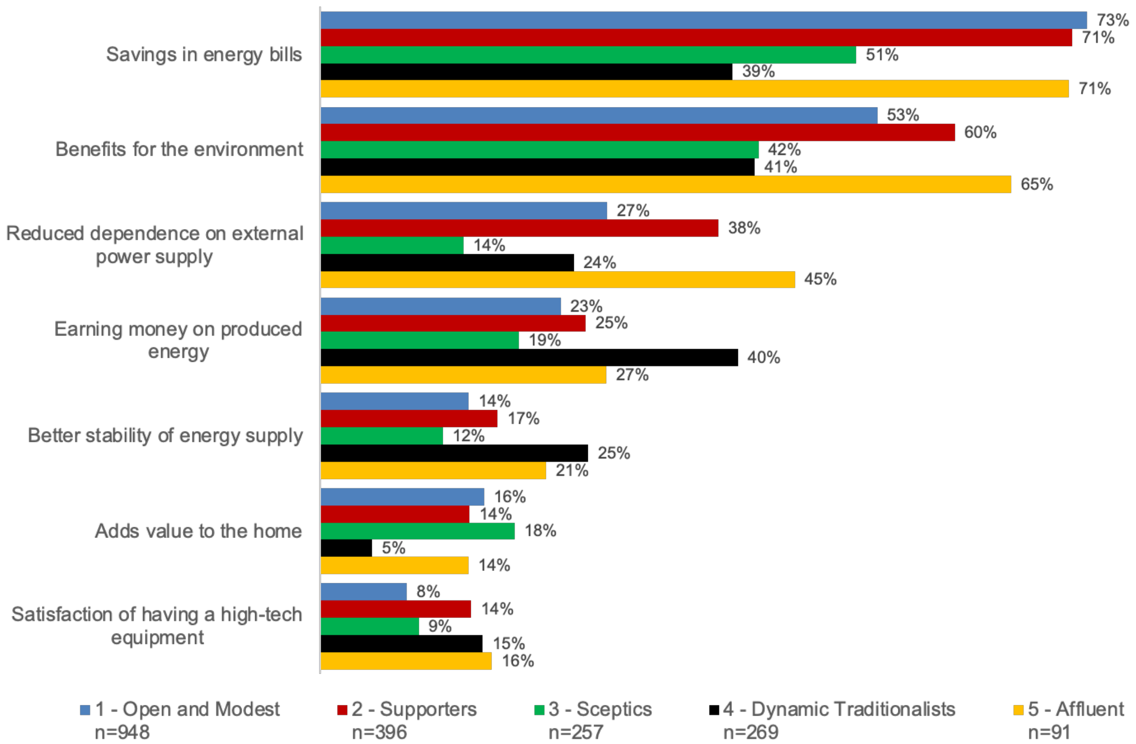

Figure 20: Perceived benefits of energy production facilities

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Eighty-two percent of the Affluent segment, 63% of the Supporters segment, and 56% of the Open and Modest segment considered it profitable to install energy production and storage equipment. Among the Dynamic Traditionalists segment, this amounts to 46%, and among Sceptics, only 33%.

Do you believe that installing renewable energy production and storage equipment can be economically justified?

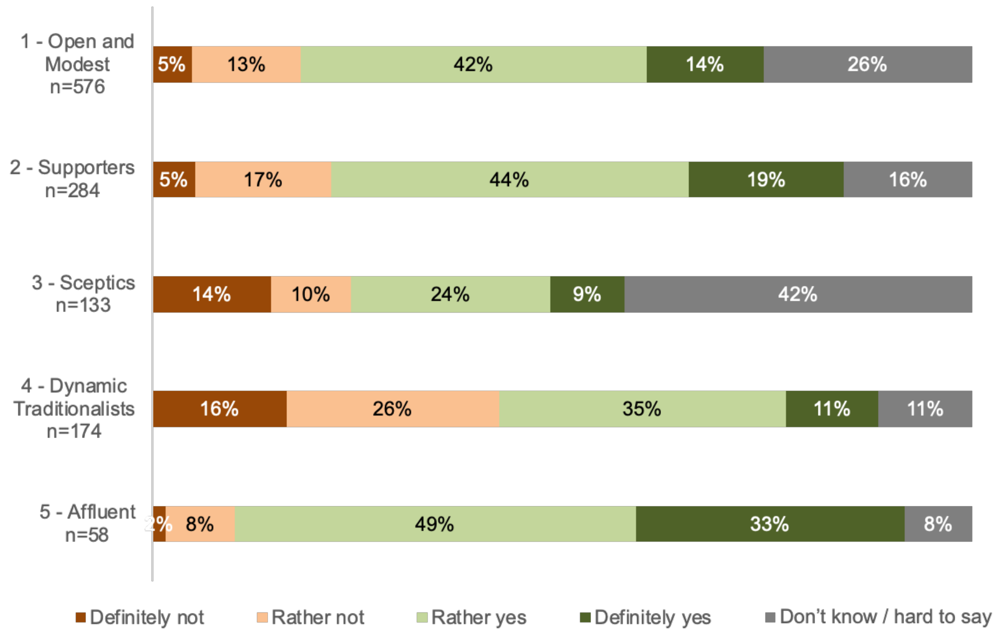

Figure 21: Perception of installing renewable energy production and storage equipment

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5.8 Evaluation of Concepts

The quantitative survey presented in this section was conducted as a first step in exploring the needs of individual electricity users. In this study, three concepts of smart electricity management solutions were evaluated and presented to the respondents in the following form:

- **Concept 1. Automatic lighting control in the apartment/house.**

The system consists of sensors detecting human presence, which are located in all rooms of the flat or house. Based on this information, the automatic system can switch on the lighting in the rooms where someone is staying and switch it off when leaving. This means that you do not need to use switches to light each room and you can reduce your electricity consumption.

- **Concept 2. External washing machine control.**

In this solution, the user of the washing machine decides not the moment when the laundry starts, but the time at which the laundry is to be finished (e.g. in the morning, before going to work the user loads the washing machine and decides that the laundry is to be finished by 17.00). The system controlling the start of the washing machine will switch it on at the most convenient time for the whole power network, i.e. when the total demand for electricity is low. Thanks to this solution, it is possible to postpone electricity consumption for a period of lower demand and reduce the total energy consumption from the area during peak hours. This reduces the load on the power grid and reduces the cost of electricity.

- **Concept 3. External charging control for an electric car.**

Imagine you have a fully electric car that you are charging from an outlet in your home or from a charging station near your apartment. In this solution, once the car is connected to a charging station, you determine by which time the car should be fully charged. For example, when you return home, you connect the car to the power supply and decide that it should be ready to drive the next day at 7.00am. The control system will decide on the exact time to start charging the car's battery so that this will take place at the most convenient time for the entire electricity grid, i.e. when the total demand for electricity is low. With this solution, it is possible to shift electricity consumption to a period of lower demand and reduce the total energy consumption of the area during peak hours. This reduces the load on the power grid and reduces the cost of electricity.

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The concepts presented in the study were understood by approximately 90% of individuals representing the Affluent and Supporters segments, while this was true for only a third of the Sceptics. In all segments, the electric car smart charging concept was slightly less well understood than the others.

