islander
ACCELERATING THE DECARBONIZATION OF ISLANDS' ENERGY SYSTEMS

PROGRAMME: H2020-LC-SC3-2020-EC-ES-SCC
START OF PROJECT: 01.10.2020
DURATION: 48 MONTHS

DELIVERABLE 5.4:

REPORT ON THE CONSUMER ENGAGEMENT ACTIONS

Authors: KU Leuven
Due date of deliverable: 31.12.2022 (delayed)
Actual submission date: 02.05.2023

Deliverable Name	Report on the consumer engagement actions
Deliverable Number	D 5.4
Work Package	WP 5
Associated Task	All
Covered Period	M01-M31
Due Date	31.12.2022
Completion Date	27.04.2023
Submission Date	02.05.2023
Deliverable Lead Partner	KU Leuven
Deliverable Authors	KU Leuven
Version	**3.0**

DISSEMINATION LEVEL

PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Change Control

DOCUMENT HISTORY

Version	Date	Change History	Author(s)	Organisation
1.0	03.04.2023	Table of content drafted	Sarah Delcourt	KU Leuven
2.0	25.04.2023	Document drafted	Sarah Delcourt, Siegfried Dewitte	KU Leuven
3.0	02.05.2023	Last version	Sarah Delcourt, Siegfried Dewitte	KU Leuven

DISTRIBUTION LIST

Date	Issue	Group
27.04.2023	Revision table of content	SEZ and DAFNI
27.04.2023	Revision document	SEZ and DAFNI
02.05.2023	Submission and distribution to partners	PO + All partners

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

TABLE OF CONTENT

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

EXECUTIVE SUMMARY

With deliverable 5.4, the consortium is expected to report on the different actions that could increase end-users' engagement in the Islander project. The deliverable is expected to provide insights in different ways that could be developed and used to promote an engagement from Borkum's citizens in the project. The goal of the actions would be to promote an adaptation in end-users energy consumption (and production) behaviour and their engagement with the demand response app. Those engagement actions are necessary for the ISLANDER project, as it is important that the end-users adapt their behaviour according to the technology installed on the island in order to be as efficient as possible.

This report will be updated regularly during the whole duration of the ISLANDER project with new insights based on the data. Furthermore, consumers' behavioural adaptations and willingness to adapt in the future will be tracked with the data collection organised in T4.1. Based on the collected data, we might need to develop new actions, and report on their efficacy.

This deliverable report is structured as follow: a short introduction, a section focussing on features that should be implemented in the demand response app in order to increase consumers' engagement, followed by a section reporting on the efficacy of different actions that could be implemented to increase consumers' engagement in the project, and finally a short conclusion.

1 INTRODUCTION

To a greater or lesser extent, European islands are facing several challenges in achieving zero-emission energy systems. The ISLANDER project was funded by the European Union to investigate whether we can propose a solution for those challenges experienced by islands on the road to decarbonization. The ISLANDER project focuses on the German island Borkum, as it is an ideal case for showcasing how an island can be fully decarbonized, for the following reasons: (1) the company NBG, which makes decisions in the energy matters on the island, is involved in the project; (2) Borkum's energy mix is heterogenous; (3) energy consumers on the island are heterogenous and representative for other islands; (4) Borkum has a variable climate; and (5) citizens of Borkum are energy and climate change aware. The results of the investigations on Borkum will be used as an inspiration to other European islands. The final goal will be guidelines towards island decarbonization.

In order to achieve decarbonization on Borkum, the ISLANDER project will focus on: (1) the development of an advanced smart IT platform using latest mathematical optimization techniques, and which will flexibly manage Distributed Energy Resources (DER) coupled with Hybrid Energy Storage (HES) while also incorporating Demand Response (DR) and Local Power Balancing (LPB); (2) the development of an improved multi-scale forecasting methodology relying on comprehensive modelling of demand and supply and on the recent advances of machine learning; and (3) the implementation of a methodology on the large-scale design of optimal distributed DER+HES systems.

However, in order to have a positive impact on the future of our environment and to achieve a zero-emission island, technology on its own is not sufficient. The responsibility relies on politics, industry, and also consumers. Scientists agree that on top of systemic changes that should be organized in a top down way, individuals, their lifestyles and behaviours can make an important contribution to addressing this challenge as well (Karpudewan, Roth, & Bin Abdullah, 2015; Balunde, Perlaviciute, & Steg, 2019; Pinzone, Guerci, Lettieri, & Huisingh, 2013). In the context of the ISLANDER project, it is important that consumers engage with the installed technology, in order to achieve the best results.

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Different technologies will be installed on the island and in consumers' houses. Starting with a demand response app, solar panels, and batteries. The goal of the different actions reported in this report would be to (1) stimulate consumers to engage with the demand response app and use the insights from the app to adapt their daily consumption adequately, and (2) stimulate consumers to adapt their daily energy consumption in order to be more in line with the production of the renewables installed in their houses.

In the next section, we will report on the features that should be implemented in the demand response app in order to stimulate consumers' engagement. In the third section, an action using psychological distance in order to stimulate consumers to adapt their energy consumption will be presented. Two studies using psychological distance were conducted. As the first study was not conclusive, the second study was developed in order to test whether the limitations of the first study could be explaining the lack of results. However, as the second study was not very conclusive either, we focus on a new way to develop effective actions in the fourth section. We will report on the use of a qualitative method, an interview, in order to understand consumers' barriers and motivations to build-up on those to be able to develop an effective action.

2 ENGAGEMENT WITH DEMAND RESPONSE APP

The development of a smart IT platform to make the most of Borkum's zero-carbon infrastructure is a central pillar of the project. The smart IT platform services will provide two main grid capabilities: (1) optimal aggregation and local power balancing of the renewable power plants and (2) demand response to be enabled by a consumer app (both in Android and iOS operating systems) and conceived to be used by all the residents of the island. This way, all residents will receive best consumption patterns based on the results of the mathematical optimization performed by the smart IT platform, so they are able to adapt their consumption profiles according to the generation and current status of the energy storage systems in the island.

The demand response app of the ISLANDER project has the goal to inform Borkum's citizens about the optimal consumption patterns, allowing them to adapt their own consumption to align with the current production and storage levels of the island. An advantage for the citizens will be the potential energy costs savings resulting from their adapted energy consumption patterns. However, in order to profit from those advantages, it is important that consumers engage with the demand response app and use the information of the demand response app in order to adapt their behavior accordingly.

In the current literature review, different features of effective demand response applications will be presented and explained. To conclude, clear advice for the Islander's demand response app will be formulated.

2.1 Literature review insights

2.1.1 Energy consumption and environment

A life domain with a particular large influence on individuals' carbon footprint is energy consumption (Ivanova, Barrett, Wiedenhofer, Macura, Callaghan, & Creutzig, 2020). The European Green Deal aimed to achieve a certain percentage of renewable energy production in all EU-countries by 2020. Despite of this aim, only 10 out of the 28 EU-countries reached this energy renewable goal, and fossil fuels (coal, oil, gas) remain the most used energy source in Europe (European Commission, 2019). In a common household, 64,1% of energy is used for heating, 14,8% is used for water heating, 5.6% is used

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

for cooking, and 14,4% is used for lighting and appliances (European Commission, 2019). Knowing the environmental impact of fossil fuels on the environment, those data are frightening. Fuel combustion is related to air pollutants, oil spilling and coal mining are related to water pollution, and burning fossil fuels are related to the emissions of greenhouse gases (European Environment Agency, n.d.). On top of the negative impact on the environment, fossil fuels have the disadvantage of not being infinite. We expect our known oil deposits to run out by 2052 and our known coal and gas reserves to be run out by 2060 (Howarth, J., 2019). Renewable energy sources, such as solar or wind energy, are concrete alternatives to fossil fuels as they won't run out and have less negative impact on the environment.

2.1.2 Reducing energy consumption

This negative impact on the environment and the finite nature of fossil fuels, and the fact that energy consumption is a daily life behavior adopted by everyone, independent of the consumer type, makes energy consumption an ideal target to maximize the impact of the application of behavioral insights on a sustainable future. By motivating consumers to use energy more wisely and investing in renewable energy sources, we could be able to lower human impact on the environment.

Previous studies already investigated how consumers could be stimulated to adapt (reduce) their energy consumption. Some previous studies focused on the effect of "feedback" on energy consumption. For example, Houde, Todd, Sudarshan, Flora, and Armen (2013) found that an access to real-time feedback on energy consumption led to an average reduction of 5.7% of household electricity consumption and this reduction persisted for 4 weeks, while participants still received access to the real-time feedback. In line with those results, Jessoe & Rapson (2014) reported that providing consumers with information on price events combined with in-home displays providing feedback on energy consumption, reduced energy consumption by 8 to 22%. Jain, Gulbinas, Taylor, and Culligan (2013) reported that feedback in the form of social information (social feedback) can also reduce energy consumption and could lead to more energy savings. A more recent study reported similar results: Burchell, Rettie, & Roberts (2016)'s findings support the idea that providing feedback on energy consumption (and compared to neighbors) can positively affect energy consumption within households.

2.1.3 Demand response app and in-home displays

The results of previous studies confirm the idea that providing feedback to consumers about their energy consumption can motivate them to adapt their consumption. Based on this insight, research is now investigating how feedback can be provided to consumers in order to promote a behavioral change in energy consumption.

Feedback can be provided in different ways. There are three broad ways of providing feedback to consumers: the monthly/annual energy bill, web portals or display devices (e.g. mobile apps, in-home displays…; Valor, Escudero, Labajo & Cossent, 2019). Studies by the British Office of Gas and Energy Markets and the Norwegian Ministry of Petroleum and Energy showed that feedback should be real-time to be the most effective (Organisation for Economic Co-operation and Development, 2017). Researchers and utilities have focused on ways to provide real-time feedback on energy consumption, and provided consumers with in-home electricity displays (IHDs) that are able to provide near real-time information about electricity consumption (Krishnamurti, Davis, Wong-Parodi, Wand & Canfield, 2013).

2.1.4 Effective features of demand response app and in-home displays

Providing real-time feedback, by the mean of IHDs or demand response apps, was proven to be effective in promoting energy conservation in consumers. However, the effectiveness of providing feedback on energy conservation varies considerably across studies (Schultz, Estrada, Schmitt, Sokoloski & Silva-Send, 2015). As a result, it is important to have a clear insight in which features of

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

IHDs and/or demand response app are more or less effective or efficient in promoting energy conservation in consumers. In this section, we review the research on various features that have been implemented in IHDs and demand response apps.

