

# **CHANGING HOUSEHOLD BEHAVIOUR TO USE ELECTRICITY FROM SUSTAINABLE SOURCES**

*Research paper*

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## **Abstract**

*The consumption of energy in households is not well aligned with the production of sustainable energy and battery technology cannot effectively solve this problem right now. Therefore, we need to change behaviour in private households. In this paper, we report from a lead user study with 9 households focusing on how to change the behaviour in a robust, permanent fashion. Through a grounded theory analysis of the interview transcripts, we identify 17 patterns, derive four main challenges and discuss how they can be overcome to change the collective behaviour. Together these patterns and challenges give an account of the households' dynamics as the world transitions towards greener and more energy saving behaviours.*

*Keywords: Sustainability, Behavioural change, Lead User study, Patterns.*

## 1 Introduction

The average temperature on Earth is on the rise. One important factor is the greenhouse effect caused by increasing levels of CO<sub>2</sub> in the atmosphere. The Paris Agreement from 2015 aimed to keep the global temperature rise in the 21<sup>st</sup> century below 2 degrees Celsius and even pursue efforts to limit the temperature increase to 1.5 degrees Celsius (UNFCCC 2015). In October 2018, however, The International Panel on Climate Change warned that “Limiting global warming to 1.5°C would require rapid, far reaching and unprecedented changes in all aspects of society” (Allen, Dube et al. 2018).

One of the solutions to reduce the rising temperatures is to lower or even abandon the use of fossil fuels such as coal and oil and use solar energy, wind power and other sustainable sources. But solar energy is produced when the sun shines, wind power is produced when the wind blows. Hence, consumption of energy for transport, heating, cooking etc. is often misaligned with the production of sustainable energy during a day or during a year. It requires technical solutions such as effective storage of energy – batteries – to save sustainable energy from day to night and from summer to winter. Despite the severe limitation of current lithium ion battery technology (Kraytsberg and Ein-Eli 2011), recent research shows promise (Lin, Wang et al. 2019). While we wait for technology an alternative solution is to use the energy when it is produced through a behavioural change in private households and industry. However, changing behaviour and maintaining the changed behaviour is challenging. What motivates such a change? How do we ensure that the change is a lasting one? How do we coordinate with the electric grid so it keeps its balance and avoids unwanted peaks and gaps?

These questions about changing behaviour of private households to consume energy when the wind blows and the sun shines are what we set out to answer in a project called “Intelligrid” funded by the European Regional Development Fund; The Interreg programme.

In the concrete we formulated our research question in this way: *How can we create a change of behaviour in private households so that they use electricity when it is produced from sustainable sources?*

To answer the research question we set out to understand the current situation of users who have already implemented lasting changes – so-called 'lead users' – in order to comprehend and understand the mechanisms underlying behavioural change.

The remainder of the paper of the paper is organised as follows. In section 2 we give an account of existing research on behavioural change. We then in section 3 give an account of our research method and how we used lead-user interviews and grounded theory analysis. In section 4 and 5 we present our findings in the form of a number of behavioural patterns found among the lead user. In section 6 we then discuss our findings before we finally conclude the paper in section 7.

## 2 Existing Research on Behavioural Change

Considering that the alignment of green electricity production to its consumption require a change to happen -somewhat- in households, we undertook a structured review of the literature on behavioural change to investigate and critically assess how behavioural change has been researched and conceptualised to date.

Literature reviews are an appropriate method to systematically and critically assess the state of research on a particular phenomenon: they help to inform concept and theory development (Rousseau, Manning et al. 2008, Rowe 2014) and to develop agendas for future research (Webster and Watson 2002, Boell and Cecez-Kecmanovic 2014).

Our decision to include psychology publications was due to the limited availability of academic publications to date, to capture views and terminology of cognitive praxis and to access and include detailed reports of cases not found in academic publications with detail

Our interest was in the actual doing of behavioural change at an individual/household level (rather than success or performance measures).

To identify relevant academic sources, we conducted keyword-based searches in several leading academic databases to identify relevant sources, we searched leading online repositories (e.g., Gartner). We used keyword-based searches to avoid an overly narrow focus on particular outlets and to find all (or almost all) available publications (Kitchenham and Charters 2007).

