



Discovering Barriers of Sustainable Energy Transition For Sustainability-Oriented, Low-Income Citizens

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Abstract

The topic of sustainable energy transition became forefront in the last two decades as a part of tackling the problem of climate change. Although attention is high on the harm caused by industries, individuals and households can and should also enhance the transition. Four groups of actions of individuals were taken into account, namely choosing energy sources, making their surroundings energy efficient, adopting energy-saving habits, and limiting their indirect energy use through responsible consumption. This research aims to explore barriers of sustainable energy transition for sustainability-oriented but low-income individuals. This specific group was chosen because lower-income groups of developed countries seem to be stuck at using fossil fuels, and to highlight that although motivation and an interest in sustainability are important, it is unfortunately not enough to make changes. This topic was approached with an exploratory qualitative research including semi-structured interviews to gain detailed insights. The results show twenty separate barriers, that could all be linked to the motivation, knowledge, and context triad. This study raises awareness about the fact that sub-groups of society can have unique barriers that need to be overcome, enriches theories about implementing sustainable energy transition, and gives insights to sustainable entrepreneurs to support energy transition.

TABLE OF CONTENTS

INTRODUCTION.....	3
THEORY.....	6
Entrepreneurship and Energy Transition	6
Sustainable Energy Transition for Individuals	6
Barriers and Enablers of Sustainable Energy Transition.....	9
METHODOLOGY	13
Research design	13
Data collection.....	13
Data analysis.....	14
Ethical considerations.....	15
FINDINGS	16
Motivation	18
Knowledge.....	21
Context / Ability	23
DISCUSSION	27
LIMITATIONS	30
CONCLUSION	31
APPENDIX	33
Appendix A - Interview Guide	33
Appendix B – Coding Structure	36
BIBLIOGRAPHY	37

INTRODUCTION

Climate change has been recognized to pose an adverse threat to the Earth and its habitats with already occurring weather and climate extremes across the globe, damaging both nature and people (1). The topic of sustainable energy transition became forefront in the last two decades as a part of tackling the problem of climate change, since energy production and consumption accounted for about 76% of annual human-caused greenhouse gas emissions in 2018 (2), and was also proved to have increased in emissions the most these past years (1).

Sustainable energy transition is used as an umbrella term including aspects such as energy efficiency, affordability, reliability, lower dependency on the fossil fuel industry, and energy independence (3). Taking steps towards it can take various forms, however, some examples include chain efficiency such as producing goods with lower resource use, efficient use of clean and green gas including the energy efficiency of buildings, sustainable mobility solutions, CO₂-free electricity, and optimization of the built environment (4). Sustainable entrepreneurs are constantly emerging with new energy solutions, consultancy services and educational programs, but the pace of the transition is still relatively low (5). The increased attention on these topics is also represented by the growing number of national and international regulations and incentive systems. To deliver on the Paris Agreement's claims, the European Union introduced the *Clean Energy for All Europeans* program in 2019 to accelerate the process. This includes the following targets for 2030:

- At least 40% cut in greenhouse gas emissions
- At least 32% renewables in energy consumption
- At least 32.5% energy efficiency (6).

At the same time, the European Green Deal appointed the goal of zero net emission of greenhouse gases to the year 2050 amongst other goals, in order to turn the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where

economic growth is decoupled from resource use (7). The context of this research is the Netherlands, which was one of the first countries to aim to eliminate natural gas from its energy-mix, and is transitioning according to the *Energy Agreement for Sustainable Growth* policy signed in 2017 (8).

Although industries are certainly a key group of actors, consumers can also have the power to stimulate transformation as they shape the demand side of markets. The European Green Deal also acknowledged that the driving force of the transition is and has to be the citizens (7). Therefore this study focuses on individual or household energy consumption, which accounted for almost 20% of gross inland energy consumption or in other words, the overall supply of energy for all activities on the territory of the EU in 2020 (9).

Finances have been a key issue in energy transformation from the beginning, as capital flowing into the fossil fuel industry is still greater than those aiming for climate adaptation and mitigation (1). Although the costs of solar energy, wind energy and batteries have seen a sustained decrease in the past decade (1), the extent to which lower-income consumers are able to engage in energy transition even if they are motivated to do so remains uncertain. Researchers found that low-income countries tend to use traditional bioenergy by burning natural materials for household needs, while higher-income citizens of developed countries usually adopt a higher percentage of modern renewable sources, but those in the middle tend to be stuck at using fossil fuels (10). This led this study to the assumption that low-income groups of high-income countries might be an interesting group to examine.

Furthermore, acknowledging that education and motivation towards mitigating climate change is a broad and difficult topic by itself, this study focuses on people who are already sustainability-oriented. This segment has the ability to show that often this orientation that nowadays more and more people feel is key, but not enough for transition to happen. Although incentives and the longing for a greener future might bring the motivation for energy transition,

these measures often remain unimplemented due to amongst others, the complexity of the process, the size of the necessary investment or the lack of specific expertise (11–16). This study intends to provide insight into this matter by answering the following research question:

How do low-income, sustainability-oriented individuals perceive

the barriers of sustainable energy transition?

Accordingly, the main aims of this research are to explore and raise awareness about the barriers of sustainable energy transition and encourage sustainable entrepreneurs to think about these barriers and how to overcome them to accelerate the transition. Additionally, by looking at the low-income, sustainability-oriented group this study gives a potential explanation for the value-behaviour gap in sustainable transformations and highlights that different groups may face different barriers and therefore require different solutions.

In the next section, the important theories are introduced, including how sustainable energy transition can look like for individuals and what barriers were already discovered by researchers. Then the methodology of this study is described for transparency and replicability reasons, before introducing, discussing, and drawing conclusions from the twenty barriers found in this research.

THEORY

Entrepreneurship and Energy Transition

This study aims to offer insights to sustainable entrepreneurs in the field of energy transition, as entrepreneurs are key actors in such innovative fields. While traditional businesses mainly focus on profit (17), sustainable entrepreneurs are balancing between the triple bottom line of planet, people and profit (18,19). Green energy solutions often serve as business cases for sustainability, where economic success is increasing as the company performs in sustainability related issues (20–22), as with sustainable solutions purchased by individuals, both economic and environmental business performance increases. Besides offering innovative products and services, entrepreneurs can also engage in institutional entrepreneurship and shape the context they operate in (23). Overall due to this immense power of sustainable entrepreneurs, supporting them with insights about their target customers has the possibility to increase the pace of sustainable development.