In their study, Asensio and Delmas (2016) investigated the effect of different framings (messaging approaches) feedback on energy consumption provided by a real-time appliance. The authors compared the effect of a traditional cost saving frame, meaning, the savings resulting from reducing energy consumption, and a health-based frame, meaning the environmental and health consequences of energy consumption. Asencio and Delmas (2016) found that while traditional cost saving frames (money) were not effective, a health-based frame of information was effective in promoting energy savings by 8-10% over 100 days. The evidence that cost framed feedback was not the most effective feature of the IHDs was confirmed by the study of Krishnamurti, Davis, Wong-Parodi, Wand and Canfield (2013) who found a discrepancy between consumers' reported feedback preferences and the actual effectiveness of different types of feedback. The authors found that consumers had a strong preference for more detailed appliance-specific feedback in dollar units and no preference for social/green comparison, they actually learned the relative electricity consumption of appliances more from a summary of their current kWh usage (Krishnamurti, Davis, Wong-Parodi, Wand & Canfield, 2013). Similarly, Schultz, Estrada, Schmitt, Sokoloski and Silva-Send (2015) conducted a study with four groups (control group, a kWh feedback group, a kWh+cost feedback group, and a kWh+social norm feedback group) to investigate the effect of different kinds of feedback on energy consumption. The results showed that participants in the social norm framed feedback condition had a significant reduction in energy consumption in the short and long term. Additionally, results indicate that participants enjoy the IHD and 85% wanted to keep it. Respondents thought that feedback and cost framed feedback IHD was influencing their behavior to the largest extent, while this was not supported by their actual consumption. This indicates that the effect of norm feedback is partially unnoticed by consumers (Schultz, Estrada, Schmitt, Sokoloski & Silva-Send, 2015).

The studies mentioned hereabove provide evidence for the low efficiency of a cost-framed feedback and at the same time for the fact that consumers overestimate its effect. That means that providing feedback about the cost (in money) of one's energy consumption might not be enough to stimulate a behavioral change in consumption and should not be the only feature implemented in the IHD and demand response app.

In a more recent paper, Valor, Escudero, Labajo and Cossent (2019) listed clear evidence-based guidelines that should be taken into account when designing an IHD or demand response app. Valor, Escudero, Labaio and Cossent (2019) conducted a literature review of the existing evidence and research on interactive device and deduced guidelines for the design of IHD and demand response apps. Firstly, the authors argue that feedback concerning consumption (in kWh) should be both general (full consumption of the house, across all appliances) but also localized (specific for each appliance), and that the display should be anthropomorphized (use of spoken messages, faces…). Secondly, both push and pull messages should be used to encourage engagement over time. Thirdly, the content of the application is important. Historical comparison (compared to previous consumption) should be broken down by appliances, social comparison should be implemented but allowing for customization of the peer comparison group, the device should allow consumers to set personally relevant goals and provide feedback on the goal achievement, initial feedback should be positive to promote interaction with the device, and finally the information should be provided in a friendly way, avoid overloading and prefer intuitive graphics (e.g. pie chart) and show performance by means of a traffic-light color code. Fourthly, level of consumption data should be provided by appliances (see 1) but focus on appliances that can be adapted (e.g. TV instead of the fridge). Fifthly, the measurements units used matter. kWh units can be used but might not be very effective, while money or ecological effect (eco-visualization) can be more effective. However, as the studies mentioned hereabove indicates that the use of money effect might not be as effective, stakeholders could focus on ecological effects or social comparisons. Sixthly, incentives, such as rewards, colors or emoji's, should be used to promote behavioral change. It is also important to think of the whole household when designing the device. The

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

feedback and visualizations features should be speaking to the different members of the household. The device itself should be attractive and have both external and internal aesthetic appeal. And last but not least, ensure the trust in the device and privacy.

2.2 Concrete advice for the Islander demand response app

Based on previous literature and studies, mentioned in this report, we will formulate clear advice for the development of the demand response app of the ISLANDER project.

- Include feedback on energy consumption in terms of: kWh, cost (money) and environmental impact (CO2)
  - kWh and cost were proven less effective than environmental impact, but still preferred by consumers. Therefore, the three feedbacks should be implemented. But make the environmental impact the default feedback (the one presented first when opening the app), and allow consumers to switch to another feedback;
  - Make use of visuals such as graphics or images;
  - Present the information in two ways: a feedback for the general consumption, then a feedback per important appliance (in graph for example). The important appliances can be defined in WP4 (T4.1);
- Include application notifications, to keep consumers engaged with the application
  - Example, send a weekly summary of the household's consumption;
- Provide comparison feedback and include visualization of the behavior (colors or emoji's to indicate whether they are doing better or worse)
  - Historical: allow consumers to check how their consumption evolved compared to previous week (and perhaps previous month, and previous year)
  - Social: allow consumer to check how their consumption is situated compared to similar households on the island (with respect to the privacy of all individuals)
    - This feature should be highlighted in the application, as social comparison was proven effective in stimulating behavioral change;
- Make the demand response app attractive;
  - The application should not contain too much text, but clear information of one's consumption;
    - Visuals are better to attract attention and make information comprehensible
  - Make the application intuitive and user friendly;
- Ensure trust in application and respect of one's privacy;
  - When launching the application on the Island, provide enough information about the application, its function, and how data will be used;
    - If necessary, a responsible can be designed to give workshops or individual explanation sessions about the application

<u>In Annex A-B-C, you can find an overview of possible visuals that could be implemented in the demand response app to present feedback to the consumers.</u>

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

3 LITERATURE-BASED ACTION

In the following section, we will report on the efficacy of an action based on literature-review insights.

3.1 Engage consumers with psychological distance

Previous studies investigated how consumers could be stimulated to adapt (reduce) their energy consumption. Those previous studies focused on the effect of "feedback" on energy consumption. For example, Houde, Todd, Sudarshan, Flora, and Armen (2013) found that an access to real-time feedback on energy consumption lead to an average reduction of 5.7% of household electricity consumption and this reduction persisted for 4 weeks. In line with those results, Jessoe & Rapson (2014) reported that providing consumers with information on price events combined with in-home displays, providing feedback on energy consumption, reduced energy consumption by 8 to 22%. A more recent study reported similar results, Burchell, Rettie, & Roberts (2016)'s findings support idea that providing feedback on energy consumption (and compared to neighbors) can positively affect energy consumption within household. The action of providing feedback to consumer can be linked to the previous section, in which advice is given on how to develop a demand response app that will engage consumers.

The results of previous studies confirm the idea that providing (real-time) feedback to consumers about their energy consumption can motivate them to adapt their consumption. However, the focus of the literature on (real-time) feedback ignored other possible interventions that were already applied to other PEBs. For example, in the context of turning off car engine at a stop, Meleady et al. (2017) found that evocating the private self-focus was more effective than a surveillance condition in stimulating to turn down car engine. Another intervention tested in the context of food disposal was the design of the building. Wu, DiGiacomo, and Kingstone (2013) found that people were more likely to engage in pro-environmental food disposal in a building that is designed according to it, compared to a "normal" building.

The current study aims at filling in the gap in the current literature by investigating the effect of an intervention unrelated to providing (real-time) feedback on stimulating consumers in adapting their energy consumption. More concretely, we conducted a literature review to identify factors and interventions that were already (successfully) applied to other PEB's and we will investigate whether those factors and interventions can be successfully implemented in the domain of energy consumption.

The current study will investigate the effect of knowledge and psychological distance of the consequences of energy consumption behavior on the willingness to adapt energy consumption and the willingness to invest in renewable energy system (solar panels).

Concretely, we hypothesize that:

1. *H1a&b: participants in the intervention conditions will show a greater willingness to adapt energy behavior & invest in renewable energy than participants in control condition*

We expect that a document containing knowledge, independent of the psychological distance, of the consequences of energy consumption will increase the willingness to adapt behavior as Meyer (2015) stated that education can increase a range of PEB's , such as recycling and energy consumption, because it causes consumers to be more concerned with the consequences and social welfare.

2. *H2a & b: participants in the short psychological distance condition while show a greater willingness to adapt energy behavior & invest in renewable energy than participants in the far psychological distance condition*
3. *H3a & b: participants in the short psychological distance condition while show a greater*

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

willingness to adapt energy behavior & invest in renewable energy than participants in the control condition

We expect the document containing knowledge on consequences of energy consumption, framed in a short-term consequences to be the most effective intervention as Lee, Sung, Wu, Ho, and Chiou (2020) found that episodic future thinking leads to more PEB's, such as air conditioning use reduction, vegetarian food choice, beach cleaning, because it makes events more concrete and decreases psychological distance.

3.1.1 Methods

3.1.1.1 Participants and design

In total, 747 individuals filled in the online survey. As willingness to invest in solar panels is only relevant for individuals owning their place (investing for themselves) and not having invested in solar panels yet - data were filtered according to the following criteria: (1) complete participation, (2) owner of the house/apartment, and (3) not having solar panels at the moment of the study, resulting in 217 usable data. The sample's age ranged from 18 to 79 years old (M= 27.39, SD= 9.22), with 146 men, 62 women, and 3 others. Participants were randomly divided into three groups, 74 participants were assigned to the first condition (control, condition 1), 71 participants were assigned to the second condition (long-term consequences knowledge condition, condition 2), and 72 participants were assigned to the third condition (short-term consequences knowledge condition, condition 3).

3.1.1.2 Procedure

Participants were recruited through the online platform Prolific. Participants received a participation fee through their Prolific account after completing the survey. After receiving a notification of participation, participants were redirected to the Qualtrics survey. Before answering the questions, an informed consent was presented, and participants had to agree with it to be presented to the first question. To start, participants were asked if they owned solar panels. If the answer was positive, participants were automatically redirected to the end of the study. If the answer was negative, participants were asked to answer demographical questions, such as gender, age, professional status, education, yearly gross income, and household size. The household size was used later in the survey to calculate how much investing in solar panels would cost, as price of the investment depends on the number of solar panels which depends on the number of individuals in the household. Thereafter, participants were randomly divided across the three conditions and presented with their condition document (Appendix A). After carefully watching the document, participants were asked to fill in questionnaires on willingness to adapt (energy) behavior, and willingness to invest in solar panels. After filling in the questionnaires of the dependent variables, participants had to fill in a PEB questionnaire (Kaiser & Wilson, 2004), which will serve as control variable. To finish, participants were asked if they did consider the possibility to install solar panels before participating in this study.