In addition, we used backward and forward searches (Webster and Watson 2002). That is, we analysed the reference lists of identified relevant publications (backward search) and, using the “cited by” functions of Google Scholar and Web of Science, we searched for newer publications citing.

Behaviour change is the art of changing people’ behaviour by using insights from behavioural science to sway how people make decision (Münster 2019).

We were able to structure insights from the reviewed literature into a total of six debates that form central challenges for households when they try organise themselves to make green energy work for them.

Before the change happens, knowledge about the said change needs to be acquired. Author Don Norman explores ways in which knowledge is gathered by individuals in his book ‘The design of everyday things’ (Norman 2013). Don proposes two types of knowledge: Knowledge in the head and Knowledge in the world.

On one hand, knowledge in the head is to do with cultural constraints which are learnt restrictions on behaviour that reduce the set of likely actions (Norman 2013). This includes conceptual models, cultural semantic and logical constraints on behaviour and analogies between the current situation and previous experiences with another situation (Norman 2013).

Thus, the upbringing culture can have a huge influence in behavioural change. Don Norman coins the phrase ‘Knowledge in the head’ as a starting point for behavioural change. On the other, the idea of knowledge being available in the world, supports that much of the knowledge an individual needs to do a task can be derived from information in the world – through internet searches for instance.

Don Norman goes on to say perfect behaviour results if the combined knowledge in the head and in the world is sufficient to distinguish an appropriate choice from all others. This then raises a challenge in terms of trying to marry what individuals know already (or their internal values) to the idea presented in the ‘new’ behaviour.

Individuals often would use others ‘experience from their internet search for example in order to form the basis of their own decisions – including behavioural change. Barry Schwartz (2004) coins the term ‘Anchoring’ in his book ‘The paradox of choice’. Anchoring happens when an individual uses another’s choice as a benchmark for the choices they make. A self-confessed nerd interviewee illustrated how he looked at the latest trends in smart home solutions to customise his own. He explained how knowledge is shared in various user groups he is part of.

Moving on from that, knowledge trickles down from leaders- who could well be parents- to adopters. That is the subject in the book by Everett Rogers, ‘Diffusion of innovations’ (Rogers 2010). This diffusion theory has proven one of the oldest yet most popular theories on how new ideas are spread and adopted across a wide range of social systems with many different actors. The theory was pioneered in the sixties by Everett M. Rogers (Rogers 2010) and has since been refined and re-confirmed in many Information Systems settings (Weigel, Hazen et al. 2014). It has been compared to other adoption theories such as the Theory of Reasoned Action (Moore and Benbasat 1996), Theory of Planned Behaviour (Ajzen 2011), General adoption of technology systems in organisations (Green and Hevner 2000, Mustonen-Ollila and Lyytinen 2003), and database development environments (Nilakanta and Scamell 1990) to mention but a few. The main idea proposed by Rogers in this work is the speed and effectiveness in the spread of an innovation idea in a given social system based on different types of inde-

pendent variables. The spread capacity is however tied to the type of innovation and the categories of actors involved in the social system.

Once gathered, knowledge is to be grasped and somehow put into play for the change in behaviour to happen. This is where the work by one of the pioneers of behavioural economics (Kahneman 2011) becomes very poignant. Nobel Prize winner Kahneman proposes that people draw on two main types of thinking called system 1 and system 2. System 1 is fast. It makes one act quickly and instinctively based on one's current needs and desires. It is helpful in situations where quick actions are needed and where the basic needs need to be met. For instance, it would be at play when one is hungry and thus has difficulties thinking.

System 2 is the more rational, cognitively taxing, and long-term way of thinking. System 2 is slow. System 2 considers, reflects and takes well-planned actions in the long term. Some examples will include setting up a child fund or deciding on when to inoculate children. System 2 thinking also has some setbacks. It takes up energy and is rather time consuming. Due to the energy demands of System 2, System 1 will often take over and make decisions requiring less cognitive effort. Appealing to and taking those two systems into considerations is essential when assessing behavioural change.

Authors and brothers Chip and Dan Heath (Heath and Heath 2011) go further by using a rider and an elephant analogy when looking at behavioural change. In their New York Times No1 bestseller 'Switch', they propose three key factors in driving behavioural change:

First, 'Direct the rider'; the suggestion is that what looks like resistance to change is usually a lack of clarity. Second, they put forward the idea of 'Motivating the elephant'; it is to do with involving an individual and making them be part of the change in order to motivate them. Essentially, we have to stimulate individuals' interest in the change by making them part of it as oppose to the change being something "inflicted upon them".