Sustainable Energy Transition for Individuals

The essence of energy transition can be summarized as developing and increasing the production and adoption of less harmful energy sources, while reducing the production and use of fossil-based energy sources (24). Although there is plenty of attention on the decarbonization of companies and industries, individuals can also take their part in sustainable energy transition. Based on various literature (12,25–28), individuals' or households' contributions can be categorized into four main groups, namely the *sources of used energy*, the *energy efficiency of surroundings and devices*, the individual's *habits regarding energy use*, and *indirect energy use*.

The sources of energy

Unfortunately in 2019, burning fossil fuels is still the way 85% of the world's energy needs are met (29). Besides being non-renewable, the main problem with using fossil fuels is the disproportionately high amount of greenhouse gas emitted, and the potential consequences of air pollution for both the health of people and the environment (30). Alternatives include biomass which emits less than half of fossil fuels per the same amount of energy, but still significantly more than standard renewables (30), hydrogen which is still a developing field and the emissions depend on how the hydrogen is created (31), and nuclear energy, which competes with renewables in emissions, but is surrounded by political and security related controversies (30,32). The standard forms of renewable energy sources include hydropower, wind, solar, and geothermal energy, which all come with very little emissions and potential negative consequences compared to the other solutions, but require infrastructure improvements such as new energy storage solutions amongst other investments (30).

Moving towards renewable energy sources is therefore a goal and a challenge in sustainable energy transition (25). Fortunately, most of these less harmful sources have already been translated into household solutions. In many countries it is possible to choose your energy provider, therefore some can choose providers who use more renewable sources. There are also various solutions that are more local. Household energy can be generated through solar panels, smaller wind turbines, and smaller hydroelectric systems set up on and around the house, while specifically for heating purposes, besides solar heating panels, biomass heating systems, and air source heat pumps which derive heat from the air outside can be utilised. (33)

The energy efficiency of surroundings and devices

The energy efficiency of one's surroundings and devices is key for smarter resource management. This category includes two main ideas for households, the energy efficiency of the building, and the devices they surround themselves with. The energy efficiency of a building

can be improved by for example gas leak detection, insulation and air sealing, thoroughly planning the heating system, and creating opportunities to use more daylight (34). When it comes to devices, one important decision is how many devices are even necessary for the household, for instance, one can easily choose to live without a drying machine and hang-dry their clothes. After identifying the necessary devices, they can be chosen with the energy consumption taken into consideration, like buying a smaller refrigerator with smaller energy consumption or choosing based on energy efficiency rankings of products. These rankings are often published by the manufacturer of the device, or by third parties. (27)

Habits

Besides the amount and kind of devices a person owns, their energy efficiency also depends on how they are using them. Although adopting new energy-saving habits often brings only smaller changes in an individual's overall consumption, they are a relatively easy and zero- to low-cost methods. There are many small changes someone can do. For example, turning off the lights and devices when they are not in use and pulling out unused devices to eliminate standby energy waste. Appliances should be used to their full capacity, for example, washing machines and dishwashers need to be full in order to use the least energy per item. Newer appliances also have eco modes which are aimed to use less water and energy (35). From an electricity point of view, doing some tasks manually instead of using appliances is also a sustainable option, however there is the chance of a negative spillover effect (25) for example washing dishes by hand often uses more water than dishwashers do. On average 63% of household energy use comes from heating (9), therefore reducing the use of heating and air conditioning and instead dressing based on the weather is important. An individual's energy use does not only happen at home, another major contributor tends to be personal mobility, therefore a more sustainable life can be facilitated by choosing to walk or bike more often, using public transport instead of a car and choosing trains instead of flights for longer travels (12,25,36). The last part of the habit

category is whether someone tracks their energy use in any way, as knowing your consumption can enable the reduction process (37).

Indirect energy use

The last category of household energy use is a very significant one taking up more than half of a household's energy needs in developed countries (28,38). So far the direct ways of using energy were discussed which originate directly from one's actions such as heating or lighting a home, however, energy use also comes indirectly, from the energy that is used for the production, transportation, and disposal of goods and services purchased by households (25,39–41). Individuals can limit their indirect energy use by being conscious about the products and services they obtain and taking the full lifecycle of a product into consideration. This is unfortunately quite challenging due to the lack of data, as these lifecycle assessments often haven't been conducted yet, or contain vague estimates, or are not publicly available.

Barriers and Enablers of Sustainable Energy Transition

Researchers identified various drivers and barriers of the energy transition process (11–15).

Steg et al. discussed three main factors that can enable or hold back an individual's progress for sustainable energy transition, knowledge, motivation, and context (25). Due to the universality of this theory, barriers previously identified by researchers are discussed in line with these three groups.

Knowledge and Motivation

Knowledge and motivation are two closely interlinked aspects. Before a person takes conscious steps towards sustainable energy, they have to be aware of the problem. This can be the realization that the current energy system is a big contributor to climate change, but energy-saving habits can also start with the aim to reduce household expenses. Second, after being aware of the problem the person needs to care about it enough or in other words find the motivation to look for solutions. And third, the person needs to know about potential solutions

they could take (25). Researchers in the past pointed out that people tend to have a lack of knowledge and serious misconceptions about the topic of energy. Some examples are individual activities being insignificant compared to industries and therefore they don't matter (42) and energy use being proportional to the size of the appliance (43). Additionally, many people are unaware of or have misconceptions about the energy system, the energy sources and their other options (44–46).

Regarding knowledge and motivation, the IPCC noted the lack of citizen engagement, low climate literacy, and low sense of urgency as barriers for of the energy transition (1).

When it comes to motivation and deciding whether or not to act on an issue, people compare their costs and benefits (25). The costs and benefits that apply to a situation are highly dependent on personal values, as it is often their perception of costs and benefits that they can compare rather than factual information. Those with more prevailing egoistic and/or hedonic values are less likely to positively evaluate sustainable transformation due to their focus on personal gains and pleasure, while those with stronger altruistic and biospheric values are more likely to engage in sustainable changes because they hold the well-being of society and the environment to a higher value (47–49).