3.1.1.3 Measured variables

3.1.1.3.1 Willingness to adapt energy consumption behavior

The willingness to adapt (energy) consumption behavior was measured with the help of four separate statements (Hayles, & Dean, 2015; Brody, Grover, & Vedlitz, 2012). Three statements were scored on a 4-points Likert scale, going for strongly disagree (1) to strongly agree (4), and one question scored as 0 or 1 depending on the chosen option. The four statements were analyzed separately and are described in Table 1.

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Table 1 – Statements used to measure willingness to adapt (energy) consumption behavior, with their answer options and score of each answer option

Statements	Scale
I will take steps to reduce my energy consumption (S1)	1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree
I will change my energy consumption (S2)	1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree
I am willing to switch to solar panels or other renewable energy systems (S3)	1: Strongly disagree 2: Disagree 3: Agree 4: Strongly agree
What is your reaction when you hear climate change discussed? (S4)	0: Anger 0: Helplessness 0: Skepticism 1: Any interest 1:Desire to make a difference

3.1.1.3.2 Willingness to invest in solar panels

The willingness to invest in solar panels was measured with the help of the "Choice Experiment Scenario", which consisted of two parts. The two parts are similar, however they measure the willingness to invest at once (part 1 – full investment) or the willingness to invest spread over time (part 2 - spread investment). The Choice Experiment Scenario presents participants with two options: (1) the status-quo option, which is keeping their energy production as it is, and the (2) renewable energy option, which is investing in solar panels. Before making a choice, participants were informed about the price of the solar panels investment, the saving in CO2 when choosing the solar panels, and the return to investment of the solar panels installation. The price of the solar panels and the return to investment were adapted to the household size, with being higher for a larger household. After reading the information about both choices carefully, participants were asked to make a choice between both options. If participants decided to go for the solar panels installation, they were asked whether they would be willing to pay the suggested price of the installation (see above). If their answer was yes, they were asked whether they were willing to pay the same amount raised by 1000€ for the solar panels installation. If they again answered positively they were asked a last time whether they would pay the amount raised by 1000€. Alternatively, if they indicated not being willing to pay the original installation price, they were asked if they would be willing to pay an amount 1000€ lower. If they again responded negatively, they were proposed to pay a price 1000€ lower. At the end, participants were asked to indicate how much they would be willing to pay for the installation. This was done in order to estimate how much consumers would be willing to invest in a solar panels installation. The result of the Choice Experiment Scenario is twofold:

- Willingness to invest in solar panels: did participants choose option 2
- Maximum amount willing to pay for the investment

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

3.1.1.4 Analysis

In the current study, we are comparing three different conditions on different dependent variables. Therefore, one-way ANOVA's were computed in the statistical analyses program R. A significant p-value of .05 was used to evaluate whether a difference was significant or not.

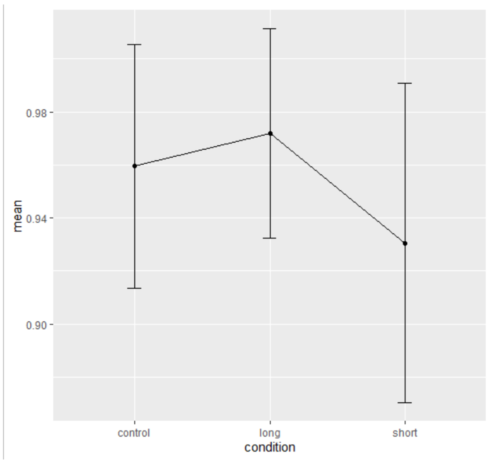
3.1.2 Results

3.1.2.1 Willingness to adapt energy consumption behavior

3.1.2.1.1 I will take steps to reduce my energy consumption (Statement 1)

On the statement "I will take steps to reduce my energy consumption", no significant differences between the three conditions was found ($F(2,214) = .73$, $p = .49$). As can be seen on Figure 1, participants in the short-term consequences knowledge condition ($M = .93$, $sd = .26$) were not more willing to take steps to reduce energy consumption than participants in the control condition ($M = .96$, $sd = .20$) and the long-term consequences knowledge condition ($M = .97$, $sd = .17$).

Figure 1
Mean willingness to adapt (energy) consumption behavior S1 by Condition

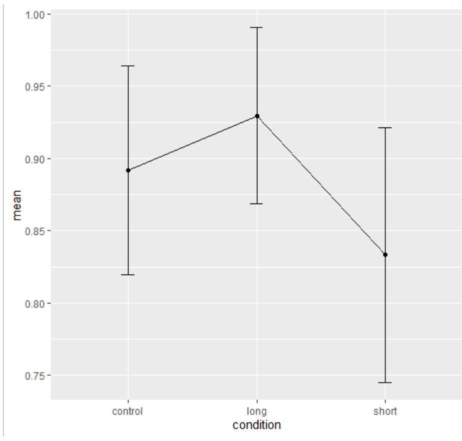


3.1.2.1.2 I will change my energy consumption (Statement 2)

On the statement "I will change my energy consumption", no significant differences between the three conditions was found ($F(2,214) = 1.65$, $p = .19$). As can be seen on Figure 2, participants in the short-term consequences knowledge condition ($M = .83$, $sd = .38$) were not more willing to change energy consumption than participants in the control condition ($M = .89$, $sd = .31$) and the long-term consequences knowledge condition ($M = .93$, $sd = .38$).

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

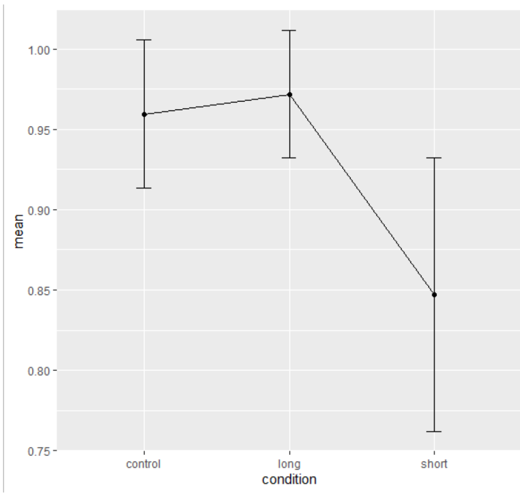
Figure 2
Mean willingness to adapt (energy) consumption behavior S2 by Condition



3.1.2.1.3 I am willing to switch to solar panels or other renewable energy systems (Statement 3)

On the statement "I am willing to switch to solar panels or other renewable energy systems", a significant difference between the three conditions was found (F(2,214) = 5.14, p = .007). As can be seen on Figure 3, participants in the short-term consequences knowledge condition (M = .85, sd = .36) were less willing to switch to renewable energy systems than participants in the control condition (M = .96, sd = .20) and the long-term consequences knowledge condition (M = .97, sd = .17). A Tukey test confirmed that participants in condition 3 significantly differed from participants in condition 1 (p = .02) and condition 2 (p = .01).

Figure 3
Mean willingness to adapt (energy) consumption behavior S3 by Condition



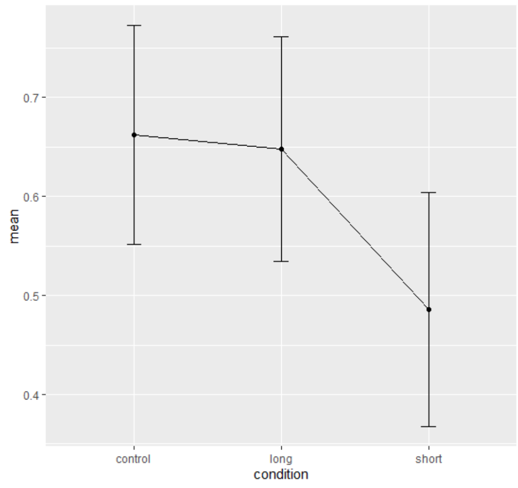
3.1.2.1.4 What is your reaction when you hear climate change discussed? (Statement 4)

On the question "What is your reaction when you hear climate change discussed", no significant differences between the three conditions was found (F(2,214) = 2.92, p = .06). As can be seen on Figure 4, participants in the short-term consequences knowledge condition (M = .49, sd = .50) were not more willing to feel interested or willing to make a difference than participants in the control condition (M = .66, sd = .48) and the long-term consequences knowledge condition (M = .65, sd = .48).

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Figure 4

Mean willingness to adapt (energy) consumption behavior S4 by Condition



3.1.2.2 Willingness to invest in solar panels

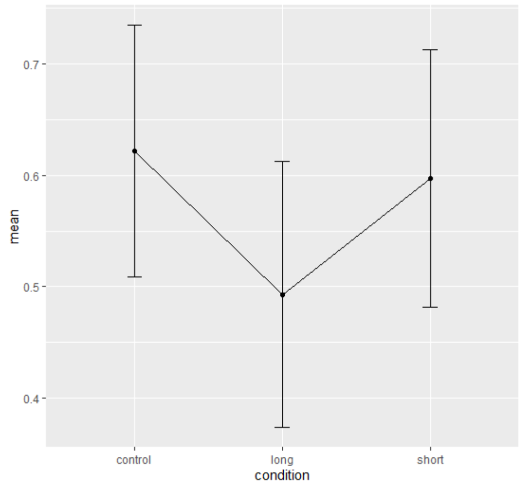
3.1.2.2.1 Willingness to invest

3.1.2.2.1.1 Full investment

As stated hereabove, participants were asked if they were willing to choose for the option in which they had to invest (and pay the investment at once) in solar panels instead of choosing the status quo option. We compared the three conditions in how often the participants chose for the solar panels installation option. No significant differences were found between the three conditions ($F(2,214) = 1.37$, $p = .26$). This suggests that participants in the short-term consequences knowledge condition ($M = .60$, $sd = .49$) were not more willing to choose for the solar panels installation and pay the investment at once than participants in the control condition ($M = .62$, $sd = .49$) and the long-term consequences knowledge condition ($M = .49$, $sd = .50$) (Figure 5).