Finally, 'Shape the path' – here the authors suggest that often when we think that people are stalling a change process, it is usually because of the situation they are in. Again, a combination of the above two ideas leads to this final one; the path or goal will be clear once the change is concrete and the individual is stimulated. Shaping the path with clear data or information will 'motivate' the elephant and in turn make it easier for it to be directed by the rider.

Giving the user access to their data for instance- shaping the path-, could motivate such users to keep using a particular application. Sunstein (2019) refers to this as disclosure in his principles for Nudging.

Unfortunately, Morten Munster (2019) is a bit more on the cautious side and does not think knowledge and motivation are enough when trying to instil a behavioural change. In his bestseller book "I am afraid Debbie from Marketing has left for the day" Morten Munster explores great literature on psychology to date – including Kahneman's work - to highlight five key misunderstandings in behavioural change. Morten uses vivid real-life examples to illustrate his points and relay that some of the behaviour knowledge speak to system 2 (Kahneman 2011) and are suited to a parallel universe, not the real world. He goes further in his literature review by mentioning the book by Mullainathan and Shafir (2013) 'Scarcity' and exploring the idea that the rational change that we target in our motivational talk is sometimes held back because of the 'bandwidth' in our minds already being taken by other things – basic needs for instance.

However, in this project's case there is a glimpse of hope at last, as far as behaviour change is concerned. This hope is offered by the brothers Heath (Heath and Heath 2007) in their book 'Made to stick'. Essentially this hope comes as a recipe for success for making an idea – a behaviour change-stick. The six principles proposed are: Simplicity, Unexpectedness, Concreteness, Credibility, Emotions, and Stories.

Given the current proliferation in smart-home solutions, the level of green energy consumption is yet to be sustainable. Resistance to change in real life is still somewhat a ubiquitous phenomenon. To use

Mullainathan & Shafir's (2013) Scarcity theory, how do we therefore make Green energy scarce to attach great attention to its consumption?

### 3 Research Method

For 'why' and 'how' research questions, interpretive qualitative methods are usually recommended as they allow to go into the necessary depth with the unit of analysis (Klein and Myers 1999, Walsham 2006). Our qualitative method of choice was that of semi-structured interviews, with a focus on selecting 'lead users'. The main point of lead users is that a lead user represents a certain group of users who use technology in new and innovative ways. By identifying and analysing their behaviour and use of technology, novel insights can be found and new products can be designed that otherwise would not have been possible (Urban and Von Hippel 1988).

Since the interviews would focus on the life, behaviour and tech choices of the interviewees, it only made sense to draw on a combination of what is called the 'romantic' and 'localist' approach (Schultze and Avital 2011). The romantic approach was used for creating rapport and trust with the interviewees and the localist perspective was used to be critical of the setting, scene and the construction of the knowledge gained.

The interview guide was structured to go through six main areas of content, divided and structured into sections of various research indicators deducted from existing theories on lead users, user adoption, consumer behaviour, and behavioural economics and design. Examples included asking open-ended questions about the technological gadgets that made up the overall system that the interviewees used in their everyday lives to support green energy (Von Hippel 1986), their initial adoption phases and the process of implementation (Venkatesh, Morris et al. 2003, Rogers 2010) as well as going through the visuals and functionality of the gadgets (Kahneman 2011, Sunstein 2014), and finally discussing how the technology fit (Dishaw and Strong 1999) with their specific household setting (Rogers 2010) and their values of being 'green'(Venkatesh, Morris et al. 2003).

As of the time of writing, the interviews were currently ongoing and we report from the first initial seven interviews, four of which took place in Denmark, and three of which took place in Germany (the overall plan is to have a total of at least 10 for stronger pattern recognition). All interviews were conducted in English, recorded and transcribed in accordance with GDPR. As we were focused on interviewing households, some of the interviews included spouses which added for stronger dynamics and broader information into the general habits and behaviour of the household.