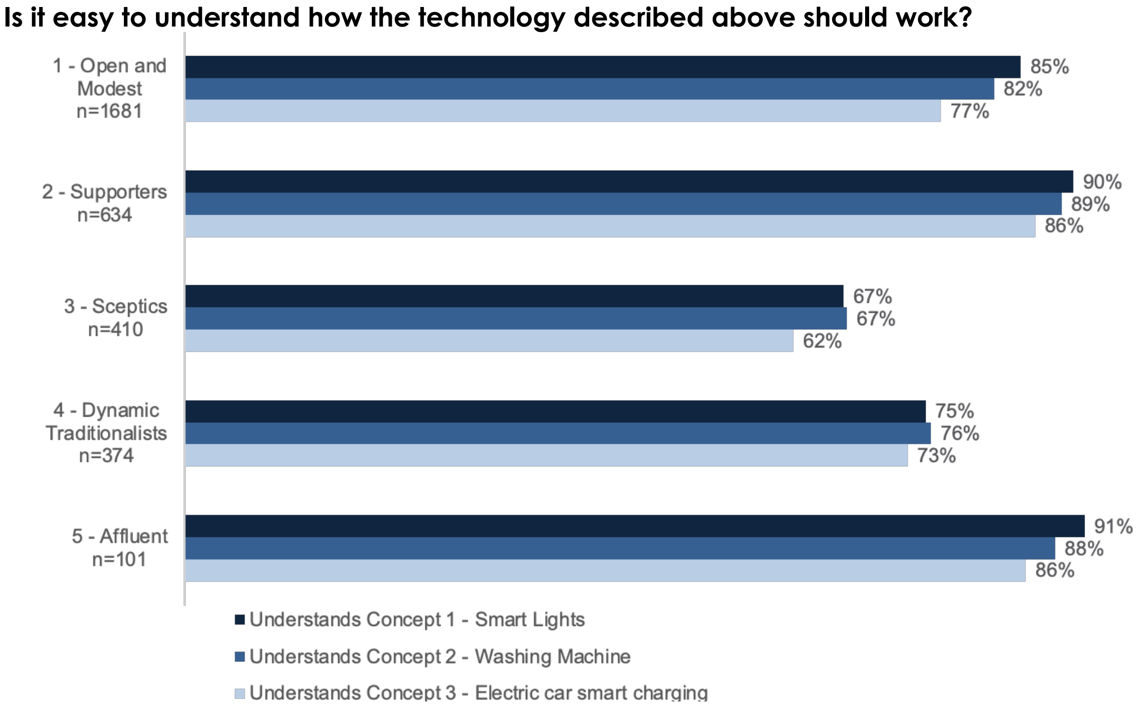

Figure 22: Understanding the concepts

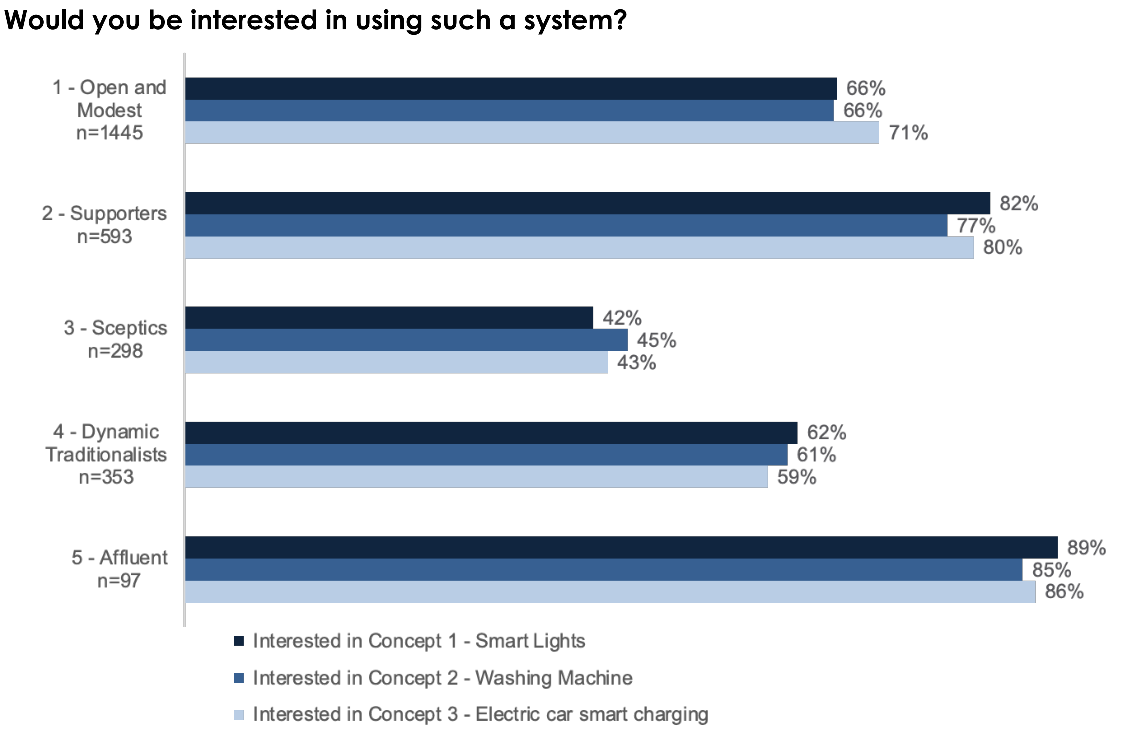

Figure 23: Interest in the concepts

The solutions presented were of interest to almost 90% of the Affluent segment and approximately 80% of the Supporters segment. They were of least appeal to the

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Sceptics (slightly over 40%). The results fail to illustrate substantial differences in the level of interest in individual concepts.

In addition to the variables on which the segmentation analysis was based, we analysed the psychographic profile of the extracted segments. The remainder of this deliverable presents the demographic profiles of individuals belonging to particular segments, their responses to questions on how they spend their free time, their life goals, as well as their attitudes towards technology, energy saving, and the environment.

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5.9 Demographic data on segments

The Open and Modest and Sceptics segments contain people of the highest average age. In the Supporters segment, no age group is clearly predominant. The Dynamic Traditionalists and Affluent segments contained the largest share of young people – more than half of whom are under 35.