Figure 5

Mean willingness to invest in solar panels and pay investment at once by Condition

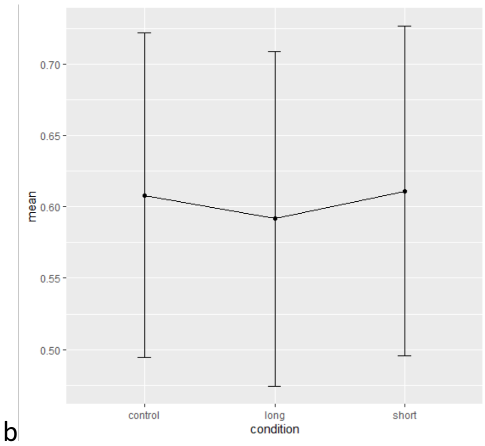


This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

3.1.2.2.1.2 Spread investment

As with investing in solar panels and paying investment at once, no significant differences were found between the three conditions (F(2,214) = .03, p = .97) when asking if participants would be willing to invest in solar panels and spread the payment of the investment. This suggests that participants in the short-term consequences knowledge condition (M = .61, sd = .49) were not more willing to invest in solar panels and spread the payment of the investment than those in the control condition (M = .61, sd = .49) and the long-term consequences knowledge condition (M = .59, sd = .50) (Figure 6).

Figure 6
Mean willingness to invest in solar panels and spread payment of investment by Condition



3.1.2.2.2 Maximum amount willing to invest

3.1.2.2.2.1 Full investment

At the end of the Choice Experiment Scenario, participants were asked to indicate the maximum amount they would be willing and able to pay at once for the installation of solar panels. The amount indicated by participants was used in this analysis to see if participants in condition 3 were willing to invest more for solar panels than participants in the other conditions. It is important to note that this analysis was conducted only on participants who indicated that they choose option 2 (solar panels) above option 1 (status-quo), resulting in a sample of 122 participants. The result of the one-way ANOVA revealed no significant differences (F(2,119) = .56, p = .57) between the three conditions, suggesting that participants in condition 3 (M = 4232, sd = 3988) were not more willing to pay more for the installation of solar panels than participants in condition 1 (M = 4898, sd = 2836) and condition 2 (M = 5012, sd = 3893).

3.1.2.2.2.2 Spread investment

When asked about the maximum amount willing and able to pay per month for the installation of solar panels, no significant differences (F(2,119) = .65, p = .53) between the three conditions were found, suggesting that participants in condition 3 (M = 94.8, sd = 82.6) were not more willing to pay more per month for the installation of solar panels than participants in condition 1 (M = 334, sd = 1475) and condition 2 (M = 292, sd = 1063).

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

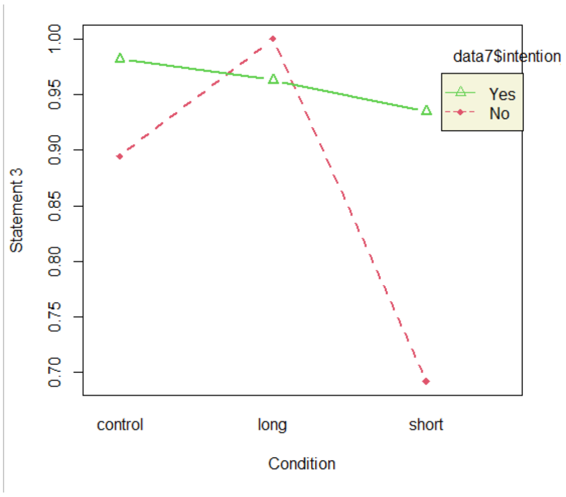
3.1.2.3 Prior considerations

At the end of the study, participants were asked whether they already have considered the installation of solar panels before taking part in the study. In a post-hoc analysis, we investigated whether the presence of consideration for solar panels before the study could have an influence on the willingness to adapt (energy) consumption behavior and the willingness to invest in solar panels. Participants were divided in a "yes"-groups, which were participants who already considered installing solar panels before taking part in the study, and a "no"-group, which were participants who never considered solar panels before.

The previously mentioned analyses of willingness to adapt (energy) consumption behavior and willingness to invest in solar panels were reconducted again, but this time with a two-way ANOVA in order to investigate the influence of previous consideration of solar panels on the results.

The results remained similar, as no main effect of previous consideration or interaction effect (between condition and previous consideration) were found. The only exception was the significant main effect ($F(1, 211) = 8.46$, $p = .004$) of previous consideration and the significant interaction effect ($F(2,211) = 4.68$, $p = .01$) on statement 3 ("I am willing to switch to solar panels or other renewable energy systems") of willingness to adapt (energy) consumption behavior. As can be seen on Figure 7, willingness to switch to solar panels or other renewable energy is higher in participants who had already considered the installation of solar panels before participating in the study (main effect), however when presented with condition 2 (knowledge and long-term consequences) participants who had never considered solar panels before were the more willing to switch towards renewable energy systems.

Figure 7
Mean willingness to adapt (energy) consumption behavior S3 by Condition and previous consideration of solar panels



3.1.3 Discussion

Based on the studies of Meyer (2015) and Lee, Sung, Wu, Ho, and Chiou (2020), we stated that presenting participants with a document containing information (knowledge) on the consequences of energy consumption and a clear short-term framing of those consequences would lead to a higher willingness to adapt (energy) consumption behavior and a higher willingness to invest in solar panels.

We failed to confirm our hypotheses with this online study, as no significant differences between the three conditions were found on the different dependent variables. However, the post-hoc analysis conducted to investigate the influence of previous solar panels consideration revealed results that could be interesting to consider. The results of the post-hoc analysis seem to suggest that consumers

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

who never considered installing solar panels in their house before, were triggered by reading information on the consequences of current energy consumption and a clear framing of the consequences in the long-term. Those results would mean that the intervention is not strong enough to stimulate consumers already interested in renewable energy to make the real investment. However, the intervention seems strong enough to elicit a first interest in consumers who were not concerned at all before.

It is important to note, that contrary to our hypotheses, it is the long psychological distance condition (condition 2) who seemed effective in eliciting interest in consumers who never considered solar panels before, instead of the short psychological distance condition (condition 3). This might be explained by the fact that the majority of consumers thinks that the consequences of energy consumption on the environment is not concrete yet and will only be felt in a long time. Then, the short-term framing of the consequences might have been experienced as unrealistic, resulting in a low influence on consumers' intentions. Follow-up studies investigating consumers' beliefs of energy consumption consequences should be conducted to test this explanation in more details.

3.1.3.1 Limitations of the study

Due to the covid-19 regulations at the time of the study, the current study was conducted online. An important limitation of an online survey is the fact that attention of participants could not be controlled. Participants were asked to carefully read and analyze the document. However, we were not able to control whether participants really took the necessary time to analyze the document and process the information. If participants were not carefully reading the document and processing the information as intentioned, this might have influenced the results.

A second limitation of the study is the use of a document. According to Lee, Sung, Wu, Ho, and Chiou (2020), making the consequences concrete and realistic foster behavioral change. The use of a video instead of a document, or the use of virtual reality, might make the consequences mentioned in the document event more concrete and lead to better results.

A last limitation is the fact that we measured participants' intentions to adapt energy consumption behavior, instead of measuring concrete and real behavior. This limitation will be targeted in the second study we conducted. As reported below, in the second study we make use of the PEBT (Lange, Steinke, & Dewitte, 2018) to measure concrete energy behavior in participants instead of intentions only.

3.1.4 Conclusion

The current study investigated if willingness to adapt (energy) consumption behavior and willingness to invest in renewable energy systems could be increased by exposing participants to an information document on energy consumption's consequences framed in a short-term timeframe. The results of the online study seem to suggest that the intervention is not strong enough to motivate consumers already considering solar panels to concretely make the investment, however the intervention seem strong enough to elicit a first interest in energy consumption and renewable energy systems in consumers who did not consider it before.

3.2 Engage consumers with psychological distance 2.0 [1]

The experimental online study described above did not allow us to conclude that knowledge about energy consumption, its consequences, and the reduction of consequences' psychological distance were effective in stimulating consumers to adapt their energy consumption or invest in solar panels.

[1] This study is still under progress, so the report is preliminary and subject to changes

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

However, this failure to confirm the hypotheses was quite unexpected as psychological distance was previously shown to be effective in stimulating pro-environmental behaviors. Recently, for example, Engle-Friedman, Tipaldo, Piskorski, Young, and Rong (2022) found that asking individuals to write, think and/or draw about themselves in the future (reducing psychological distance with the future) resulted in more pro-environmental behaviour on the FISH task than individuals who had to write, think and/or draw about themselves in the present.

This leads us to think that there are two possible explanations for the failure to confirm our hypotheses in the experimental online study reported above: (1) the concept of psychological distance is not effective in stimulating a change in energy consumption and/or production despite its effectiveness with pro-environmental behaviors in general, or (2) the limitations of the experimental online study influenced the results negatively. The goal of this second study is to investigate whether the limitations of the previous study were the reason behind the failure to confirm our hypotheses concerning psychological distance. We propose a new study, with an improved design (based on literature) to test the effect of reducing psychological distance on the willingness of consumers to adapt their energy consumption. The study is still under progress, so only preliminary results are reported.

3.2.1 Methods

3.2.1.1 Participants and design

The total sample target for following study was around 250 participants. In total, 140 individuals participated in the lab-study so far. 13 participants were deleted from the analysis, as they did not complete the intervention task correctly or with full attention, and one participant was deleted from the analysis because he/she did not complete the full study. The sample's age ranged from 18 to 56 years old (*M*= 23.09, *SD*= 4.94) with 60 men, 63 women, 1 prefer not to say, and 2 others. Participants were randomly divided into three groups, 42 participants were assigned to the control condition (1; imagine yourself in the present), 44 participants were assigned to the no consequences condition (2; imagine yourself in the future), and 40 participants were assigned to the consequences condition (3; imagine yourself in the future where we suffer from the consequences of relying on fossil fuel for too long). An overview of the three conditions can be found in Table 2.

3.2.1.2 Procedure

After being welcomed into the lab, participants were asked to read and sign the informed consent. After signing the informed consent, participants were directed to one of the lab computers and asked to start with a computer task. During the computer task, participants were first asked to write about themselves (subject differ depending on the condition, see independent variable) and after that fulfilling 30 trials of the adapted PEBT (see dependent variable). The 30 trials were divided as follow: the first 6 trials were used to let participants discover the PEBT, after that four blocks of 6 trials each were presented to the participants. The trials differed in the amount of time participants had to wait when choosing the drying rack and the amount of lights turned on and CO2 produced when choosing the dryer. To finish the study, participants were required to fill in a Qualtrics survey collecting demographical information, pro-environmental scale, CFC scale, a donation task, and a writing task.