Interview	No. of interviewees	Length (hh:mm:ss)	Medium <sup>1</sup>	Location
Lead user 'Dan'	1	01:33:50	Face-to-face	DK
Lead user 'Gitte'	2	00:43:45	Virtual	DK
Lead user Jesper	1	00:31:01	Virtual	DK
Lead user 'Britt'	2	01:01:11	Virtual	DK
Lead user Frederick	1	00:52:37	Virtual	DK
Lead user Kim	1	00:53:00	Virtual	DK
Lead user Andreas	1	00:53:31	Virtual	DE

<sup>1</sup> The interview process was interrupted by the Corona lockdown and so all but one interview were held over Skype.

Lead user Christopher	1	00:53:37	Virtual	DE
Lead user Jan	1	00:39:45	Virtual	DE

Table 1. Overview of the nine lead user interviews.

Interviews were coded inspired by grounded theory techniques (Strauss and Corbin 1994). Open coding was mainly performed as debriefings of the interviews and discussions of the general meanings of the choice of words and statements of the interviewees. Axial coding is a way to categorize the codes found in open coding and compare them through various weightings (e.g. finding the attribute of 'height' and extrapolating how interviewees deem that attribute as both 'tall', 'huge', 'short' or 'wide' in the data) was performed based on the collectively constituted meaning from the debriefings. The selective coding was then performed based and inspired from the theoretical foundation from the interview guides and constituted our 'tentative core' based on a general 'pattern recognition'.

The interview analysis followed a three-phased approach. First, lead user interviews were coded using both emergent codes close to the textual data and codes representing abstract concepts in the field of study. An example of the latter would be “Solar Panel App.” Second, all the codes were categorized in broad categories distinguishing between problem and solution-oriented observations and distinguishing between whether the coded observation was relevant to behaviour and sustainability. Finally, the categories were written up as patterns preserving the traceability to interviewees. In Table 3 you can see an example.

Pattern Name	Description	Lead-user interview coding
1- The upbringing culture has an influence on behaviour	When one is born and raised in a culture the values and habits from that culture will influence their own choices, behaviours and habits in adulthood	Hector (the husband to Gitte) told us that he was born and raised in Brisbane and that his parents built a north-facing house to cope with the then unbearable summer-heat in Brisbane. That environmentally awareness culture has stayed with Hector up until now that he lives Denmark.  Gitte: The whole family bicycle to places instead of driving. Have done that since they were kids.  Jan: I grew up in the country side ; I would like to preserve nature as much as I can”
2- Peer motivation -If another can, so can I	When one sees another achieve something, it convinces them that such achievement is possible and thus motivates them to do the same.	Gitte had three colleagues at work who became vegetarians on environmental grounds. That convinced Gitte that she could make the same change in her eating habits.

Table 3. Excerpt of two patterns. The traceability to coding can be found in column 3.

When looking at Table 3 it is clear that pattern 1 has a stronger grounding in codes from 3 interviewees than pattern 2 that only is built on one interviewee. However, as our lead-user interview study is qualitative and not quantitative it is meaningless to count or talk about significance or a number. We will only distinguish between weak grounding when a pattern was found in only one lead-user interview and strong(er) grounding when patterns were found in more interviews.

## 4 Results - patterns found

As said above our coding and categorization of the codes made elicited 17 patterns that we further grouped into five meta-groups based on semantic likeliness and relationship to an overall theme such as “causes of behaviour and change”. In the following we have used this division into five meta-groups each described in a sub-section that follows. An overview of the patterns can be found in figure 1.