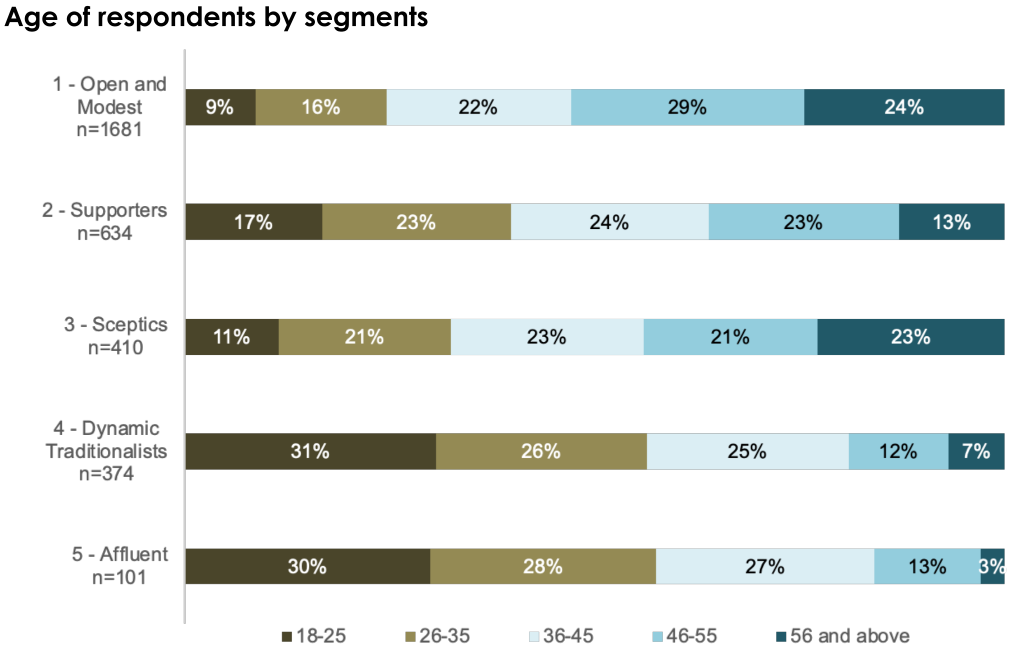

Figure 24: Demographic profile of segments - age

Based on questions 'How many people live in your household, including you?' and 'Please indicate all persons in your household, except you', we distinguished several types of frequently-occurring household: singles (households inhabited by only one person) and couples (those in which the respondent's partner lives, and others might do so), with children (those in which at least one child of one respondent lives), with parents (those in which at least one parent of one respondent lives), and with other adults (those in which other adults live, in addition to the respondents).

In the Open and Modest segment, each type of household broadly conformed to the average; only the 'with parents' and 'with other adults' categories were slightly lower. The Supporters segment mostly comprises individuals who live with partners (63%) and children (55%). The Sceptics segment exhibits by far the highest percentage of single-person households (34%), and the fewest with children (29%). In the Modern Traditionalists segment, all categories of household are close to the average, with the exception of those that are inhabited by the parents of respondents (15%). The Affluent segment has by some distance the largest share of households inhabited by respondents' children (65%) and by individuals who live with their partners (62%).

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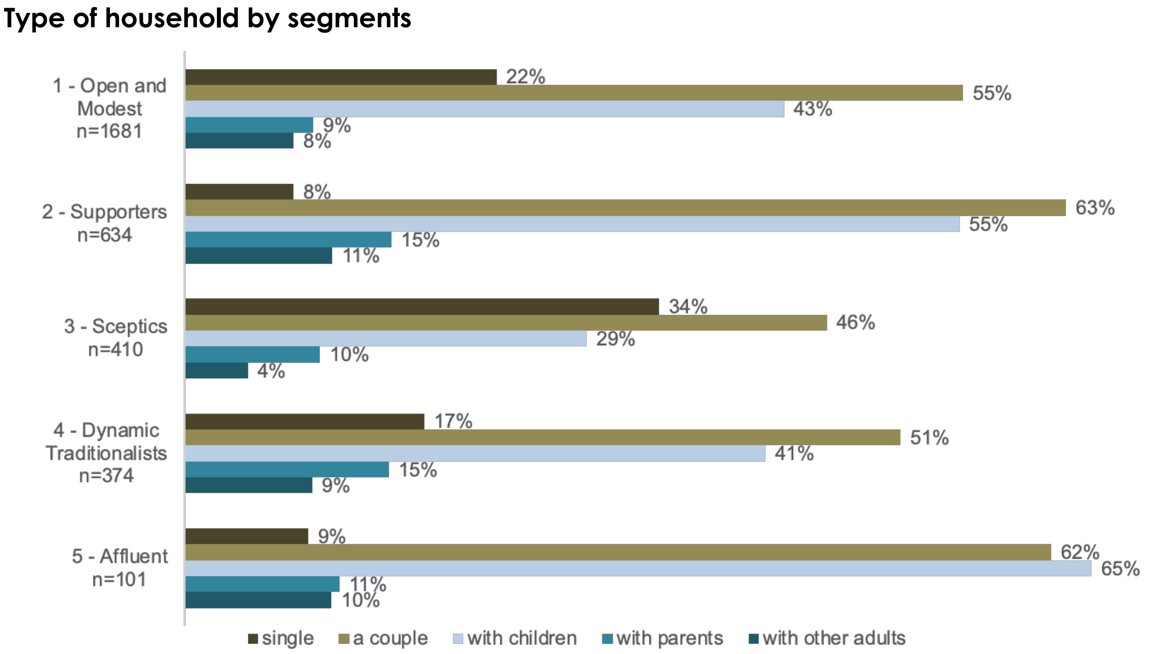

Figure 25: Demographic profile of segments - type of household

Education levels are clearly the highest among the Affluent segment (44% of respondents have university degrees) and the lowest among the Sceptics (25%). The other segments conform to the average of the sample.

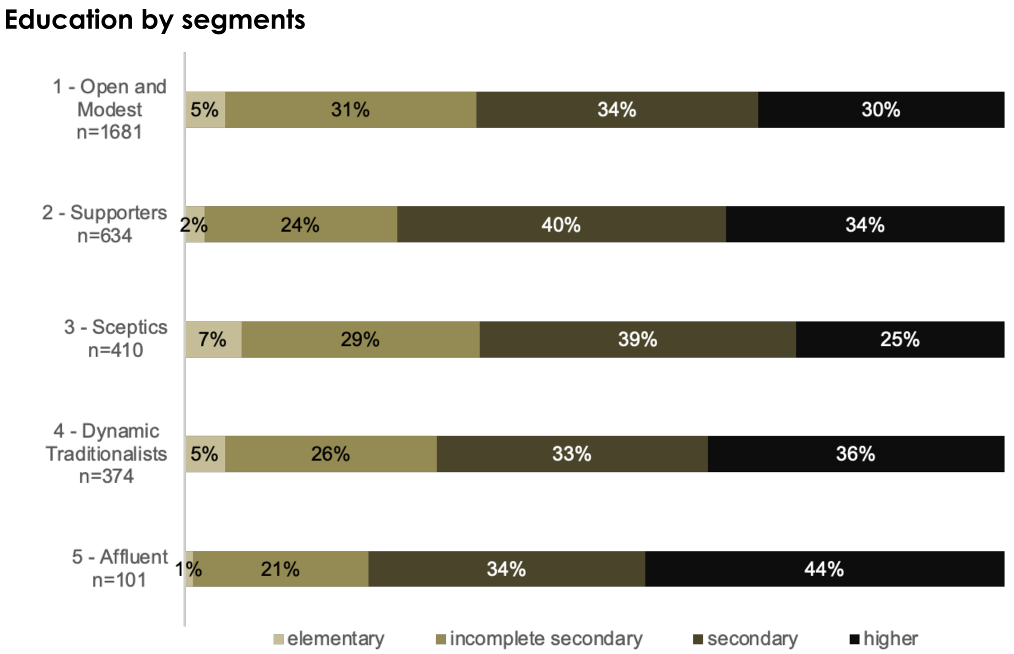

Figure 26: Demographic profile of segments - education level

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In the Open and Modest and Sceptics segments, the number of people living in rural areas and smaller towns is larger than among the Supporters and Dynamic Traditionalists. By far the largest percentage of individuals who live in medium and large cities can be found among the Affluent segment.