Biresselioglu et al. identified several potential barriers linked to knowledge and motivation (16). Although this might be starting to change due to last year's changes in energy prices (50,51), according to Biresselioglu et al. (16) decision-makers perceive energy to hold relatively low-value, due to their energy expenses being a low percentage of their overall expenditures. Households and small businesses also often take their current energy system for granted, partially because the high level of abstraction of the topic makes it difficult to imagine changing the status quo. This can be an important barrier to bigger changes like adopting a new source of energy into a home. The transition process is also slowed by the fact that most people do not know or cannot fully comprehend the long-term impacts, which limits the perceived worth of

the investments. Affecting willingness, there is the lack of interest and involvement, and the often-occurring resistance to change when it comes to transformative ideas, due to for example fear and anxiety. There are also social barriers such as norms, for instance, the idea that such investments are mainly a matter for the upper class of society. High levels of uncertainty and perceived risks restrain the diffusion of such innovative solutions. Technological and innovation uncertainty arises from the lack of expertise in the field, causing a fear of the new solutions quickly becoming outdated due to rapid development. In the regulatory context, the often-changing political environment and the interplay of international and national legislative forces make it challenging to always stay up-to-date and lead to uncertainty about the amount and kind of support decarbonization projects will get in the long run. (16)

Context and Ability

Even if people are motivated to act and have some knowledge about solutions, they can still remain unimplemented. This phenomenon is called the value-behaviour gap and can be explained by contextual factors restraining opportunities, making the person unable to take steps towards transformation (25). The IPCC highlighted limited resources and especially insufficient mobilization of finance as the main issue that hinders adaptation (1), while Biresselioglu et al. named these contextual barriers administrative and operational barriers and identified two main factors (16). First, they also elaborated on how technological improvements are very resource intensive, therefore scarcity in for example finances but also in available qualified personnel and expertise can obstruct the implementation of solutions. And second, implementing highly technological solutions, and understanding and leveraging the government's support systems including possibilities for grants and loans that could ease resource scarcity, can be complex and require great effort. Additionally the amount and kind of external support people can get including both financial and operational help from banks, governments, consultancies, energy providers, etc., immensely affect one's opportunities (16).

Researchers have found low-carbon and efficient technologies not being equally accessible to everyone, as an explanation to why these technologies are mainly adopted by higher-income groups (52–58). The high investments required by energy transition can also lead to an overall higher cost of energy in the short- to medium-term, due to the necessary infrastructure improvements, which would disproportionately harm those with low income (52).

METHODOLOGY

Research design

To answer the research question, an exploratory qualitative research was conducted. An inductive approach was applied, with the goal to explore how sustainability-oriented, low-income individuals perceive the barriers of sustainable energy transition, in other words, to build a theory for what might cause a value-behaviour gap for this specific sub-groups of society. Various aspects of the topic were taken into account to reinforce reliability through methodological consistency (59). There are already existing theories about the barriers of sustainable energy transition, however, most articles view the problem from a policymaking or industry-related perspective (11–16), whereas this research focuses on a specific actor group, sustainability-oriented but low-income individuals and the value-behaviour gap. Therefore the topic of this research is closer to nascent theory on the maturity scale, meaning the use of qualitative data is more suitable (60). Qualitative research is aimed at identifying underlying concepts and the relationships between them (61), produces a wealth of detailed data on a small number of individuals (62), and is generally regarded as an approach where theory and categorization emerge after the collection and analysis of the data, therefore is the typical design for inductive research (63). A qualitative study often focuses on real-life events, processes and experiences (63), in this case, discovering and understanding more about the barriers of sustainable energy transition. It is also the preferred method when answering research questions starting with “how” or “why”, in other words when explanations are being sought (64,65).

Data collection

The data collection of this research is qualitative by nature, in the form of semi-structured interviews, emphasizing the interpretivist view of qualitative research, where the gaining of the understanding about the world happens through discovering the interpretation of that world by its participants (63). The participants were chosen from university students from the field of

sustainability, as they are considered to represent both being sustainability-oriented and being low-income. These two sampling factors were confirmed for each individual at the beginning of the interviews. The study took place in the northern region of the Netherlands, and students were involved in courses at the University of Groningen, but apart from that the participants were chosen to be diverse in gender, age, background, and nationality to increase representativeness.

An overall of six participants were interviewed, at the beginning of May 2023. Each interview took place in person in the offices of the University of Groningen to ensure a calm, comfortable and familiar setting for the participants and lasted between 25 and 50 minutes. The interviews started with introductory questions about the participants' living situations, and general thoughts and attitudes towards the energy system, to get the discussion started. Afterwards, the main section of the interview covered all of the four types of activities discussed earlier, the sources of used energy, the energy efficiency of surroundings and devices, the individual's habits regarding energy use, and their indirect energy use. The main focus of this section was to figure out the reasons behind their current energy use and what holds them back from engaging more in sustainable energy transition. The closing section of the interviews were more generally about what they perceive to be their barriers, whether this discussion changed anything about their attitude towards energy, and offered a possibility to clear up any previous answers or share information that was not specifically asked but seems to relate to the topic. The interview guide can be found in appendix A.

Data analysis

The interviews were recorded with informed consent to transcribe and code in the later stage of data analysis. The transcription took place with the help of Otter.ai and then coded with the use of Atlas.ti software.

The coding structure was developed inductively through thematic analysis to find themes emerging from the data (66). After careful revision of the transcripts, the three main themes mentioned in the theory section, motivation, knowledge, and context were deemed fitting to be the first-order themes, because even though these categories are not necessarily mutually exclusive (for example how knowledge affects motivation), this framework provided defined categories, in which all found barriers seemed to fit. The second-order themes provide a narrower categorization, and the third-order codes were the narrowest categories, to which the answers of the participants could be compiled. The coding tree can be found in appendix B.

Ethical considerations

Throughout this study, careful considerations were taken about the ethicality of the study, and as a result, the study abides all ethical suggestions and regulations of the University of Groningen.

FINDINGS

In the following section, the results of the study are described, presented with example quotes from the interviews and discussed, intending to answer the following research question:

How do low-income, sustainability-oriented individuals perceive the barriers of sustainable energy transition?

Throughout the interviews, all participants confirmed that they are very interested in sustainability, care about the environment, and this motivates them to engage in topics such as energy transition. All of them described their motivations similarly to the following:

“I'm aware of what's going on environmentally speaking. And, yeah, when I think about the future, I know that if we continue not changing our consumption and behaviour... we're not going anywhere.”(P4)

Additionally, participants showed a sense of wanting to make a change:

“...and also, I just have the feeling if we don't do it.... this transition is not going to happen.”(P5)

At the same time, the conversations shed light on various barriers that stand in the way of sustainability-oriented low-income individuals. It is important to note, that the coding tree is although pretty close, but does not match the results model exactly, as after the coding some answers were inconclusive amongst participants thereby some codes were not concluded to be a barrier. A summary of the explored barriers is shown in Table 1.