3.2.1.3 Variables

3.2.1.3.1 Independent variable (intervention using psychological distance)

In order to manipulate the psychological distance, we decided to use an adapted version of Engle-Friedman, Tipaldo, Piskorski, Young, and Rong (2022)'s manipulation. Similar to the manipulation used by Engle-Friedman, Tipaldo, Piskorski, Young, and Rong (2022), participants will be asked to think, write

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

and/or draw about themselves whether in the present (control condition) or the future (Table 2). The experimental manipulation (future) will be divided across two conditions: (1) thinking, writing and/or drawing about themselves in the future, and (2) thinking, writing and/or drawing about themselves in the future with the consequences of energy consumption highlighted. We expect participants in the future with environmental consequences condition to show more pro-environmental energy behavior on the adapted PEBT than the participants in the other conditions.

Table 2 – Overview of the three conditions

Condition	Statement given to participants
Control	On the piece of paper present on your desk: Imagine, draw an image of, and write about your life - family life, living arrangements, how most of your time is occupied and what you for fun in free time - in the present
No consequences	On the piece of paper present on your desk: Imagine, draw an image of, and write about your life - family life, living arrangements, how most of your time is occupied and what you for fun in free time – at 60 years of age
Consequences	On the piece of paper present on your desk: Imagine, draw an image of, and write about your life - family life, living arrangements, how most of your time is occupied and what you for fun in free time – at 60 years of age, in a world suffering from the consequences of the use of fossil fuels to produce energy. To give you an idea, fuel combustion is related to air pollutants, oil spilling and coal mining are related to water pollution, and burning fossil fuels are related to the emissions of greenhouse gases (European Environment Agency, n.d.). Leading to higher temperatures, fires, and floods. Additionally, fossil fuels reserve are not infinite. By 2050 our known reserves will disappear (Howarth, J., 2019), resulting in a lack of plastic, medication, makeup, cleaning products, clothes...

3.2.1.3.2 Dependent variable

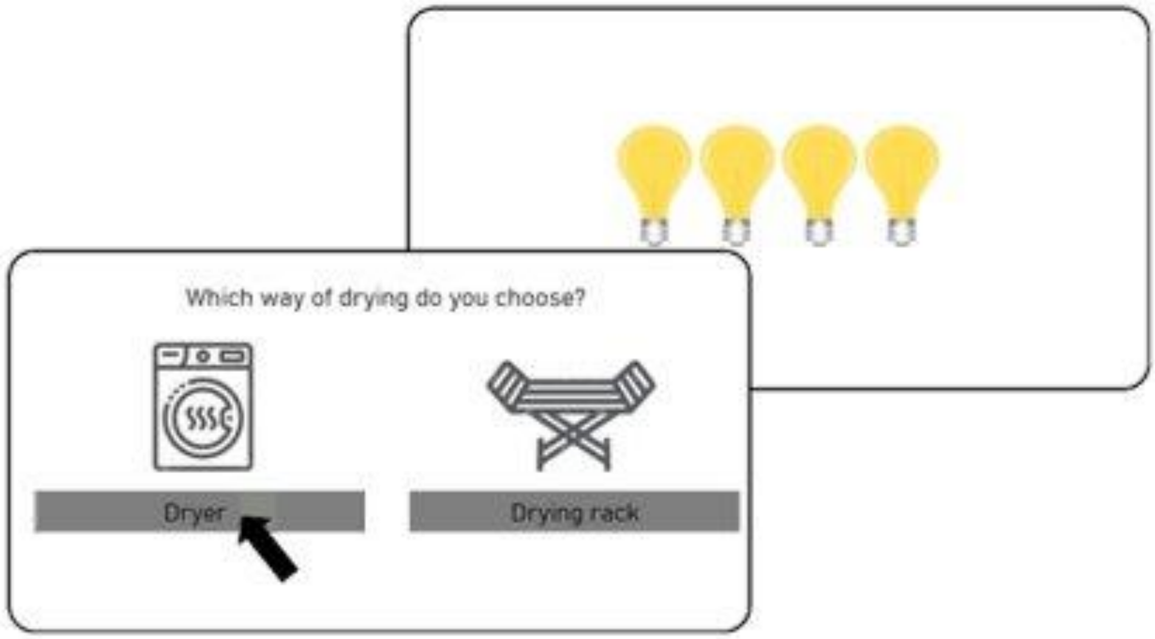
We decided to measure pro-environmental energy behavior in a more concrete way than using statements as in the previous study. Therefore, we decided to use the PEBT (Lange, Steinke, & Dewitte, 2018), which measures pro-environmental behavior in lab settings through a computer task. The advantage of the PEBT is that it presents individuals with a choice between a sustainable and a non-sustainable option, with both being linked to specific consequences. The sustainable option has no environmental consequences (lights producing CO_2), however have personal consequences (longer waiting time until next trial), while the opposite is true for the non-sustainable option. In the original PEBT, participants are asked to choose between a bike and a car as a mode of transportation. In the

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

adapted PEBT (Figure 8) we designed for this study, participants are asked to make a choice between drying clothes with a dryer (non-sustainable) and a drying rack (sustainable). When using the drying rack, participants have to wait longer for the next trial but don't produce additional CO2. When using the dryer, the waiting time is shorter but lights are turned out, producing a certain amount of CO2. Over the trials the values of this waiting time and number of lights are varied but observe the general trade-off between personal benefit and environmental cost.

Figure 8

Adapted PEBT used in the current study



3.2.1.4 Analysis

In the current study, we are comparing three different conditions on their adapted PEBT score. Therefore, one-way ANOVA's were computed in the statistical analyses program R. A significant p-value of .05 was used to evaluate whether a difference was significant or not.

3.2.2 Preliminary Results

3.2.2.1 Number of times "rack" is selected across trials

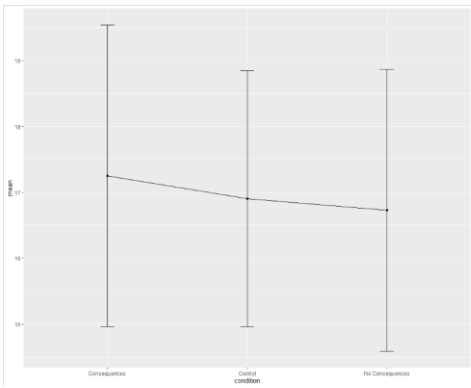
3.2.2.1.1 Across all trials

For this analysis, the number of times participants selected the "rack" (pro-environmental) option was calculated across all 24 trials of the study (Figure 9). The results do not suggest a difference between the three conditions ($F(2,123) = .06$, $p = .94$), suggesting that participants in the consequences condition ($M = 17.2$, $sd = 7.16$) were not more willing to select the drying rack than participants in the no consequences condition ($M = 16.7$, $sd = 7.04$) and control condition ($M = 16.9$, $sd = 6.23$).

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Figure 9

Mean choice for drying rack across all trials for the three conditions

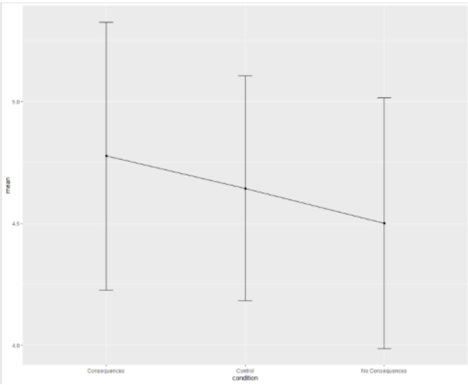


3.2.2.1.2 First block of trials

The number of times participants selected the "rack" (pro-environmental) option was calculated across the first six trials of the study (Figure 10). The results do not suggest a difference between the three conditions (F(2,123) = .30, p = .74), suggesting that participants in the consequences condition (M = 4.78, sd = 1.72) were not more willing to select the drying rack than participants in the no consequences condition (M = 4.50, sd = 1.69) and control condition (M = 4.64, sd = 1.48).

Figure 10

Mean choice for drying rack across the first six trials for the three conditions



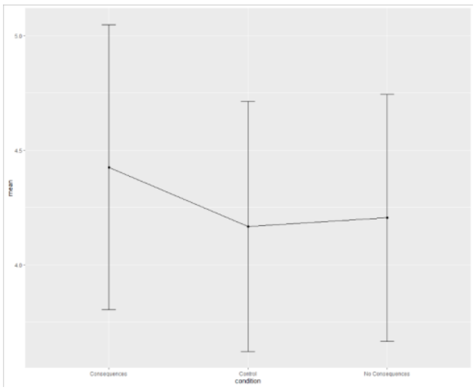
3.2.2.1.3 Second block of trials

The number of times participants selected the "rack" (pro-environmental) option was calculated across the second six trials of the study (Figure 11). The results do not suggest a difference between the three conditions (F(2,123) = .30, p = .74), suggesting that participants in the consequences condition (M = 4.78, sd = 1.72) were not more willing to select the drying rack than participants in the no consequences condition (M = 4.50, sd = 1.69) and control condition (M = 4.64, sd = 1.48).

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Figure 11

Mean choice for drying rack across the second six trials for the three conditions

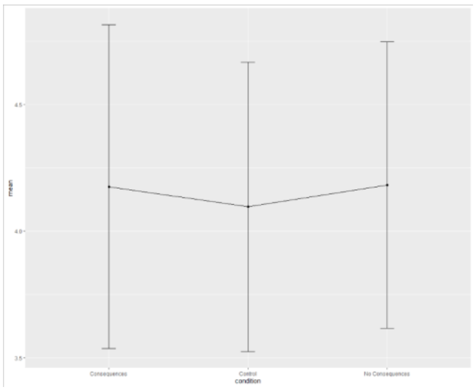


3.2.2.1.4 Third block of trials

The number of times participants selected the "rack" (pro-environmental) option was calculated across the third six trials of the study (Figure 12). The results do not suggest a difference between the three conditions (F(2,123) = .03, p = .97), suggesting that participants in the consequences condition (M = 4.18, sd = 2.00) were not more willing to select the drying rack than participants in the no consequences condition (M = 4.18, sd = 1.86) and control condition (M = 4.10, sd = 1.83).