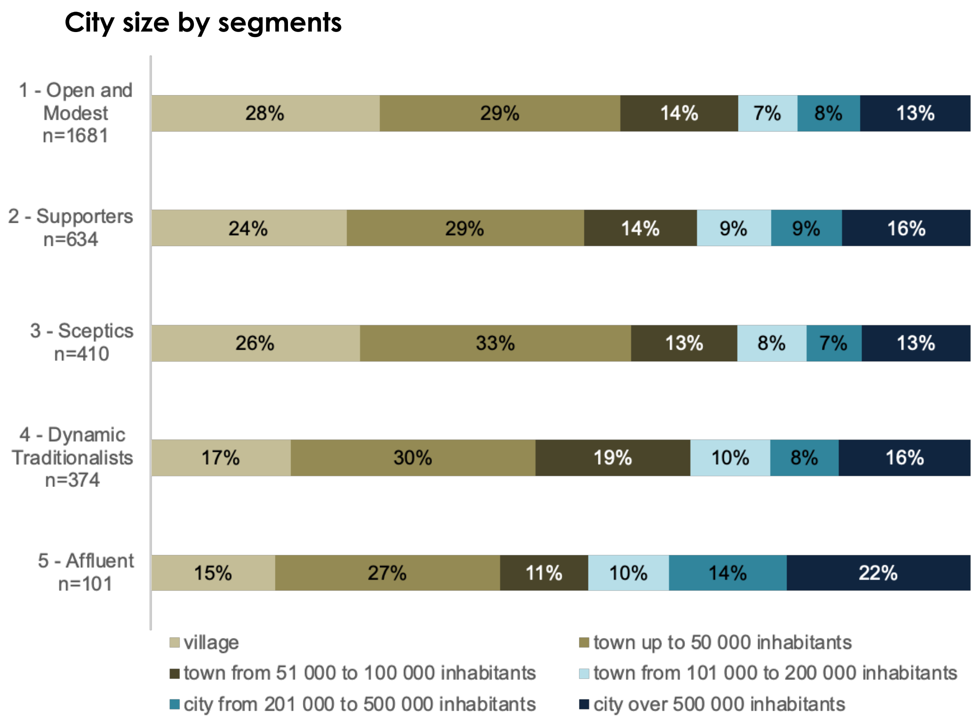

Figure 27: Demographic profile of segments - city size

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Most members of the Affluent, Supporters, and Dynamic Traditionalists segments live in their own houses. It is somewhat surprising that members of the Open and Modest and Sceptics segments do so relatively less often, despite residing most frequently in smaller towns and villages. This is an indication that living in one's own house is determined more by affluence than by place of residence.

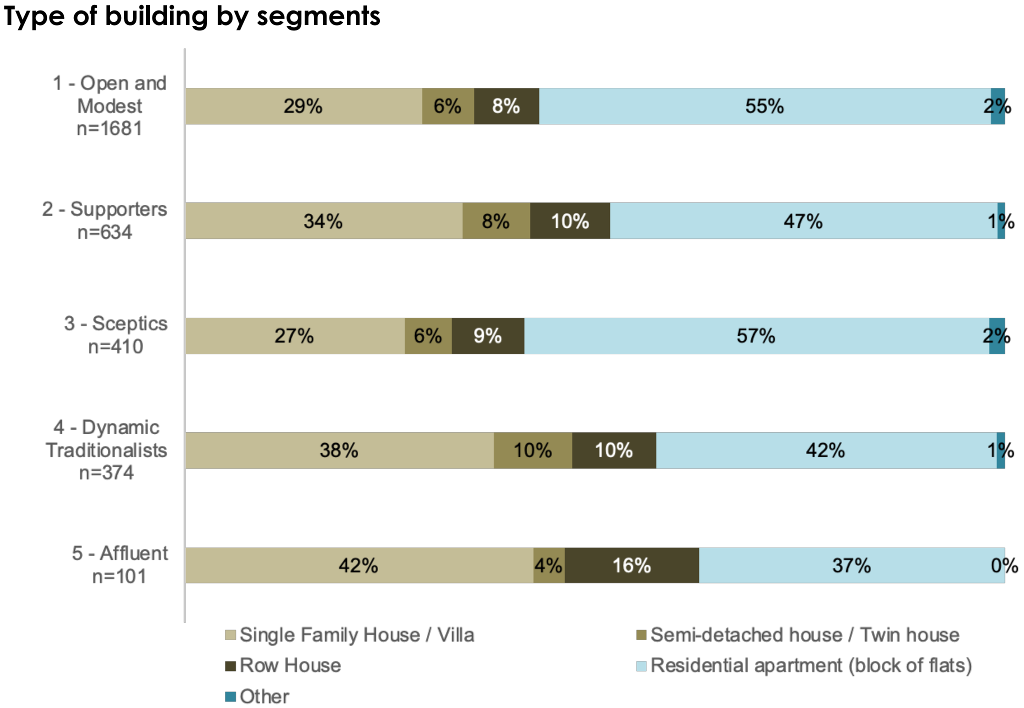

Figure 28: Demographic profile of segments - type of building

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The Affluent and Dynamic Traditionalist segments rate their financial situation much more positively than the other segments.

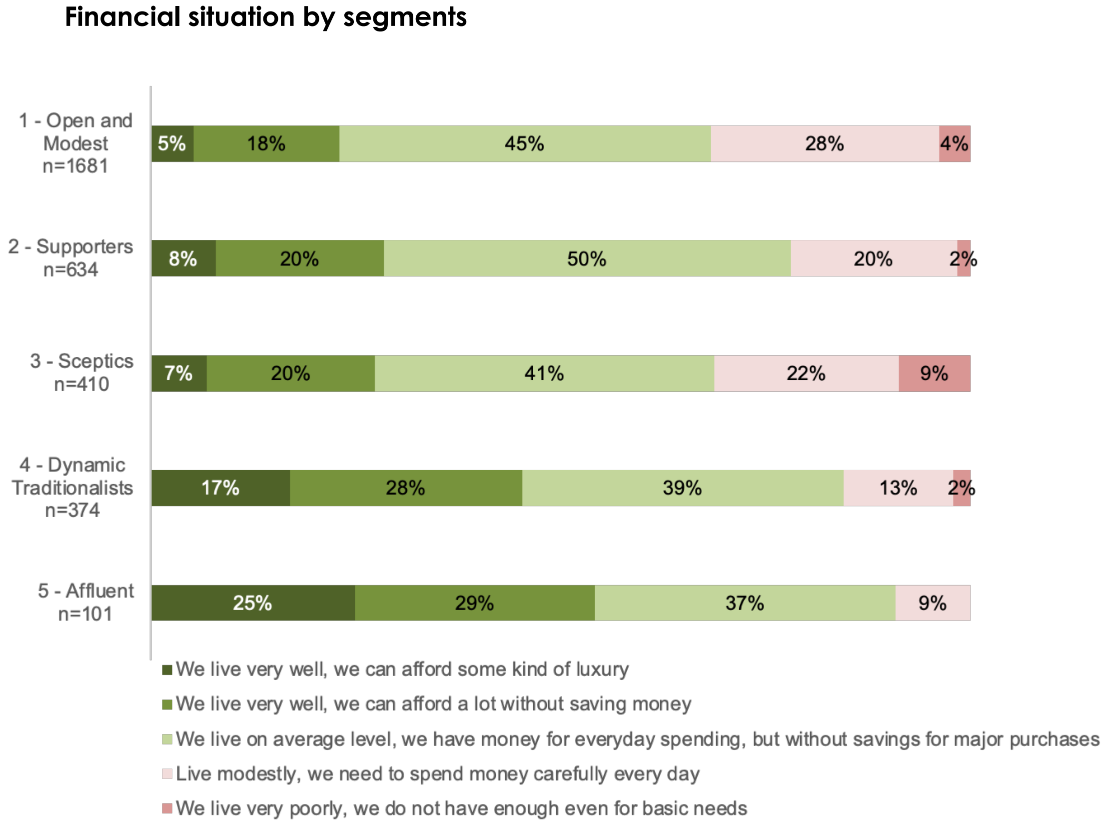

Figure 29: Demographic profile of segments - evaluation of own financial situation

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The Open and Modest and Supporters segments contain a significantly higher proportion of teachers and academics (4%) than average. The remaining employment types are represented close to the average. The Sceptics segment is characterised by the highest percentage of public sector employees. The occupations of the Dynamic Traditionalists are similar to the average distribution of the sample and are distinguished by a lower percentage of manual workers (5%) and a higher-than-average share of high-level managers (8%). By far the largest share of senior managers can be found in the Affluent segment (26%).