Barriers of Sustainable Energy Transition for sustainability-oriented, low-income individuals			
1 st -order T.	2 nd -order Themes	Barriers	Examples and explanations mentioned in interviews
M O T I V A T I O N	Self-centeredness	Comfort preference	- Using a car in everyday life - Flying instead of train use - Using/ not using eco on appliances
		Habits	- Not changing because "it has always been like that"
		Background	- Parental example about energy saving - Education
	Ambiguity, Abstractness	Taking energy for granted	- Not realizing how essential energy is, and how much it is used
		No feeling of control	- Being demotivated by feeling powerless and depending on others
		Feeling of insignificant contribution	- Being demotivated by others' irresponsibility - Waiting for bigger actors to change
		Difficulty of topic	- Being demotivated by finding the topic too complex and scientific - No motivation to research the topic due to its size
K N O W L E D G E	About current situation	Lack of knowledge about home & devices	- Not knowing the sources of energy and the energy efficiency/ energy use of home and devices, - Building on assumptions
		Value attachment problems	- Not tracking energy use - Utility cost being a fixed amount, or fully included in rent - Not paying based on how much is used
	Lack of informed decision-making	Difficulties in getting information	- Companies not displaying energy-related data - Some info being too technical, and difficult to understand
		Lack of trust in information	- Being conscious about potential greenwashing, not believing companies' claims - Being critical about certifications and metrics
		Shopping habits, bounded rationality	- People being stressed and in a hurry during shopping, not spending a lot of time with choices
	About options	Confusion about what is more sustainable	- Lack of information about the best practices in both habits and products, e.g.: boiling water on the stove or a with kettle - Acknowledging spillover effects e.g.: dishwasher uses energy but uses less water than washing dishes by hand
	C O N T E X T / A B I L I T Y	Living situation	No control over living space
Short-term focus, no attachment			- Not wanting to improve home or invest in it due to renting for a short time
Property traits			- Location influences transportation habits - Location influences the housing market, e.g.: Netherlands' housing crisis limiting renters' choices - Built-in aspects cannot easily be changed
Finances		Low-income	- Being reluctant about any solution that requires payment
		Investment, premium price of sus. products	- Sustainable products being uninviting due to higher prices - Energy-related improvements generally needing bigger investment
		Buying second-hand	- Second-hand buying eases expenses but can limit the choices, and lead to the purchasing of older, less efficient appliances
Lack of options		No available greener products	- Feeling like all options are unsustainable from a product kind e.g.: all phones are transported from far away

Table 1: Findings model, Barriers of Sustainable Energy Transition for Sustainability-Oriented Low-income Individuals

Motivation

Self-centeredness

Although sustainability served as a serious motivator for all participants, motivation-related issues were still mentioned. Comfort was repeatedly mentioned as an intense demotivator in the case of for example choosing a transportation method:

"I try to cycle as much as possible. But I can be lazy sometimes. I do have my own car, so that's a big problem. I was willing to sell it already for over a year... The thing is, it's really easy to take it. So laziness, I think that's why I never sold it yet." (P2)

Comfort or amusement is also prioritized over sustainability when it comes to travelling. Multiple participants described travelling as a very important activity in their life, however, the train is only preferred for shorter distances. Sometimes the emissions of travelling by plane comes to mind but it is seen as a must to maximize satisfaction:

"...the first time I came to Leeuwarden I used the train ... and I had really one of the worst experiences in my life of being 16 hours in one room with five people... And from there on, I said to myself, okay, that's just not okay." (P5)

Whether a person has energy-saving habits in their daily lives, is also influenced by what actions are comfortable, as shown by for example the following two discussions about using energy- and water-saving eco-programs on appliances:

"-...the dishwasher for us is always on eco, like if you don't actively change the program then it automatically does an eco-program. So, we always use the eco-program because that's just the basic option.

-And if it wouldn't be the basic option?

-I would do it still but I don't know about my roommate, I don't think so." (P1)

“-Do you tend to use eco programs on your appliances?”

-Yes, I think I use it because also this is the quickest for us. So It's more of a comfort thing.”(P3)

Closely linked with comfort there is also being used to your way of life as a barrier of any kind of transition. Having habits or situations that would require conscious effort to change. For instance, one participant had the following reaction when asked why their home works fully on fossil fuels:

„Hmm good point! Maybe because it's always been like this, it's really like I came into that house and I didn't actually make efforts to change the situation.”(P1)

On the contrary, building the right habits could also be a motivator, and highlights the important role of background, parental examples and education:

“For sure education from parents. So how they raised me. I remember my dad every time when I left my light on, remark what is happening? Turn off your lights! Who's paying the energy? I mean, he's right so yeah.... I think for them, it's not even about price or sustainability, saving is just common knowledge.”(P5)

Ambiguity/Abstractness of the problem

Motivation in the field of sustainable energy is compromised by the difficulty, technicality, and abstractness of the topic. Some participants mentioned how people tend to forget how essential energy is and take it for granted, failing to motivate them towards saving it:

„Energy hmm... I'm thinking... people take it for granted. Always.they don't think about leaving the lights on. I think people shouldn't take it for granted. Because it's kind of special. And we're very lucky here in the Netherlands that energy is everywhere.”(P2)

Because of the size of the issue of climate change and the many involved actors, the dependencies on for example energy providers create a feeling of having low control over personal energy use:

*“I don't have a choice, when I put my charger in the... *points at outlet*... charging my phone I don't know what kind of energy I'm using. Only fair I know it's electricity whether it's green or grey I wouldn't know.”(P2)*

“Of course, you have some control, in the end, you can choose which sorts of energy, which supplier you choose, but that's not right now. Of course currently me specifically no, I don't have control.... It's kind of the same as buying products in supermarkets. So you have the offers and you choose from the offers, it's not like you can pick and choose okay, I want wind energy, sun, water energy, and this all combined. So you kind of have these pre-bundled packs, which you can choose from.”(P5)

Furthermore, due to there being major actors and industries that are known for their emissions and harm, participants often have the feeling that their daily habits have insignificantly little effect:

“...when it comes to, utility usages, like with water, you can maybe influence it, but it's not going to make I think, a big difference.”(P3)

“I try to be as sustainable as I can. But I know that me alone, it's not enough.”(P4)

As discussed in the theory section, knowledge or awareness is necessary before motivation can occur. Although the participants of this study are highly interested in sustainability and regularly engage in broadening their knowledge, even they expressed feelings of uncertainty around the topic of energy transition:

“I know that our house is not with green energy and I always kind of wanted to change that. But energy for me is this topic that I just don't know a lot about so I don't touch it, you know.”(P1)

„-Can you summarize what holds you back from being even more sustainable?

-Probably, first lack of knowledge. I think that I should know way more to behave truly sustainably.”(P4)

The next section discusses the different kinds of barriers within the problem of knowledge.