Figure 12

Mean choice for drying rack across the third six trials for the three conditions



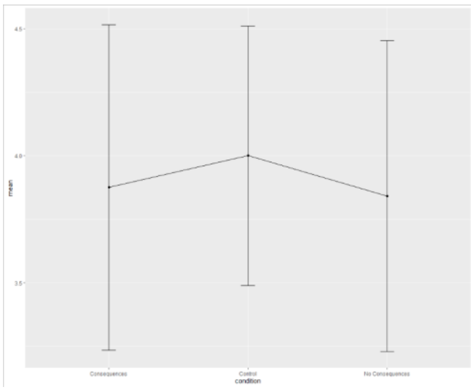
3.2.2.1.5 Fourth block of trials

The number of times participants selected the "rack" (pro-environmental) option was calculated across the last six trials of the study (Figure 13). The results do not suggest a difference between the three conditions (F(2,123) = .08, p = .92), suggesting that participants in the consequences condition (M = 3.88, sd = 2.00) were not more willing to select the drying rack than participants in the no consequences condition (M = 3.84, sd = 2.01) and control condition (M = 4.00, sd = 1.64).

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Figure 13

Mean choice for drying rack across the third six trials for the three conditions



3.2.3 Preliminary Discussion

The results reported by Lee, Sung, Wu, Ho, and Chiou (2020) suggested that a short-term framing should stimulate a pro-environmental behavioral change in consumers. This idea of reducing psychological distance to stimulate a behavioral change was confirmed by the study of Engle-Friedman, Tipaldo, Piskorski, Young, and Rong (2022). The current study was developed in order to investigate whether the limitations of the first study could explain the lack of significant effect. However, the results of the current study failed to support the hypothesis that reducing psychological distance of current behavior and future environmental consequences could efficiently promote a behavioral change in consumers.

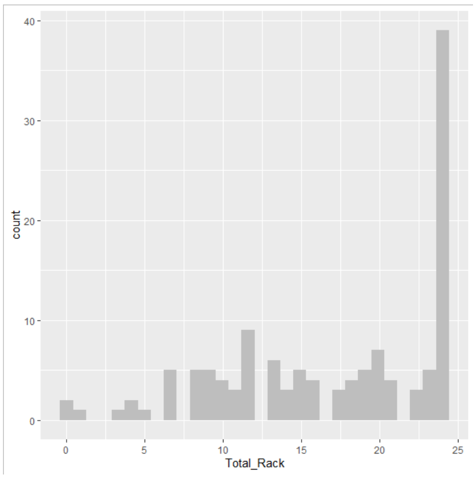
As in the previous study, we failed to confirm our hypothesis. However, this failure to find a significant effect could be due to a sampling bias. As can be seen in Figure 14, the majority of our sample did select the drying rack option quite often. As there were 24 trials, participants could select the drying rack up to 24 times. 39 participants always selected the drying rack (31%), 28 participants selected the drying rack in 75-99% of the trials (22%), 30 participants selected the drying rack in 50-74% of the trials (24%), 22 participants selected the drying rack in 25-49% of the trials (17%), and seven participants selected the drying rack in less than 25% of the trials (5%). Meaning that around 77% of our sample selected the drying rack in more than 50% of the trials.

Meaning that in general, the sample was open to use the drying rack unconditional of their condition. This is in line with the fact that out of the 74 participants who do their laundry themselves at home, 80% is always using a drying rack. Those data suggest that our sample was biased in the sense that in general, participants were already positive about using a drying rack, as they are already choosing for it in their daily life. This finding might suggest that our intervention was not effective because our sample was not in need of motivation for choosing the drying rack.

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

Figure 14

Number of time participants selected the "drying rack" during the study



4 DATA-DRIVEN INSIGHTS

In previous sections of this report, we reported the efficacy of engagement actions building on the concept of psychological distance. The first study seemed unsuccessful in stimulating a behavioral change or willingness to invest in solar panels in our participants. The only effect found suggested that highlighting the psychological distance of the consequences of reliance on fossil fuels could stimulate some first interest in consumers that never considered future possibilities before participating in the study. However, as this first study contained some limitations, we investigated the possibilities that the lack of effect could be due to those limitations. To do so, we conducted a second study in a lab setting using an adapted version of the PEBT (Lange, Steinke, & Dewitte, 2018) to measure participants' willingness to adapt behavior.

However, as the results of the second study were not as successful as expected, we might conclude that an action based on psychological distance might not be efficient enough to stimulate a behavioral change in energy consumptions in consumers. As described in the introduction of the previous section, multiple actions were already tested in previous literature. However, the mitigated effects of those different actions might suggest that we need a better comprehension of consumers' barriers and motivations in order to develop an effective action that could built on those specific barriers and motivations.

The goal of the current study is two-fold: (1) identify consumers' profiles based on a typology defined in the literature and (2) link the specific profiles to a pattern of barriers and motivations inhibiting/motivating them to consume and produce energy in a sustainable way, based on the barriers and motivations we were able to derive from the S.H.I.F.T framework (White, Habib, & Hardisty, 2019). We believe that by identifying specific patterns of barriers and motivations, we could use those insights in order to develop a more effective engagement action.

4.1 Methods

4.1.1 Participants

In collaboration with the students of the Behavioural Change course (Prof. Germeys, KU Leuven), 30 Dutch-speaking Belgian participants, with age ranging from 23 to 74 years old (M = 45.33, sd = 16.91)

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

and 18 men and 12 women were recruited to participate in a mix of quantitative and qualitative studies.

4.1.2 Procedure and measured variables

In the first (quantitative) part, we built on the consumer typology of Balderjahn, Peyer, Seegebarth, Wiedmann, and Weber (2018) to define participants' specific consumer profile. The typology of Balderjahn et al. (2018) was selected because in comparison with other typologies, it uses a broader set of information aspects in order to identify the different consumers profiles, namely values, demographics and economic (purchase) behavior. Participants were asked to fill-in an online questionnaire containing the Portrait Values Questionnaire (PVQ; Schwartz et al., 2001), the short version of the CSC scale with 12 beliefs items (Ziesemer, Peyer, Klemm, & Balderjahn, 2016), and demographical questions. Based on the profiles' description in Balderjahn et al. (2018), the responses of the participants in the online questionnaire were transformed into one of the six profiles. In the second (qualitative) part, the same 30 participants were invited for a semi-structured interview in which their general opinions on energy consumption, how they consume energy at home, their opinions about reducing daily energy consumption, investing in green house renovations (e. g. insulation) , investing in renewable energy sources (e. g. solar panels), and their opinions on existing interventions were discussed. The barriers and motivations identified during the coding analysis (in NVivo) were linked to the specific barriers and motivations we derived from the S.H.I.F.T framework (Table 1; White, Habib, & Hardisty, 2019). We aimed at identifying specific patterns of barriers and motivations (behavioral pattern) for each profile, however as stated in the "Preliminary Results", we were not able to link specific behavioral patterns to specific consumers' profiles.

4.1.3 Analysis

The interviews were analyzed with the software NVivo. Certain categories of barriers and motivations were defined before starting the analysis (e.g., financial, environmental) while others were defined while analyzing the interviews. For each participant, a pattern of barriers and motivations was created, following the similar barriers and motivations across participants were grouped and linked to one of the S.H.I.F.T derived barriers and motivations. In order to keep the details of consumers' behavioral pattern, the lead barriers/motivations were divided into sub-categories. After the analysis of the interviews, participants' profiles were computed and linked to the different barriers and motivations.

4.2 Major Results

4.2.1 Consumer profiles

The six profiles defined by Balderjahn et al. (2018) were identified in the sample: financially careless consumers (N = 10), financially careful simplifiers (N = 8), non-simplifiers (N = 8), socially conscious financial simplifiers (N = 1), sustainable non-collaborative consumers (N = 1), and sustainable consumers (N = 2). An important remark is that no clear pattern could be found between the different barriers/motivations and the specific consumer profiles. Similar barriers/motivations were mentioned by different profiles. For that reason, we focus on the barriers and motivation, irrespective of the pre-determined profiles.

4.2.2 Barriers and motivations patterns

Three behaviors were discussed during the interviews: (1) daily energy consumption behavior, (2) investment in green renovations (e.g. new appliances, insulation), and (3) investment in renewable energy sources. Those three behaviors can be seen as two broader categories of behaviors: (1) daily behavioral adaptations and (2) one-time large investments. The S.H.I.F.T barriers and motivations are

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

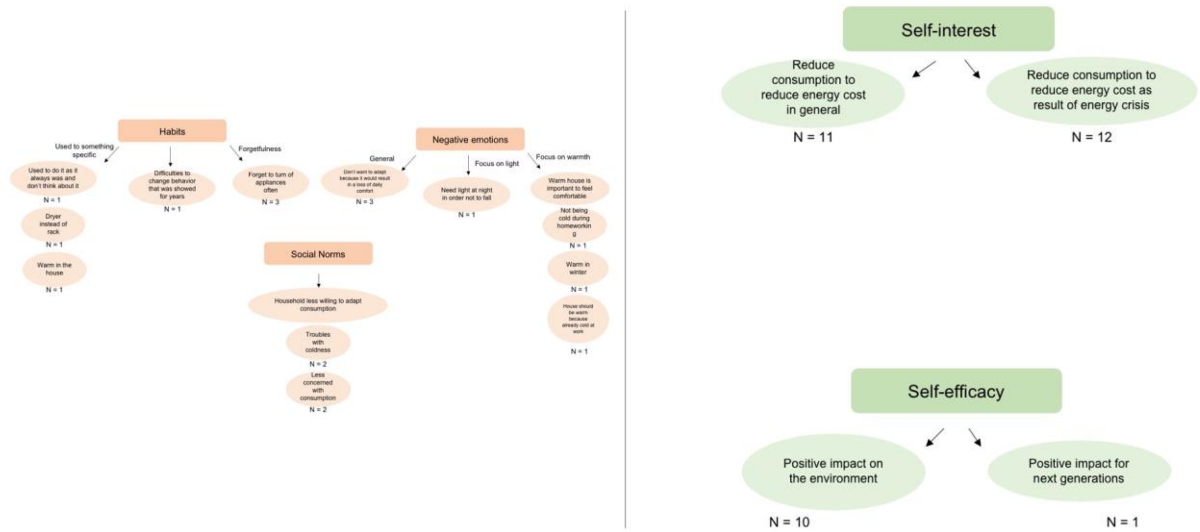
highlighted in bold.