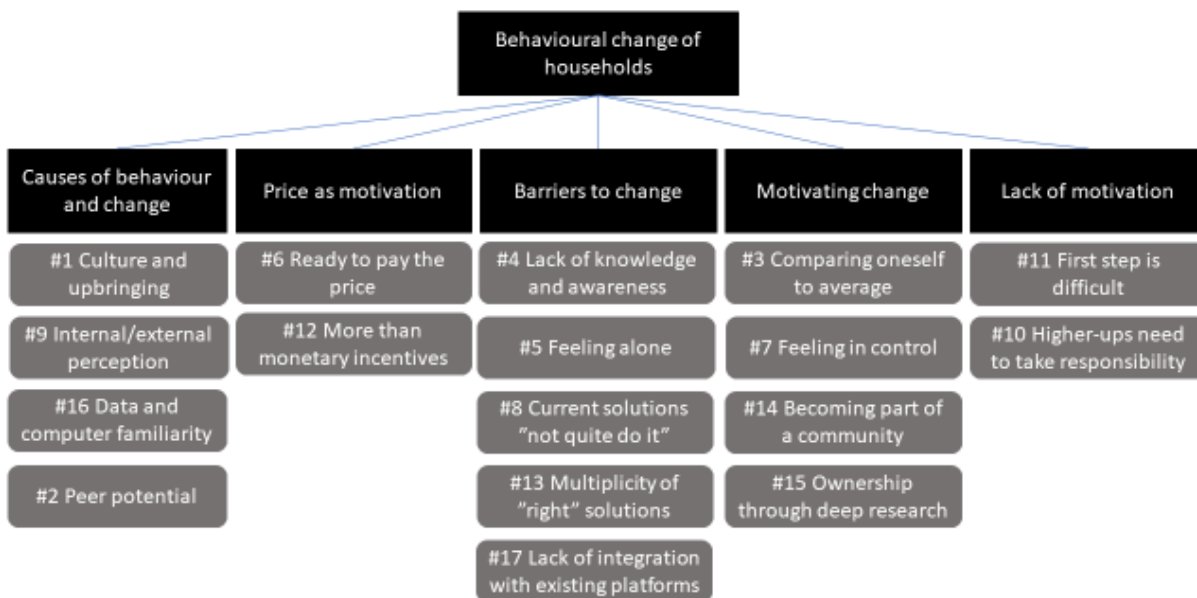


Figure 1. An overview of the 17 patterns found in lead-user interviews grouped in five meta-groups or overall categories.

### 4.1 Patterns that triggers / causes behaviour and change

We noticed during the interviews for these to be typically those ones that form the seed for the behavioural shift:

#### Pattern #1 – The upbringing culture has an influence on behaviour

For those interviewees born and raised in a culture, the values and habits from that culture influence their own choices, behaviours and habits in adulthood. One of participants we spoke to in Germany told us “I grew up in the countryside; I would like to preserve nature as much as I can”

#### Pattern #2 – Peer Motivation – if someone else can, so can I

Those lead users who had witnessed others in their social circles achieve something, were convinced that such achievement is possible and thus motivated to act in a similar manner. Gitte, in Denmark, had three colleagues at work who became vegetarians on environmental grounds. That convinced Gitte that she could make the same change in her eating habits.

#### Pattern #9 – Mismatch between internal and public perception

People want to appear to be something they are not – A participant in Denmark conceded: “what I tell outside is different from what I do...”. He knows about climate change and can engage intellectually about it in his circles but is ashamed not to have acted responsibly yet (in his own words) to match his behaviour to the knowledge he has acquired.

#### Pattern #16 – Data and computer familiarity is important

The key users in a customized energy saving solution is a sign of how interested in computation or data family members are. It also makes for drive towards a lasting change of habit. We spoke to a household in Copenhagen where both partners work in IT and seemed very structured and pleased about their bespoke system. They did however confess that ‘you have to want it to make it work’.

## **4.2 Patterns related to price as motivation**

#### Pattern #6 – The price is not a barrier

Participants we spoke to are prepared to pay more to support a change they believe in. In fact, they do not mind paying more as long as they feel it is better for the environment; a cause most of them seemed to have a strong feeling about prior to throwing themselves in a quest for a sustainable solution.

We were slightly taken aback when one participant added “energy is not currently priced properly to cover all the environmental damaged involved in its production and transport”; this to propose that he would pay more for the right energy type.

#### Pattern #12 – The monetary incentive is not enough

In the Copenhagen area, people need more than a monetary incentive to buy into the initiative. Again, just as above, participants in the Copenhagen area- and Germany in fact- were almost dismissive about pricing and not seeing any gain in adapting their lifestyles to save a a tiny fraction of the cost. Dan would pay more “if the profit did not end up in some company’s bank account and if he felt more in control”, in fact.

## **4.3 Patterns that works as a barriers to change**

As well as the pattern that trigger the change in behaviour, we identified others that are hurdles to that change

#### Pattern #4 – Lack of knowledge

The knowledge gap is a huge hurdle towards behavioural change. Although we have seen the rise of lobbyists and campaigns for green habit adoption, a significant number of people still lacks key information or tools to enable behavioural change

Gitte and her husband “put the washing machine on when it suits their needs rather than monitoring the prices” they feel they would like to monitor green energy availability but they currently don’t really know how to.