Knowledge

About the current situation

Based on the interviews, the participants proved to be somewhat unaware of their surroundings from an energy point of view, for both the source of energy they are using, and the efficiency of their homes and appliances, their knowledge is mostly based on assumptions or feelings:

“I really wouldn't know because... I never looked at it actually.... I don't know whether they are efficient or not. I know that the TV isn't because when it's like on for an hour it's heating the room up, losing a lot of energy.”(P2)

When it comes to tracking their energy use, most of them do not track it on a monthly basis, either because they don't know how to do that, or because of a lack of interest so far. This, together with paying fixed rates for energy, or the cost of utilities being included in the rent was agreed to make it difficult for them to attach value to their used energy:

„- No, no I don't track it. But I think I don't know if there's any application that we can use easily to track our energy. But yeah, if I knew that there's some kind of an app like that, I would definitely use it.

- But so far, you have not really considered looking at it?

- No, no.

....

- *And so what you pay doesn't depend on what you use? Right?*
- *It's always that. Yes.*
- *Do you think it makes it more difficult to attach value to it?*
- *Yeah, yeah, it's definitely because if I have to pay the cost of the energy based on what I use, then I will be more aware and track my energy use.”(P6)*

Informed decision making

In order to become more consciously sustainable, it is inevitable to get reliable information about the different options, products and companies. Even though the participants are more aware than the average, they still feel that finding out about a product’s energy needs throughout its lifecycle is challenging as a consumer:

“Yeah. Pretty difficult. Because... I think it's already super hard to understand where the products are coming from. Not even thinking of which energy they used, or how much energy it took for the product to be here, I think it's, like, far away from us.”(P1)

Moreover, participants expressed problems with trusting companies’ claims:

“But mostly companies start just having their own scale, and suddenly the products are super green, but in this scale, nobody is interested. It's just measurement entities made up by their company so that their product looks good.”(P5)

Unfortunately, available information and motivation are still not always enough to purchase sustainably, due to nowadays shopping habits and often being in a hurry, as explained by the next quote:

“I think often you just especially when you're stressed and at the supermarket, you're not going to start thinking about oh my god, how much energy does this

product A compared to product B use, you're just going to take the cheaper one or which one is more attractive to you.”(P5)

About options

Due to the participants’ orientation towards sustainability, they already showed some knowledge about the different energy sources and solutions:

“I’m definitely aware of some solutions and renewable sources but to me, it just feels difficult...”(P2)

On the contrary, the participants mentioned multiple situations, where it is very difficult to decide which option is the more sustainable, or more energy-conscious decision:

“I’m always struggling with the water if I want to heat up one litre of water what is now more resource efficient and more sustainable, using the kettle or the gas stove? And I actually go for the kettle, but... it’s just a feeling”(P1)

“I think nowadays, there’s so much confusion about what a sustainable product really is.”(P5)

Context / Ability

The third main group of barriers explain why someone who is motivated and has the necessary knowledge would still refrain from being more sustainable. Their contextual factors limit their ability to act.

Living situation

The feeling of low control was already mentioned as a demotivator, however, control is also a serious contextual barrier. All participants identified renting their homes as a control-reducing factor, as decisions about energy sources, efficiency improvements, and often also appliances are made by the landlord:

“I think we’re not allowed to change anything about anything.”(P2)

“...I live in a rented place and it's not exactly my place to choose which energy provider they choose for the building. So, I don't feel like I have any control now.”(P6)

Renting also leads to a short-term focus and a lack of attachment. Participants seem to accept the conditions for a short time as opposed to putting efforts into changing them:

“...the first thing that comes to mind is always my life in my home country... because that's my house or where I long term live so I feel more committed to changing the energy there, than, to be honest, get to it here in the Netherlands, where I'm just renting.”(P1)

“I know that I'm only here for one year, I would not really invest money into it.”(P3)

Given traits of the property can also be a barrier for a more sustainable life. For example, the location influences transportation habits:

“I would say in the Netherlands or in cities where you have possibilities to take public transport or cycling lanes, I always do that. However, my hometown is on a hillside where you don't really have cycling lanes and it would also be harder than in the Netherlands and the public transportation is also not that really distributed in every section of the city so in that city I use a car because it makes commuting way more comfortable and easier.”(P3)

And the built-in parts of the home influence how much a person can limit their energy waste:

“Yeah, the windows are a huge thing like my window is...bad. Even though we went to the hardware store and we bought these insulation yarns... But windows are an investment and they lose a lot of energy. Also in our main living room, we have one big window and it's like freezing in front of the window and the heater is underneath the window, it's just inefficient.”(P1)

And the current housing market at the location influences one's priorities when looking for a home:

"I moved to the Netherlands... and I already knew that the housing situation is going to be the most challenging.... the university also stated in the website that if you don't find an option to live until early August or something maybe consider postponing your studies.... the situation here in the Netherlands is always like this that you also have to compete with others because there's lack of housing facilities..."(P3)

"- When choosing your current home, was energy efficiency something you considered?"

- No, it was actually so stressful to find a house here so once I found this rental online, I immediately just clicked on it and decided to go with the house I can get."(P6)

Finances

Because this research is looking at low-income individuals, it was likely that finances will form a group of barriers. Based on the interviews, having a low income is in itself a barrier to a more sustainable life, for example by changing the attitude towards improvements:

"I should get a job first, earn money. So, I can also like, act more consciously. So, I can be more aware of the possibilities and like, because of having the money, you can also afford more or different kinds of options"(P3)

"I don't have the smart wires anywhere because we're still students and we don't have any money so yeah, I'm not buying that kind of fancy stuff."(P6)

At the same time, participants feel like sustainable travelling and sustainable products tend to have higher prices, and sustainable home improvements require an investment that is difficult to make:

“I don't know if I would be able to... at least alone to change this because there is an investment, they will have to pay a lot to install solar panels.”(P4)

“I want to become more sustainable but... well, sustainable products are subject to like, premium pricing. So sometimes I would say, it's the biggest challenge for me to like really use sustainable things.”(P6)

Due to their income situation, some participants opted for shopping second-hand, which might be more sustainable for some products, but when it comes to appliances, it can lead to buying older, less effective models, and an overall lack of focus on their energy requirements:

“So, all of our furniture we've got second-hand from Marketplace. So, everything we bought was second-hand from our oven to our fridge, dryer to our washing machine. Everything.... We got them for cheap and we took them, we didn't look at the energy class.... of course, that's a positive but... not the main focus.”(P5)