4.2.2.1 Daily behavioral adaptations (Figure 15)

Different barriers were mentioned by the participants. The first barrier mentioned was cognition (N =7) such that it was difficult to adapt because participants felt they were not aware of what they could do more than what they already do, and they also reported a lack of information and feedback on how their energy consumption could be reduced or which appliances are requiring most energy. **Habits** was another important barrier to energy consumption adaptations, as participants mentioned to often forgetting turning off appliances, or found it difficult to change behavior that was applied for years, another found it difficult because using the dryer was more habitual than using a drying rack and a last one was habitude to a high temperature in the house. Related to temperature, some participants mentioned an unwillingness to adapt because it would lead to a colder house (one mentioned coldness during home-working, another coldness during winter, and another coldness in the house while it was already cold at the workplace). Those temperature issues can be defined as **negative emotions** experienced during energy consumption adaptations, together with other participants who mentioned that adapting energy consumption would result in a loss of comfort. **Social norms** was also an often mentioned barrier as participants explained that the rest of the household was less willing to adapt due to their troubles with coldness and an inattention for energy consumption. Lastly, there was also a lack of believe that adapting consumption would have an impact (**self-efficacy**). Some reported low self-efficacy because they believed their house was already energy neutral and/or were not often at home, while another reported that individual consumption is only a small percentage of the whole consumption. Different motivations for adapting daily energy consumption were mentioned. The most often mentioned motivation was **self-interest** as reducing energy consumption was a way of saving on energy costs. Self-interest wad divided into two groups, one group were participants who saved on energy costs in general, while the other group started savings on energy due to the energy crisis. The second most often mentioned motivation was **self-efficacy** as participants believed that it would have a positive impact on the environment, or believed it would be beneficial for future generations. **Personal norms** are the last-mentioned motivation, with participants mentioning that they are adapting energy consumption because it is how they were raised, or because they do not want to waste energy, and one participant because it was important to do something for the environment.

Figure 15

Main barriers (left) and main motivations (right) mentioned during the interviews when discussing the daily behavioral adaptations



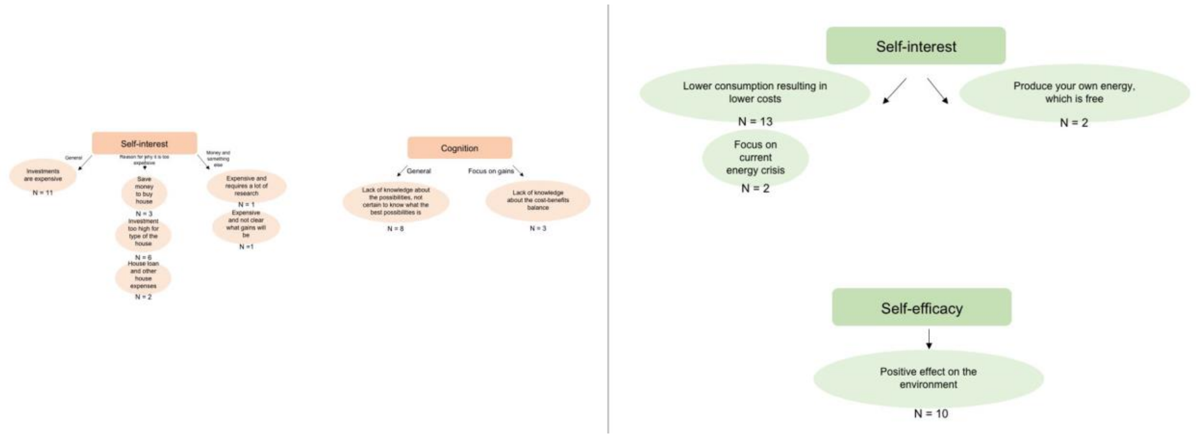
This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

4.2.2.2 One-time large investments (Figure 16)

Seven barriers were mentioned when discussing one-time large investments. The most mentioned barrier is **self-interest** as such investments are too expensive, and some even preferred to keep their money for something else such as saving to buy a house, giving priority to the current house loan and other house-related expenses, and the investment is too large compared to the type of house (old house, bad roof..). Some participants found the investments too expensive and requiring too much research work and lack of information about the balance costs-gains. **Cognition** was also often mentioned, mentioning a lack of knowledge about the different possibilities and which of the possibilities is the best, and a lack of knowledge about the costs-benefits balance. **Self-efficacy** was also often mentioned by participants. Some mentioned that the investments (e.g., new appliances or heat pumps) were not necessarily greener than current technologies, other found that technology behind green and renewables investments was not efficient yet, two participants mentioned their older age as a barrier as it was too late for them to make a difference, and one participant found it better to focus on reducing consumption than investing in renewables to make a difference. The lack of long-term perspective on how we would make the green alternatives feasible (e.g. electricity network, charging stations for EV's…) were a barrier for them to invest (**tangibility**). **Social norms** was mentioned by one participant who received negative reviews on renewables from her social circle. Finally, three other barriers were identified but could not be linked to the barriers derived from the S.H.I.F.T framework. Renting, the built/orientation of the house that is not ideal for renewables, and the fact that renewables' production is not easily matched with daily life needs. Similarly to the daily behavioral adaptations, **self-interest** was often mentioned as a motivation as participants agreed that investing would result in a lower consumption and thus in reduced energy costs in general while two other framed it in terms of the current energy crisis, and two other participants mentioned that producing your own energy would result in free energy. Investing in green renovations and/or renewables would have a positive effect on the environment (**self-efficacy**) was also mentioned as a motivation by our participants. **Tangibility** was also mentioned as producing its own energy would result in an independence from companies, suppliers, and other countries and renewables are future ways of producing energy. Finally, **personal norms** were mentioned as participants wanted to do something for the environment or wanted to do something to be in line with their personal view/life (working in an environment-related field).

Figure 16

Main barriers (left) and main motivations (right) mentioned during the interviews when discussing the one-time large investments



4.3 Major Conclusions

The six profiles proposed by Balderjahn et al. (2018) were identified in the sample, however with a

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

small representation of the socially conscious financial simplifiers, sustainable non-collaborative consumers, and sustainable consumers. We managed to identify the six profiles in our sample but failed to link the different profiles to specific patterns of barriers and motivations. Therefore, we plan to investigate whether other factors (such as demographical information) could be more suitable to define specific profiles related to the different patterns of barriers and motivations identified in the current study.

The three behaviors, namely daily energy consumption, green investments, and investments in renewables were divided into two broader categories: (1) daily behavioral adaptations, and (2) one-time large investments. Across participants, we found that the most important barriers for behavioral adaptations in daily life were habits, negative emotions, and social norms. This suggests that in general consumers find it difficult to adapt their daily energy consumption because they have difficulties breaking their habits, expect a loss of comfort (e.g. warmth) if they adapt, and report a low willingness from their household to adapt. The most important motivations were self-interest, as participants expect to reduce their energy costs, and self-efficacy as most expected to positively impact the environment by adapting their daily energy consumption. Concerning the one-time large investments, the most important barriers were self-interest and cognition. Self-interest showed that a major barrier for consumers was the expensive price of the investments, with some participants mentioning concrete reasons why they were not willing to spend the money on investments. Cognition highlighted the fact that consumers miss knowledge on the possible investments, their advantages and the balance between the costs and benefits from such investments. The most mentioned motivations were like the motivations mentioned for the daily behavioral adaptations.

The preliminary results do not allow us conclude that different consumer profiles present different patterns of barriers and motivations. However, the preliminary results suggest that different patterns of barriers and motivations are present for distinct categories of energy sustainable behaviors. This can suggest that different interventions are necessary when a different kind of behavior is targeted. At this point, we are unable to formulate definitive conclusions on the link between specific consumers profiles and specific patterns of barriers and motivations. Further research is necessary to investigate if a link is possible using other profiles.

5 MAIN CONCLUSIONS

The success of the ISLANDER project relies on both the implemented technology and the willingness of consumers to engage with the technology and to adapt their daily energy consumption behaviour. In the current report, we presented different insights that could help increase consumers' engagement with the project and its technologies.

In a first section, we reported on the specific features that could be implemented in the demand response app such that consumers would increase their engagement with the demand response app. In a second section, we reported on two studies we developed in order to test whether an action based on the concept of psychological distance could increase consumers' willingness to adapt their daily energy consumption behaviour. However, as the results suggested that such action was not very effective, we focused in the last section on the idea of using a qualitative approach to design effective actions. With the help of a semi-structured interview, we investigated the different motivations and barriers reported by consumers when asked to adapt and invest in pro-environmental energy consumption. As stated hereabove, we found that the most important barriers for behavioral adaptations in daily life were habits, negative emotions, and social norms. This suggests that in general consumers find it difficult to adapt their daily energy consumption because they have difficulties breaking their habits, expect a loss of comfort (e.g. warmth) if they adapt, and report a low willingness

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

from their household to adapt. The most important motivations were self-interest, as participants expect to reduce their energy costs, and self-efficacy as most expected to positively impact the environment by adapting their daily energy consumption. Concerning the one-time large investments, the most important barriers were self-interest and cognition. Self-interest showed that a major barrier for consumers was the expensive price of the investments, with some participants mentioning concrete reasons why they were not willing to spend the money on investments. Cognition highlighted the fact that consumers miss knowledge on the possible investments, their advantages and the balance between the costs and benefits from such investments. The most mentioned motivations were like the motivations mentioned for the daily behavioral adaptations.

The next step would be to develop an intervention based on the insights collected during the interviews. By identifying the specific barriers and motivations of consumers, we could develop an intervention targeting those factors. The efficacy of such an intervention could be tested with a field or lab study in a later stage.

6 REFERENCES

Asensio, O. I., & Delmas, M. A. (2016). The dynamics of behavior change: Evidence from energy conservation. *Journal of Economic Behavior & Organization*, *126*, 196-212.

Balderjahn, I., Peyer, M., Seegebarth, B., Wiedmann, K. P., & Weber, A. (2018). The many faces of sustainability-conscious consumers: A category-independent typology. *Journal of Business Research*, *91*, 83-93.

Balunde, A., Perlaviciute, G., & Steg, L. (2019). The Relationship Between People's Environmental Considerations and Pro-environmental Behavior in Lithuania. *Frontiers in Psychology, 10*, 2319. doi: 10.3389/fpsyg.2019.02319

Burchell, K., Rettie, R., & Roberts, T. C. (2016). Householder engagement with energy consumption feedback: the role of community action and communications. *Energy Policy, 88*, 178-186.

Engle-Friedman, M., Tipaldo, J., Piskorski, N., Young, S. G., & Rong, C. (2022). Enhancing environmental resource sustainability by imagining oneself in the future. *Journal of Environmental Psychology*, *79*, 101746.