#### Pattern #5 – Feeling isolated

Some of the households feel somewhat ‘isolated’. More policies needed to support their behavioural changes. Many suggested a change of local or governmental policies for a more effective impact.

#### Pattern #8 – The available solutions do not quite ‘do it for us yet’



There are plenty of unsatisfied users out there...they wish their systems would do more.

One of the lead users told us: “I spent 100s of coding hours on it to make it suit my needs.” Another added: “not enough features on my Danfoss system”; whilst a third, an engineer who was constantly optimising his solution, conceded: “there is more you can do”.

#### Pattern #13 – Different perceptions of what is the right solution

Whilst some are passionate about their solution, others have reservations. The opinions seem divided when it comes to what is what. Some of the lead users we spoke to were positive about the prospect of saving energy using batteries for instance whereas others found battery production to be an environmental issue in itself.

#### Pattern #17 – Integration with existing appliances/systems

Users would like to integrate various appliances in their homes but often find that integration and compatibility between appliances is an issue. There is no ‘plug and play, one solution fits all’ answer out there currently. One engineer we spoke to suggested a change in policy in the EU to allow for open APIs to pave the way for easy integration.

### **4.4 Patterns that motivate change**

#### Pattern #3 – Comparing yourself to the average

Seeing the average consumption of gas, electricity or water in the area can be a motivation factor for behaviour change. A lead user, Gitte from Denmark, explained that she receives reports showing her water consumption as well as that of neighbours. The water bills also display expected future consumption. Her household therefore take great pleasure in trying to consume lower water than that expected of them each time and they seem very proud of it

#### Pattern #7 – I want to feel in control

People want to know the direct benefits of a green energy solution and want to feel in control of it. One of the users we spoke to in Germany wanted to be so in control of his system that he even installed a private server to control his data. With a grin on his face and a sense of proud of ownership, he explained: “I don’t want to be connected to theirs server in the cloud. I use my own server. All works locally in my house”.

#### Pattern #14 – Becoming part of a community

There is a sense of community that is instilled from acquiring these solutions. People feel part of something ‘bigger’ once they have settled for a particular solution. Illustrating the energy exchange in his community in Germany, Andreas serenely said: “If I don’t use the energy, someone else in my community will”.

#### Pattern #15 – Change is a rational optimised choice

Extensive research and knowledge acquisition goes into a solution choice typically. From the interviews conducted, several man-hours had gone into choosing the right solution. A lead user explained that he had spent 7 weeks choosing a solution and it took another couple of years to implement the installation.

## **4.5 Patterns that shows lack of motivation**

### Pattern #10 – Being green is not my problem

A huge push on who should take responsibility for being green...

Jesper, a late adopter, to use the phrase by Rogers, explained that the government should initiate green energy adoption by making available more car parking spaces for electric cars for example in order to make households like his decide on buying an electric cars.

### Pattern #11 – I know what I should be doing but I am just not doing it at the moment

For some, the knowledge has been acquired but action is still lacking. A particular lead user seems to be waiting for an apocalyptic trigger for the change. He admitted “I feel a bit embarrassed because I know these things but I am not doing it yet.”

## **5 Discussion**

Studies on how to motivate individuals to adopt a new behaviour have been the focus of several academic studies (cf. Rogers 2010, Heath and Heath 2011, Kahneman 2011). The emphasis of such work lies in how and what can influence change - the pivoting point so to say.

From analysing our 17 patterns we have found four major recurring themes when it comes to sustainable energy solution adoption during the interviews. First of all, change is influenced by internal factors such as the culture. Second, it is difficult to make sustainable energy solutions compatible with everything else in households. Third, users who dare to attempt the change of habit are driven by their individual motivation e.g. the need to be in control, and fourth, this change needs a lot of backing and support from local institutions or governments in order to have an impact at a bigger scale.

The culture or upbringing, although bearing a lot of weight in terms of instilling the idea for a change ought to be complimented by knowledge from the outer world (Norman, 2013). To illustrate the knowledge or values inside the head of this interviewee that was the seed for his quest to seek sustainable energy solutions, one participant reflected by sharing this: “I was brought up in a farm with nature around me; now that I live in the city, I want to preserve that nature.” Another interviewee gave out thoughts on how his family cared for the environment when he grew up in Brisbane.