Professional status by segments

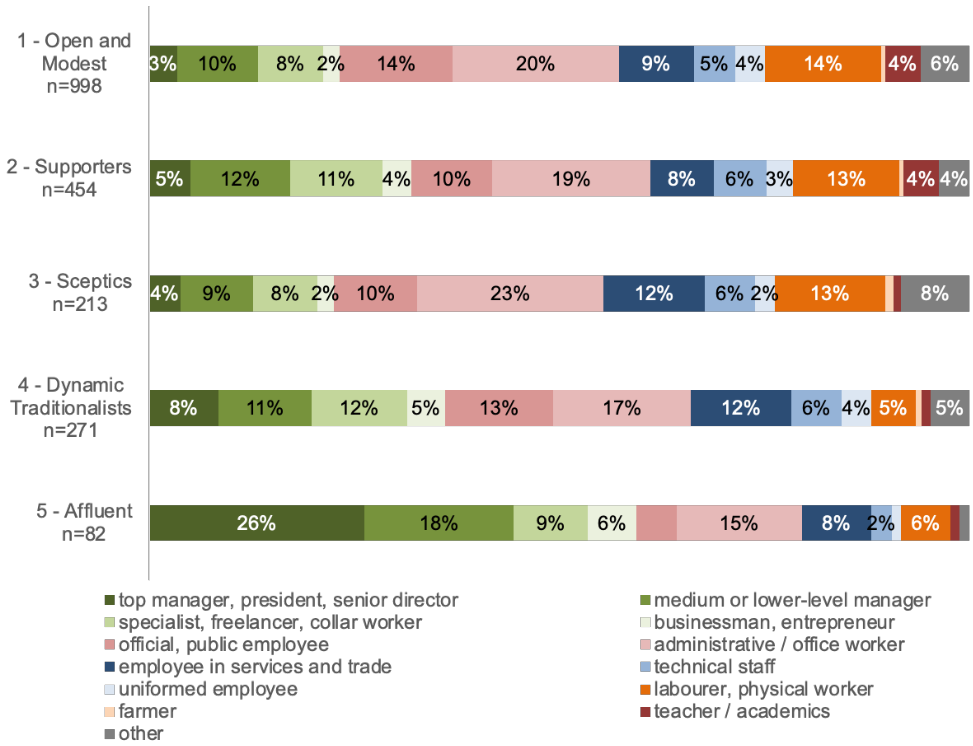

Figure 30: Demographic profile of segments - professional status

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5.10 Attitudes towards energy and electricity

The highest percentage of individuals who claim that electricity is cheap can be found within the Dynamic Traditionalists (31%) and Affluent (21%) segments; only 11-12% of respondents from the remaining segments believe this to be true.

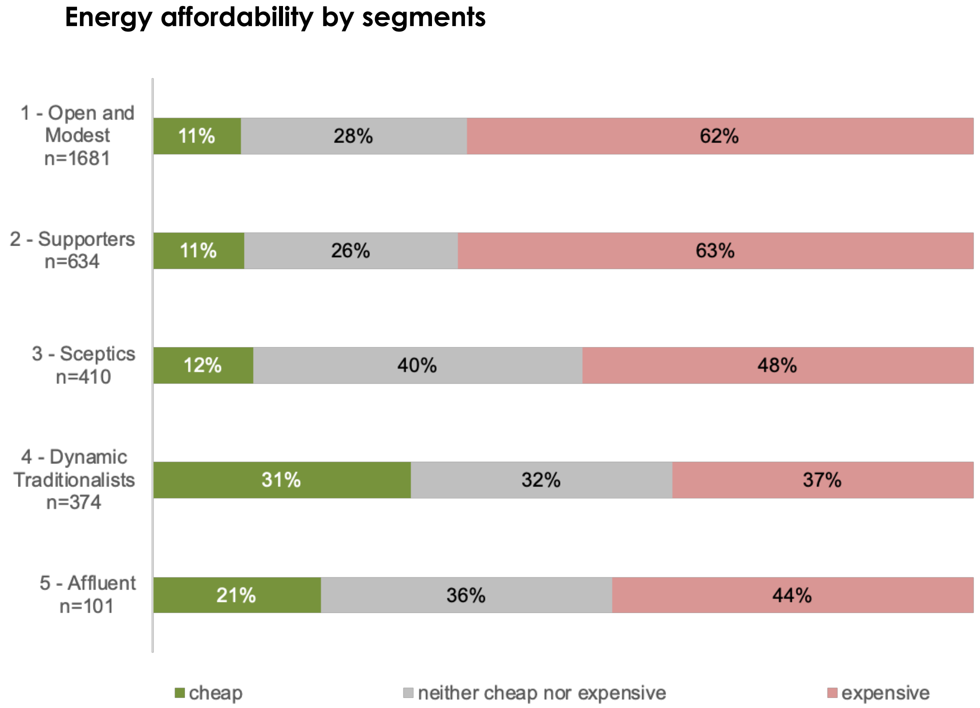

Figure 31: Demographic profile of segments - energy affordability

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Members of the Open and Modest, Supporters, and Affluent segments believe that renewable energy sources should be developed, and that the state should be closely involved in the energy market. Relatively speaking, the Dynamic Traditionalists exhibit the greatest support for maintaining fossil fuel-based power generation, while the Sceptics are the least likely to agree with such statements.