European Commission. (2019). *Energy, transport and environment statistics*. https://ec.europa.eu/eurostat/documents/3217494/10165279/KS-DK-19-001-EN-N.pdf/76651a29-b817-eed4-f9f2-92bf692e1ed9

European Environment Agency. (n.d.). *Environmental Impact of Energy*. https://www.eea.europa.eu/help/glossary/eea-glossary/environmental-impact-of-energy

Houde, S., Todd, A., Sudarshan, A., Flora, J. A., & Armel, K. C. (2013). Real-time feedback and electricity consumption: A field experiment assessing the potential for savings and persistence. *The Energy Journal*, *34*(1).

Howarth, J. (2019). *When will Fossil Fuels run out?.* https://octopus.energy/blog/when-will-fossil-fuels-run-out/

Ivanova, D., Barrett, J., Wiedenhofer, D., Macura, B., Callaghan, M., & Creutzig, F. (2020). Quantifying the potential for climate change mitigation of consumption options. *Environmental Research Letters*, *15*(9), 093001.

Jain, R. K., Gulbinas, R., Taylor, J. E., & Culligan, P. J. (2013). Can social influence drive energy savings? Detecting the impact of social influence on the energy consumption behavior of networked users exposed to normative eco-feedback. *Energy and buildings*, *66*, 119-127.

Jessoe, K., & Rapson, D. (2014). Knowledge is (less) power: Experimental evidence from residential energy use. *American Economic Review*, *104*(4), 1417-38.

Kaiser, F. G., & Wilson, M. (2004). Goal-directed conservation behavior: The specific composition of a general performance. *Personality and individual differences*, *36*(7), 1531-1544.

Karpudewan, M., Roth, W.M., & Bin Abdullah, M.N.S. (2015). Enhancing Primary School Students' Knowledge about Global Warming and Environmental Attitude Using Climate Change Activities. *International Journal of Science Education, 37*(1), 31-54. doi: 10.1080/09500693.2014.958600

Krishnamurti, T., Davis, A. L., Wong-Parodi, G., Wang, J., & Canfield, C. (2013). Creating an in-home display: experimental evidence and guidelines for design. *Applied Energy*, *108*, 448-458.

Lange, F., Steinke, A., & Dewitte, S. (2018). The Pro-Environmental Behavior Task: A laboratory measure of

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

actual pro-environmental behavior. *Journal of Environmental Psychology*, *56*, 46-54.

Lee, P. S., Sung, Y. H., Wu, C. C., Ho, L. C., & Chiou, W. B. (2020). Using episodic future thinking to pre-experience climate change increases pro-environmental behavior. *Environment and Behavior*, *52*(1), 60-81.

Meleady, R., Abrams, D., Van de Vyver, J., Hopthrow, T., Mahmood, L., Player, A., ... & Leite, A. C. (2017). Surveillance or self-surveillance? Behavioral cues can increase the rate of drivers' pro-environmental behavior at a long wait stop. *Environment and behavior*, *49*(10), 1156-1172.

Meyer, A. (2015). Does education increase pro-environmental behavior? Evidence from Europe. *Ecological economics*, *116*, 108-121.

Organisation for Economic Co-operation and Development. (2017). *Tackling environmental problems with the help of behavioural insights*. OECD.

Pinzone, M., Guerci, M., Lettieri, E., & Huisingh, D. (2019). Effects of 'Green' Training on Pro-Environmental Behaviors and Job Satisfaction: Evidence from the Italian Healthcare Sector. *Journal of Cleaner Production, 226*, 221-232. doi: 10.1016/j.jclepro.2019.04.048

Schultz, P. W., Estrada, M., Schmitt, J., Sokoloski, R., & Silva-Send, N. (2015). Using in-home displays to provide smart meter feedback about household electricity consumption: A randomized control trial comparing kilowatts, cost, and social norms. *Energy*, *90*, 351-358.

Valor, C., Escudero, C., Labajo, V., & Cossent, R. (2019). Effective design of in-home displays.

White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT consumer behaviors to be more sustainable: A literature review and guiding framework. *Journal of Marketing*, *83*(3), 22-49.

Wu, D. W. L., DiGiacomo, A., & Kingstone, A. (2013). A sustainable building promotes pro-environmental behavior: an observational study on food disposal. *PloS one*, *8*(1), e53856.

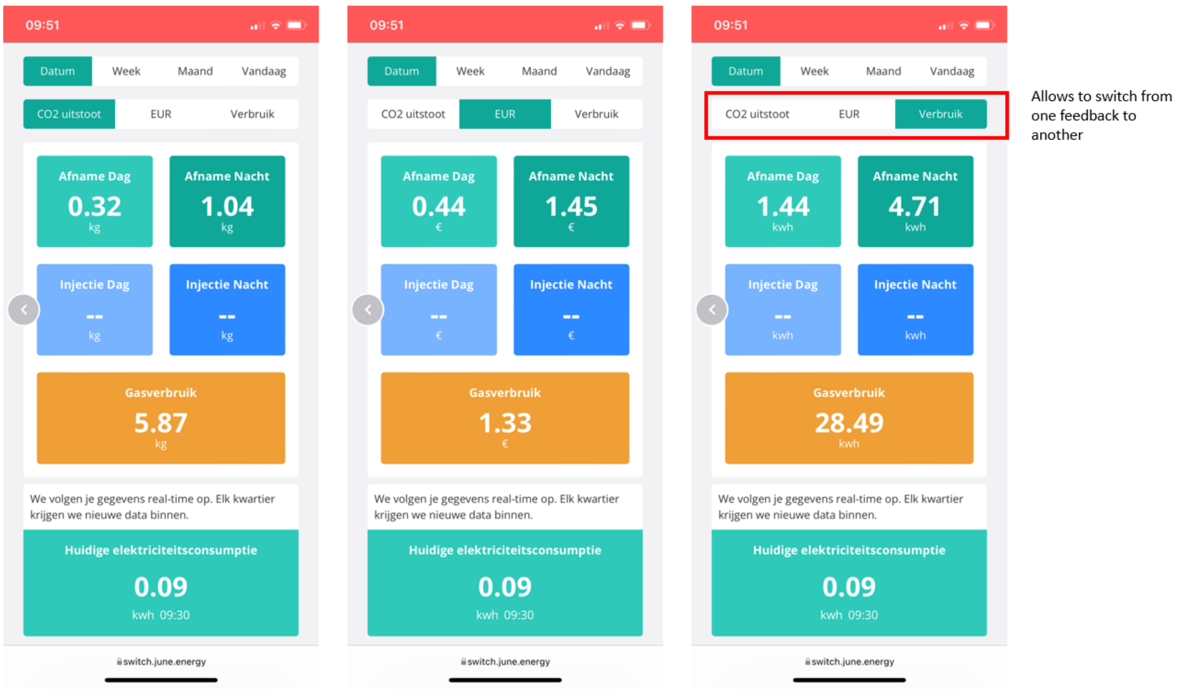
Ziesemer, F., Peyer, M., Klemm, A., & Balderjahn, I. (2016). Die Messung von nachhaltigem Konsumbewusstsein. *Ökologisches Wirtschaften-Fachzeitschrift*, (4), 24-26.

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

DEVIATIONS

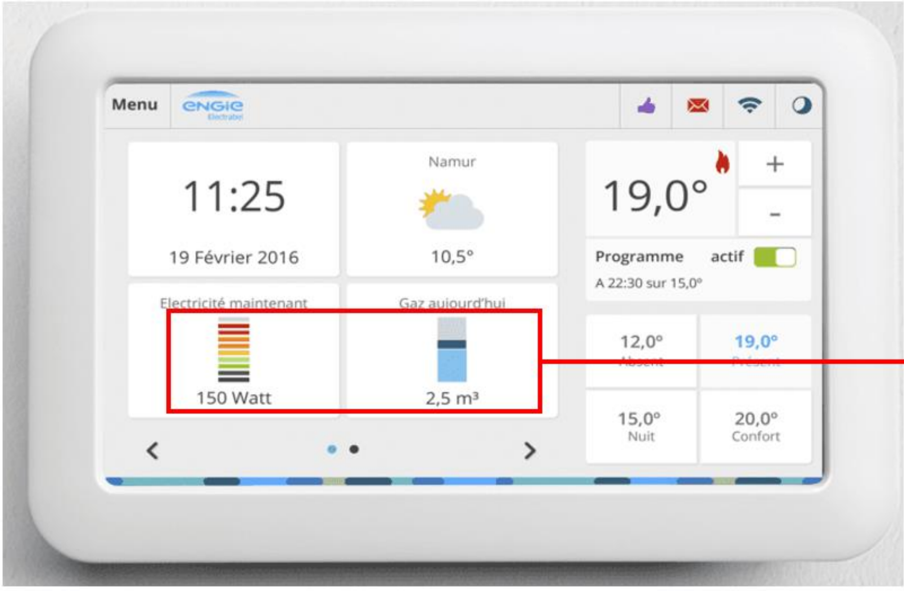
Delivery of the content was delayed for a few months, however the content is to full satisfaction and without any deviations from the actions planned and discussed during the meetings with the consortium partners.

ANNEX A: VISUAL EXAMPLE DEMAND RESPONSE APP 1 (JUNE)



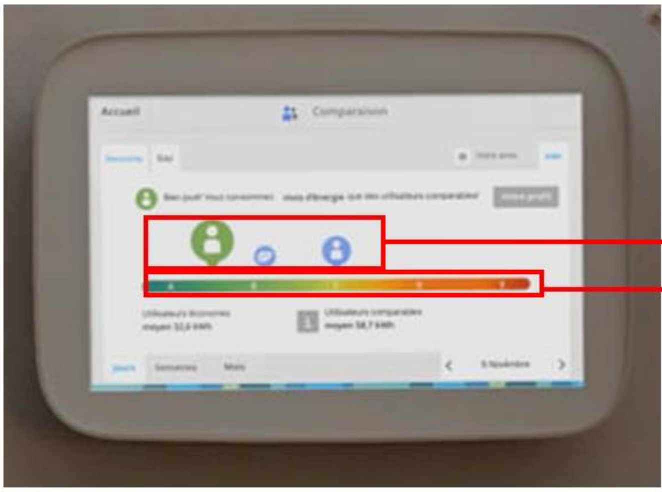
This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669

ANNEX B: VISUAL EXAMPLE DEMAND RESPONSE APP 2 (BOXX)



Uses colors to indicates when consumption is higher than normal

ANNEX C: VISUAL EXAMPLE DEMAND RESPONSE APP 3 (BOXX)



Compares consumption to other individuals

Uses color bar to indicates whether consumption of "good" or "bad"

This project has received funding from the European Union's Horizon 2020 research and innovation under grant agreement No. 957669