Lack of options

The last contextual barrier that was found is that sometimes it feels like none of the available options are truly sustainable, as explained in the next quote:

*“-When buying any kind of product or service, do you consider it sustainability?
-No, I would say no, I guess, like, I know for sure that this one is not produced here *points at phone*... And I know that all the big businesses have their factory, planted in China, for example, and the other part of it is, from another country made with very low wages, then they export everything, and I know that they produce a lot of emissions and use energy. So, it's hard for me to take the sustainable option, because of the fact that they are not sustainable.
-So, you feel like there are not really any more sustainable options?
-Yes.”(P6)*

DISCUSSION

As a result of this research, an overall of twenty barriers were found that hinder the adaptation of sustainable energy transition practices. This section compares the results to the previously existing theories, to see what confirms and what diverges from them. As no previous research was found for the specific group of sustainability-oriented, low-income individuals, the results were expected to have some overlap with the general barriers of different authors, but some newly discovered insights were also awaited. It has to be noted that most of the results, especially the first- and second-order themes have already been mentioned previously in some ways as factors that affect sustainable energy transition, but the detailed barriers discovered in this study enrich the explanations of how and why those categories limit the adaptation of solutions.

The fight between altruistic and biospheric values on one side and egoistic and hedonistic values on the other side (47–49) was shown to be intensified for the group of sustainability-oriented, but low-income individual as their motivation to act is strong from caring about nature and society but being somewhat self-centered is still present within them. Thomas Hobbes proposed that human motivation mainly emerges from self-interest (67), therefore being reluctant about compromising on comfort is likely.

Energy being taken for granted has also been confirmed by the participants, although based on the discussions it might not be associated with a low perceived value of energy as Biresselioglu et al. stated (16), it was mentioned more as a reason people do not think about changing it.

Interestingly within motivation, the topics of fear, anxiety, a general resistance to change, and perceived risks (16) were not mentioned by the participants. Two possible explanations can be that either the participants' lack of focus on adopting new energy solutions caused them to not yet consider the risks, or that sustainability-oriented individuals have more trust in sustainable solutions and are less afraid of and resistant to change.

Two relatively newer additions to the topic of energy transition (although they have been noted in general sustainability studies (68)) are first, the unmotivating feeling of having no control, which can be attributed to the high number of dependencies when it comes to energy consumption (e.g.: being dependent on energy providers and having to choose from the available options), and second, feeling that the size of an individual's contribution is insignificantly small, due to bigger actors being out there still engaging in unsustainable practices, and both energy and our planet being a common pool good where great results can only be achieved if all actors are cooperating (69).

Although knowledge has been described as a precondition for motivation (25), and the complexity of the topic of energy was also discussed before (16), this research emphasizes how the ambiguity of the topic can serve as a serious demotivator. Low climate literacy was acknowledged as a problem by the IPCC (1), however, the barriers found in this study give a more detailed description of the fact that people don't only have an issue with knowing about the solutions, but they are also barely aware of their own current surroundings and their current energy use. Because the assessed group was sustainability-oriented, they had fewer problems with understanding the importance of the topic and knew about existing solutions but still expressed a need for more guidance on what are the best options. The barriers around informed decision-making are relatively new to be put into the context of energy transition, but both trust and bounded rationality have previously been associated with issues in sustainable consumption (70–74). It is worth mentioning that these two barriers were brought up by participants a lot more around indirect energy use and habits and not so much around changing energy sources or the effectiveness of surroundings.

As it was expected, finances did become a group of barriers for the low-income group, but it is highlighted how low-income and the premium prices of sustainable solutions can be viewed as two separate issues, besides the interesting aspect of shopping second-hand not always being

the most sustainable option being raised. Interestingly none of the participants mentioned available financial support systems (subsidies, loans, etc) even though they are highly educated and therefore most likely aware that they exist. This can lead to the conclusion that finances might not be the main barrier, for one-time investments as there would be available solutions for it, but it does define a lot of the daily purchases.

One of the most important barriers seemed to be associated with the living situation, as renting led to having no control, no attachment and therefore no will to change much about their energy efficiency. This is an especially important finding, because on average about 30% of the EU-s population lives in rented homes (75), and the majority of the low-income individuals rent their homes (76) and therefore become limited in their ability and motivation for energy transition.

A lack of available sustainable options was also described previously (52–58), besides it being mentioned as a consequence of low-income (e.g.: financial barrier, second-hand buying), this problem was also acknowledged regarding whether sustainable products even exist for all needs in general.

Overall, this study was relatively in line with previous theories about barriers of sustainable energy transition but gave a more detailed understanding of what stops those who are already sustainability-oriented but have a lower income, from participating in practices supporting sustainable energy transition.

LIMITATIONS

As usual, this study was also subject to certain limitations. The depth of the study was limited by the narrow timeframe for completion. This specifically affected the data collection, limiting the number of interviews taken, however within the six interviews, a multitude of answers overlapped, therefore it can be concluded that data saturation was reached. Potential biases were carefully considered and actions were taken to reduce them throughout the process, however, it is important to mention them as potential limiting factors. Selection bias can appear when choosing the interview participants (77), for this study apart from the criteria of sustainability-oriented and low-income, participants were chosen to diverge in traits such as nationality, gender, and age, but still, generalizability can be limited by the fact that all participants were chosen from the students of the University of Groningen, for feasibility reasons. Any research on the topic of sustainability has a high chance of suffering from social desirability bias (78), in this study, this could mean the participants posing themselves as more energy conscious than they are, however the participants were informed about the anonymity of the study and were asked to answer honestly and as a result various answers contained major room for improvement within the topic of sustainable energy. Important to note that English is not the first language of either the participants nor the researcher, but all of them have professional English proficiency, therefore there were only minor misunderstandings that were solved with more explanation. Lastly, to reduce acquiescence bias, participants being more inclined to agree with the interviewer (79), extra care was taken to eliminate leading questions.

CONCLUSION

This research shed light on barriers of sustainable energy transition for sustainability-oriented but low-income individuals, through an exploratory qualitative method. As a result, twenty potential barriers were discovered and grouped into the groups of motivation, knowledge, and context, following the theory of Steg et al. (25).