Opinions on electricity and energy

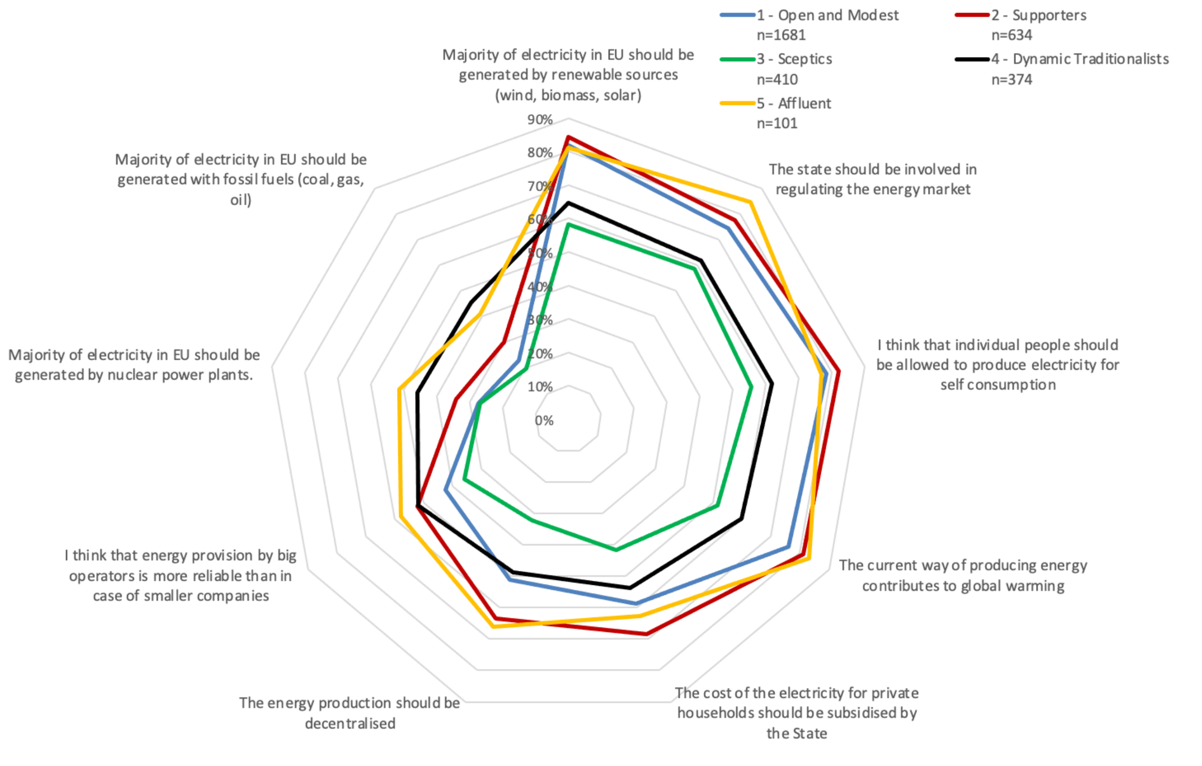

Figure 32: Demographic profile of segments – opinions of electric energy

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5.11 Lifestyle and Attitudes

How free time is spent has changed radically among the Affluent, Open and Modest, and Supporters segments during the COVID-19 pandemic. Previously, every third or fourth member of these segments spent the majority of their free time outside of the home; this reduced to every tenth member during the pandemic. The reactions of the Sceptics and Dynamic Traditionalists segments differed, however. Although a reduction was observed, it was much less pronounced than among the other segments, declining only 5 to 7 percentage points.

Leisure Time (% of respondents who spend most of their leisure time outside the home)

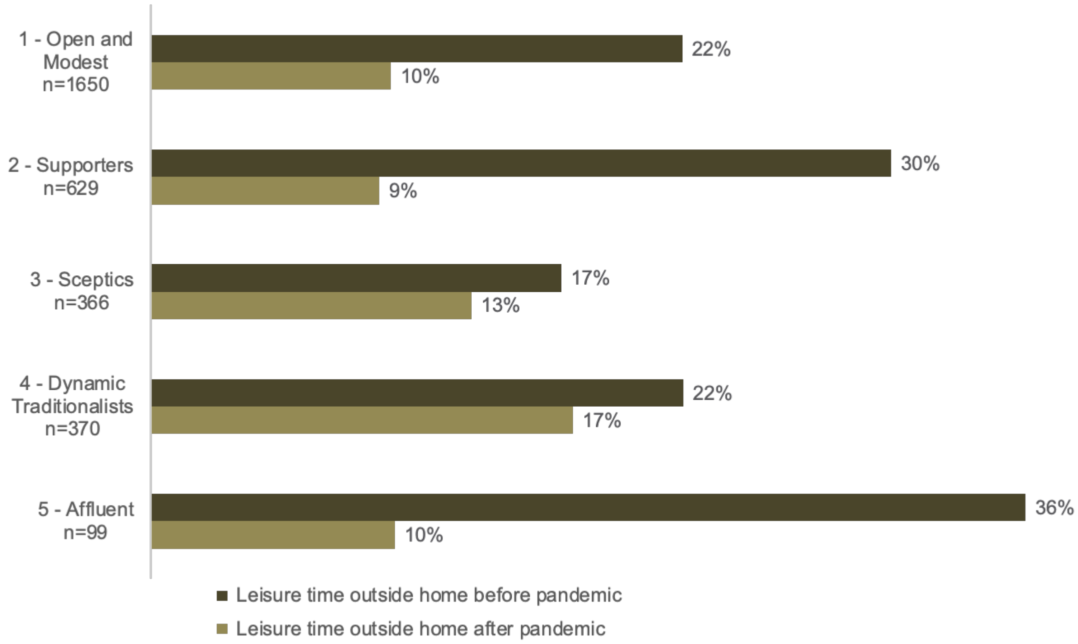

Figure 33: Demographic profile of segments – leisure time

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Health, family, safety, and positive relationships with loved ones were the dominant and most frequently-stated life goals among all segments.

By analysing the profiles of selected responses for particular segments, a number of notable characteristics can be observed. Prestige, competition, and success are relatively insignificant for those in the Open and Modest and Sceptics segments, while they carry great importance among the Affluent and Dynamic Traditionalists. In the Supporters segment, self-realisation and achievement of high material status play important roles. The Sceptics segment is distinguished by the goals of 'cheerfulness', 'compliance with moral principles', and 'peaceful lives'.

Life Goals and Values

Figure 34: Demographic profile of segments – life goals and values

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5.12 Attitudes towards technology

Members of the Affluent segment use modern technologies most freely. They often help others to learn about new technologies. Members of the Open and Modest segment like technology and are confident using it. The most reluctant are those who belong to the Sceptics segment. They are also the least comfortable using technology. Members of the Dynamic Traditionalists segment on one hand know and understand technology well, but on the other are reluctant to depend too heavily on it.