The knowledge and values stemming from the inner world and the culture gels with knowledge from internet searches - knowledge in the outer world - to form the basis for the right sustainable energy solution adoption. Some of the users we spoke to happened to be engineers or programmers and sometimes spent several hours customising a chosen solution to make it work for their specific household. They were quite sceptical towards the idea of a ‘one solution fits all’ on the market and the fact that most existing sustainable solutions suffer from being incompatible with existing households' appliances. One participant ("Chris") went further by explaining that making sustainable solutions work in – sometimes very complex- household settings “is still a very convoluted thing to do”. The implementation requires technical knowledge from the users in order to suit the households needs and wishes.

Furthermore, Heath and Heath (2011) recognise the need for individuals to want to shape the change themselves. Our findings confirmed this theory with clear indication during the interviews that our lead users wanted to be in control of the change - after they had acquired enough knowledge about the sustainable solution. They wanted the system to work for them and their needs instead of it being something they couldn't control – through the over-riding of settings for example.

During the interviews, all but one user had spent a lot of time choosing the solution they finally decided to adopt. There is a clear sentiment of wanting to make it happen, of wanting to make it work 'their way'. Heath and Heath (2011) describe this as motivating the elephant. It seems that once the elephant is motivated by the idea of being in control of their own household sustainable output, finding a solution to enable them to make it work is a vital task that requires knowledge from the world (Norman 2013) and quite a lot of taxing work from System 2 (Kahneman 2011).

All the above considered, users also felt more can and should be done by governments to support green initiatives. There was a real sentiment of wanting the 'path to be shaped' – to use the terminology from Heath and Heath (2011) – when it comes to sustainable solution. It is not surprising that Sunstein highlights the role in institutions when nudging individuals towards adopting a new habit (Sunstein 2019) – though speed limits road signs for example. Although sometimes clearly determined and satisfied with the solution they had chosen to adopt, some lead users we spoke to express a little regret for not enough being done to support their initiatives and feeling their – time consuming in many cases- efforts did have as much of an impact. One user proposed that 'green was not his problem' and he was waiting on the government to introduce more electric car parking spaces for example, before he would consider changing his car – a sobering insight.

However, Munster supports that knowledge and motivation are not enough and that pamphlets -or flyers - are usually written for system 2 and most decisions taken by system 1. We found this theory not to be the case when it came to choosing sustainable energy solutions. Households typically spent quite some time looking and definitely got their system 2 involved when making these – financially demanding in many cases – choices.

One user mentioned spending several weeks researching the right solution, whilst another spoke of the 100 programming hours put into customising the system. One cannot but believe a huge involvement of system 2.

Overall, most of the users we spoke to were white middle class male who also happened to be very technically minded. The systems we surveyed were in the same context but quite varied and the duration of the interview depended extensively on how we recruited the participant – the existing ties. Most of the questions we asked could have been applied to any of the multitude of available choices we are required to make as individuals in life and that Barry Schwartz talks about in his book 'The Paradox of choice' for example.

Perhaps in a different context and with a more specific line of enquiries the sentiments might have been different. It was clear nevertheless that the financial incentive was not a clear driver for the search for sustainable solutions; so clear that asking the question sometimes sounded cynical -and this has usually been big institutions selling point.

The participants dismissed the idea of turning on an appliance at a specific time – and therefore change their habit -to save pennies. It therefore felt somewhat difficult to instil the idea of using Green energy in them when it was available unless they could see very little disruption in their daily activities in doing so.

Further studies with more interview data, workshops and even prototypes ought to take place before design methods for sustainable solutions can be carefully recommended.

## **6 Conclusion**

In this paper we have pursued the research question: "How can we create a change of behaviour in private households so that they use electricity when it is produced from sustainable sources?". Through a qualitative study interviewing nine households in Denmark and Germany represented by 'lead users', we identify 17 common patterns for the specific demographics of challenges that can be considered necessary. The patterns lead us to draw out three overall four main challenges that need to be overcome for the design of artefacts that can support household behavioural change towards sustainable energy consumption. The three challenges include 1) existing norms and values derived from

a culture of green actions, 2) a necessary compatibility with the existing technical household platform solutions 3) the desire to have control of their technical devices and data, and finally 4) support from local, municipal and national legislation.

We argue that for future studies and designs that support household behavioural changes, these four properties need to be looked at for collective success on a national and global scale.

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