Attitudes towards technology

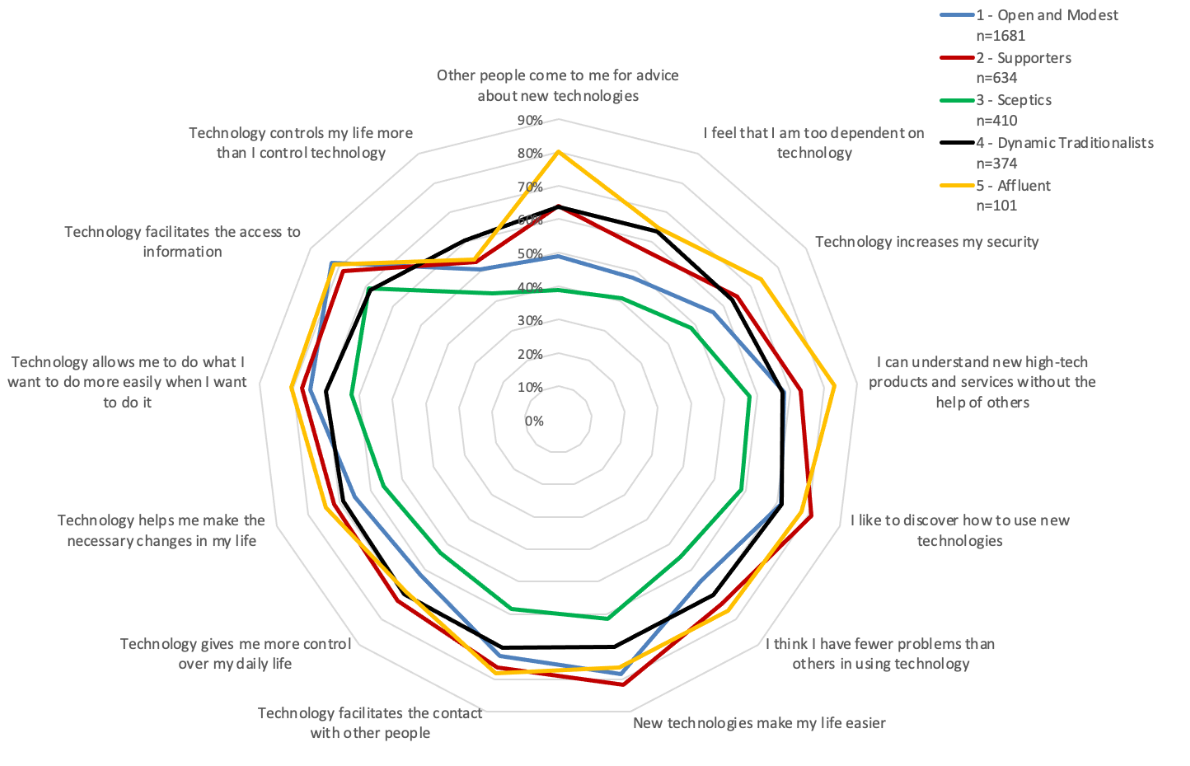

Figure 35: Demographic profile of segments - attitudes towards technology

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Almost half of the Affluent segment claim to be among the first to use new technologies. A large percentage of those who rapidly adopt new technologies can also be found in the Supporters and Dynamic Traditionalists segments; this can likely be explained by their relative youth. The Sceptics segment exhibits the highest percentage of members who are suspicious of novelties and prefer to use proven solutions.

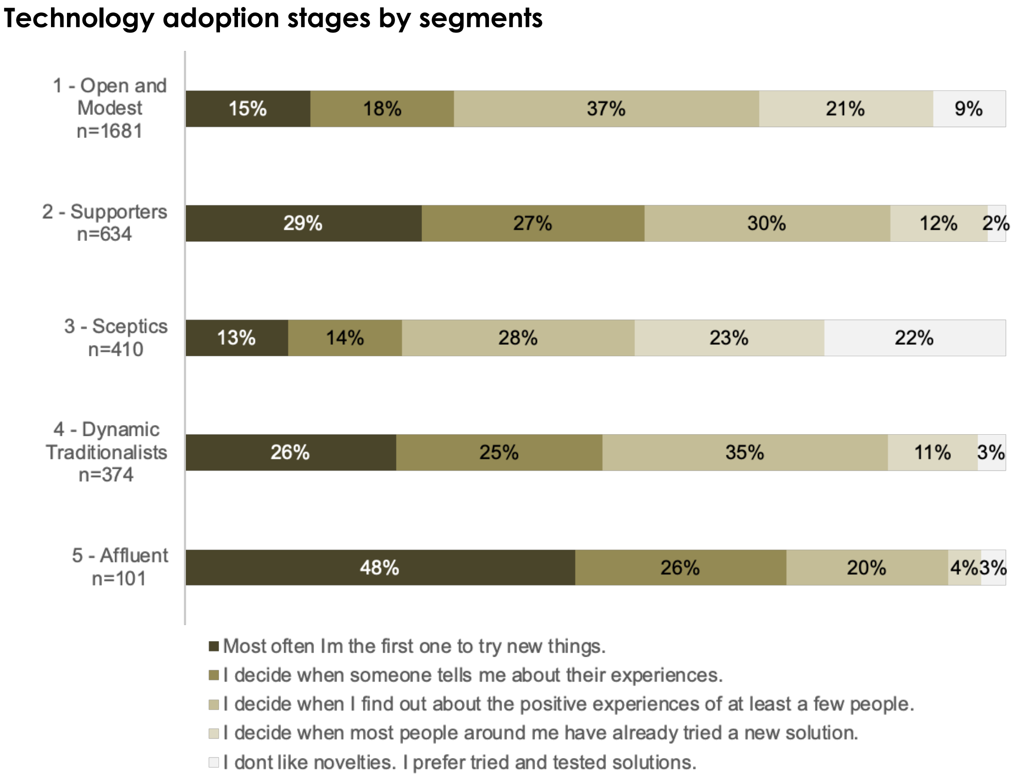

Figure 36: Demographic profile of segments - technology adoption stages

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5.13 Awareness of climate change threat

Members of the Open and Modest and Supporters segments agree most often and the Sceptics least often with statements describing the threats resulting from climate change. Members of the Dynamic Traditionalists and Affluent segments, on the one hand, are aware of the risks, but also see opportunities in business and increases in agricultural production as results of climate change.

What do you think the consequences of climate change might be? Please indicate how likely you consider the following phenomena to occur in the future.

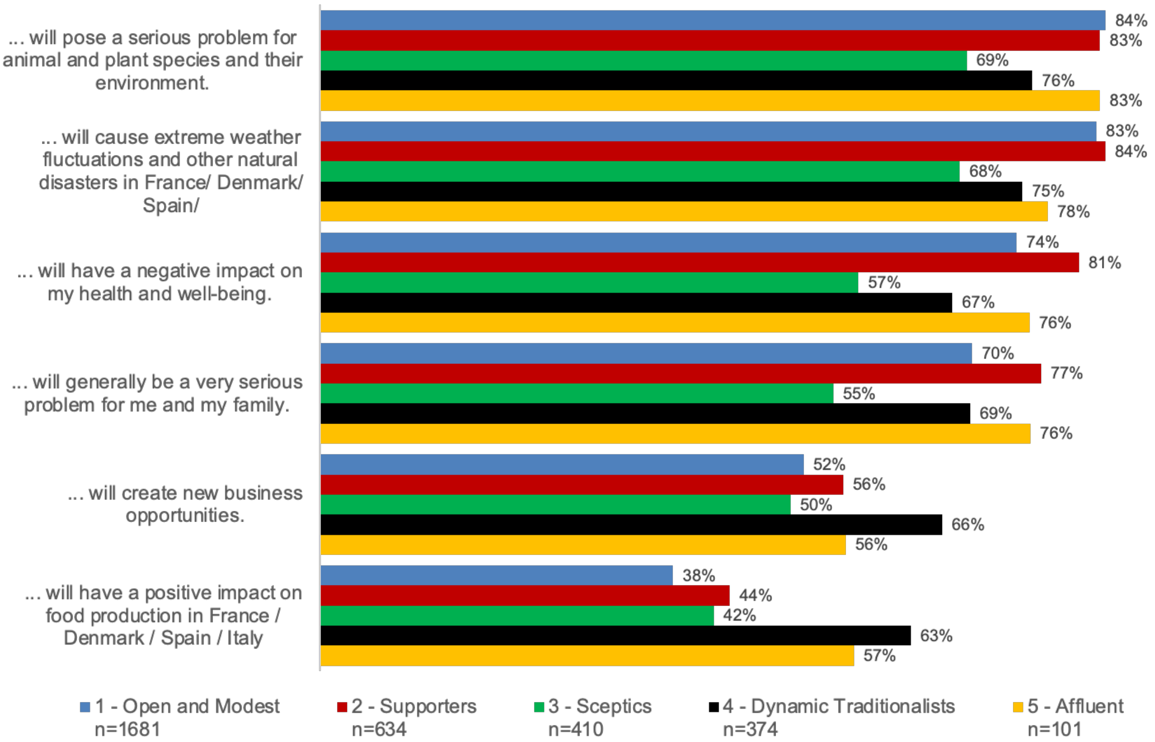

Figure 37: Demographic profile of segments – perception of climate change

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5.14 Share of segments in the samples of individual countries

Here, we present the share of individuals representing different segments in the samples of the four countries studied.

France has the highest percentage of Sceptics (33%); the Open and Modest and Dynamic Traditionalists comprise approximately a quarter each. France has the lowest percentages belonging to the Supporters and Affluent segments: 15% and 14%, respectively.

Italy has a large proportion of Supporters (38%), while Sceptics comprise only 16%. The remaining segments contain similar proportions: approximately 23% each.

The Spanish sample contains large numbers of individuals who fit into the Affluent (41%) and Supporters (34%) segments. Open and Modest comprises 26%, and the Sceptics and Dynamic Traditionalists 14% each.

The Danish sample includes a large proportion of Sceptics (37%) and Dynamic Traditionalists (38%), an average proportion of Open and Modest (24%) and Affluent (21%), and a lower-than-average percentage of Supporters (13%).

Share of segments in researched countries

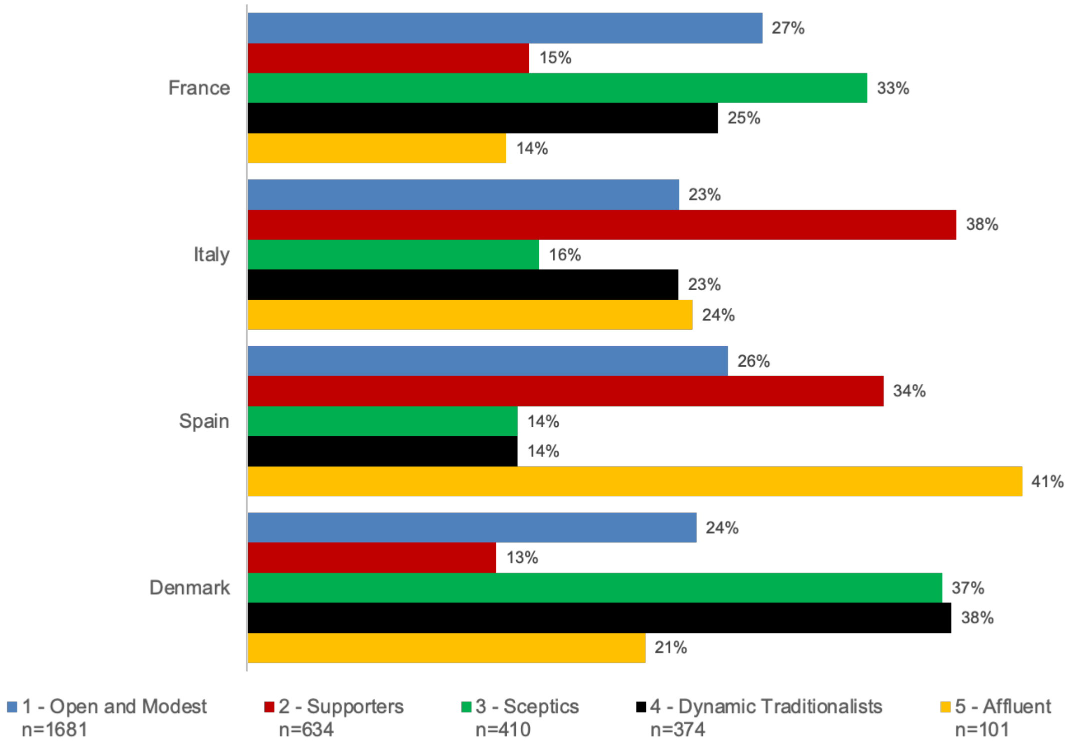

Figure 38: Demographic profile of segments - share of segments in countries

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5.15 Conclusions from the consumer segmentation analysis

How can members in the various segments best be convinced to increase their energy literacy and flexibility in use of electricity?

Open and Modest

These are individuals who display positive attitudes towards energy saving and new technologies, are aware of current environmental problems, and support the energy transformation. They are limited by relatively meagre financial resources, and occasionally need assistance in familiarising themselves with new electronic devices. The segment is open to solutions that make the demand for electricity more flexible, provided that favourable financing, simple operation, and service support are provided. It is also expected that members of this segment will support system solutions that lead to increased flexibility of energy demand.

Supporters

This segment is mostly employed, willing to use new technologies, and actively saves energy to reduce greenhouse gas emissions and costs. We expect these individuals to be open to the installation of energy management equipment and teach others in their communities to do the same. In implementing such solutions, they might be limited by lack of information, excessively high costs, and difficult operation.

Sceptics

The segment comprises individuals who have little to no desire to save electricity. This is due to a lack of trust in new solutions and little recognition of the need to reduce greenhouse gas emissions. This segment is also hampered by limited finances and difficulties in using modern technologies. For members of this segment, the financial benefits resulting from economical and flexible use of electricity might be the most convincing argument.

Dynamic Traditionalists

This segment demonstrates similar attitudes to the Sceptics, but are younger, have higher incomes, and demonstrate activity levels. These individuals are confident with new technologies and view them pragmatically. They select what is convenient and financially advantageous for themselves; ecological considerations and social norms are of less importance. Members of this segment might decide to alter their electricity consumption when they are convinced that it will benefit them directly – both in terms of comfort and finances.

Affluent

This segment comprises individuals with high incomes and prestigious careers. They are active, use new technologies with great confidence, and are aware of current ecological problems. Members of this segment are the most willing to reduce and make their energy consumption more flexible, in addition to possessing substantial financial resources that allow them to fund the initial investments. Simultaneously, they are the individuals who, due to their high incomes, consume the most energy. They are the first to use the new solutions, and often share their experiences with their families and friends.

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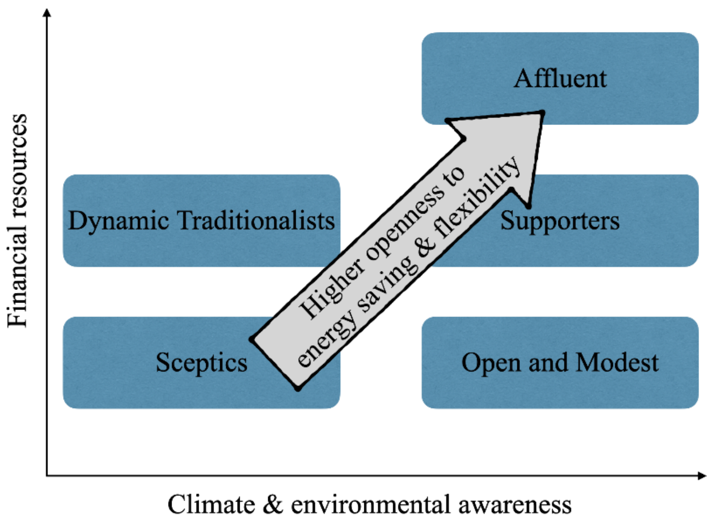
The solutions offered to members of this segment should have clearly defined benefits and be of high quality. Barriers might be complex processes of ordering and installation, illegible communication, unconvincing benefits, or lack of information.

Visualisation of consumer segments in terms of finances and climate and environmental awareness. Segments further towards the right and the top are more open to energy saving and flexibility. It is noteworthy that finances correlate with energy consumption.



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