This research can be seen as transdisciplinary due to the facts that the research question arose from a real life problem, namely the low implementation rate of sustainable energy solutions, and that the researcher's heightened interest in sustainable energy transition was caused by previous discussions with stakeholders of the field (80). Due to the increased practicality of transdisciplinary research, the contributions are of heightened importance. The contributions of this research can be seen as threefold, practical implications for society, theoretical contributions for academia, and raising awareness for both society and academia. The main practical implication of the results is that those who wish to accelerate the process of energy transition can do so by focusing on overcoming the discovered barriers. For educators, this study provides the insight that the topic of energy transition is so complex, that even those who are already somewhat interested feel major uncertainties. For governments, energy providers and consultancies within this topic, besides the necessity of more education, the need for financial support and the important role of landlords, causing renters to feel incapable is highlighted. For companies producing sustainable products, the barriers about the lack of options, the financial difficulties, and the lack of informed decision-making are important barriers to decreasing the indirect energy use of individuals through their products. For sustainable entrepreneurs, all discovered barriers are important, as they have great capabilities in tackling them through innovative business ideas and therefore are encouraged to use the results of this study to enhance sustainable energy transition.

For academia, this research was enriching the theories about barriers of sustainable energy transition and the theory of Steg et al. (25) and specified it to the case of sustainability-oriented, low-income individuals. Linked to this study, some suggestions for future research are looking at the potential value-behaviour gap within sustainability-oriented but higher- or middle-income groups, to figure out whether it even exists, and find explanations if it does. Linked to specific barriers it would be interesting to research the most effective ways to educate people about energy transition, and because renting was found to be a significant cause, look into the viewpoint of landlords and how to incentivize them to improve when it comes to energy.

Lastly, the most important value of this research is raising awareness about sustainable energy transition in general, about some ways individuals could be more conscious, and about the fact that low-income groups can face specific barriers, and therefore a multitude of mitigating actions are necessary to support the different groups within society.

By all of the above, this study contributes to easing the problem of limited research and slow uptake of adaptation science, which the IPCC identified as one of the key barriers to sustainable energy transition (1).

APPENDIX

Appendix A - Interview Guide

Starting questions:

1. **Please describe your current living situation!** (renting/owning; room/apartment; shared/alone; newer/older; closer/further)
2. **How do you generally think of energy in our lives and the current energy system?**

Do you have any pre-existing thoughts around the topic?

- a. What comes to mind if I say energy transition?
3. **Do you consider yourself a conscious energy user?** Why/Why not?

Main part: This section is organized based on the four factors around energy use, Source of energy, Habits, Surroundings and Devices, and Indirect energy use.

Source:

4. **Are you aware of the kinds of energy sources at your home?** What are they?
 - a. Why do you have these ones?
 - b. Are you aware of different energy sources you could use?
 - c. Do you feel like you have control over the sources of energy you use?
 - d. Are you considering implementing greener sources at your home?

Devices & Surroundings:

5. **Are you aware of the energy efficiency of your home?** (Through for example a rating)
 - a. Was this important to you when choosing a home? Why/Why not?
 - b. Would you be able to improve it? Why/Why not? How?
6. **Would you say that your devices and appliances are energy efficient?**
 - a. Do you feel like you have control over the kind of devices you use?
 - b. When you are shopping for devices, do you take energy efficiency into account?

7. **Can you list some devices or appliances you use that you think probably use the most energy in your household?**

Habits:

8. **Do you in any way track your monthly or yearly energy use? Why/Why not? How?**
- Do you know how much you pay after your energy use or is it included in your rent? Approximately what percentage of your monthly expenses is that?
9. **Do you feel like you have energy-efficient habits? What are they?**
- Do you turn off lights and devices when not using them? Why/Why not?
 - Do you pull out devices or use a smart line? Why/Why not?
 - Do you focus on not overheating or overcooling your place? Why/Why not?
 - Do you tend to use eco program on appliances? Why/Why not?
10. **Tell me about your mobility or transportation habits! How often do you use a car, public transport, bike, airplane, etc and why?**
- Are you trying to travel sustainably like carsharing, using electric car, etc? Why/Why not? How?

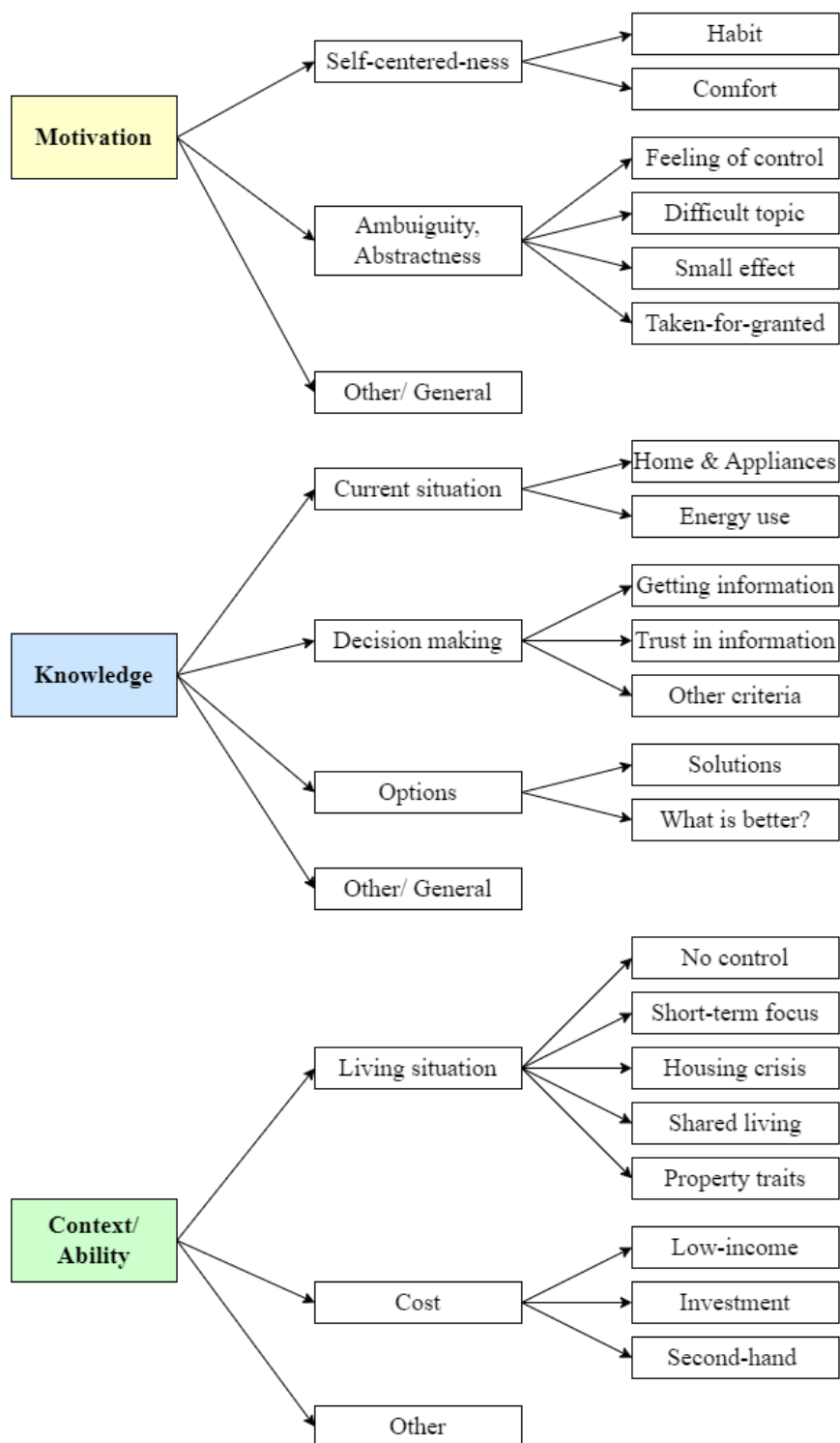
Indirect energy use:

11. **When buying any kind of product or service, do you consider its sustainability? Why/Why not? How?**
- Do you specifically consider it from an energy point of view?
 - How easy do you think it is to find out products' energy needs throughout their lifecycle?
 - If you would know every product's energy use, do you think it would affect your purchasing decisions?
 - Do you usually trust what companies claim about sustainability or energy?

Ending questions:

12. **Overall, can you tell me what motivates you to be more sustainable and more energy conscious every day?**
13. **Can you tell me what holds you back from being more sustainable and more energy conscious?**
14. **Is there anything else you would like to share about this topic or clear up anything?**
15. **Do you think this discussion affects how energy conscious you are? Will you do anything differently? Why?**

Appendix B – Coding Structure



BIBLIOGRAPHY

1. IPCC Core Writing Team. Climate Change 2023: Synthesis Report. A Report of the Intergovernmental Panel on Climate Change. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland: IPCC; 2023.
2. Ge M, Friedrich J, Vigna L. 4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors [Internet]. World Resources Institute. 2022 [cited 2023 May 14]. Available from: <https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors>
3. Vanegas Cantarero MM. Of renewable energy, energy democracy, and sustainable development: A roadmap to accelerate the energy transition in developing countries. *Energy Res Soc Sci*. 2020 Dec 1;70:101716.
4. Kern F, Smith A. Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. *Energy Policy*. 2008 Nov 1;36(11):4093–103.
5. IRENA. World Energy Transitions Outlook 2022, 1.5°C Pathway [Internet]. Abu Dhabi: International Renewable Energy Agency; 2022 Mar [cited 2023 May 26]. Report No.: 978-92-9260-429-5. Available from: <https://www.irena.org/Digital-Report/World-Energy-Transitions-Outlook-2022>
6. Directorate-General for Energy (European Commission). Clean energy for all Europeans [Internet]. LU: Publications Office of the European Union; 2019 [cited 2023 Feb 24]. Available from: <https://data.europa.eu/doi/10.2833/9937>
7. European Commission, Secretariat-General. Communication From The Commission To The European Parliament, The European Council, The Council, The European Economic And

- Social Committee And The Committee Of Regions, The European Green Deal [Internet]. Nov 12, 2019. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX%3A52019DC0640>
8. Boydston A. Netherlands Country Commercial Guide - Energy [Internet]. International Trade Administration; 2022 Sep [cited 2023 Feb 24]. Available from: <https://www.trade.gov/country-commercial-guides/netherlands-energy>
 9. Eurostat. Energy consumption in households [Internet]. Eurostat. 2022 [cited 2023 Apr 28]. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_consumption_in_households
 10. Ai XN, Du YF, Li WM, Li H, Liao H. The pattern of household energy transition. *Energy*. 2021 Nov 1;234:121277.
 11. Maswabi MG, Chun J, Chung SY. Barriers to energy transition: A case of Botswana. *Energy Policy*. 2021 Nov 1;158:112514.
 12. Dominković DF, Bačeković I, Pedersen AS, Krajačić G. The future of transportation in sustainable energy systems: Opportunities and barriers in a clean energy transition. *Renew Sustain Energy Rev*. 2018 Feb 1;82:1823–38.
 13. Todd I, McCauley D. Assessing policy barriers to the energy transition in South Africa. *Energy Policy*. 2021 Nov 1;158:112529.
 14. Sovacool BK, Griffiths S. The cultural barriers to a low-carbon future: A review of six mobility and energy transitions across 28 countries. *Renew Sustain Energy Rev*. 2020 Mar 1;119:109569.

15. Nikas A, Stavrakas V, Arsenopoulos A, Doukas H, Antosiewicz M, Witajewski-Baltvilks J, et al. Barriers to and consequences of a solar-based energy transition in Greece. *Environ Innov Soc Transit*. 2020 Jun 1;35:383–99.
16. Biresselioglu ME, Demir MH, Demirbag Kaplan M, Solak B. Individuals, collectives, and energy transition: Analysing the motivators and barriers of European decarbonisation. *Energy Res Soc Sci*. 2020 Aug 1;66:101493.
17. Schumpeter JA. *Socialism, capitalism and democracy*. 3rd ed. New York: Harper and Bros.; 1942. 381 p.
18. Thompson N, Kiefer K, York JG. Distinctions not Dichotomies: Exploring Social, Sustainable, and Environmental Entrepreneurship. In: Lumpkin GT, A. Katz J, editors. *Social and Sustainable Entrepreneurship* [Internet]. Emerald Group Publishing Limited; 2011 [cited 2023 May 26]. p. 201–29. (Advances in Entrepreneurship, Firm Emergence and Growth; vol. 13). Available from: [https://doi.org/10.1108/S1074-7540\(2011\)0000013012](https://doi.org/10.1108/S1074-7540(2011)0000013012)
19. Schaltegger S, Wagner M. Sustainable entrepreneurship and sustainability innovation: categories and interactions. *Bus Strategy Environ*. 2011 Jul 4;20(4):222–37.
20. Schaltegger S, Freund FL, Hansen EG. Business cases for sustainability: the role of business model innovation for corporate sustainability. *Int J Innov Sustain Dev*. 2012;6(2):95.
21. Salzmann O, Ionescu-somers A, Steger U. The Business Case for Corporate Sustainability:: Literature Review and Research Options. *Eur Manag J*. 2005 Feb 1;23(1):27–36.

22. Dyllick T, Hockerts K. Beyond the business case for corporate sustainability. *Bus Strategy Environ.* 2002;11(2):130–41.
23. Alvarez SA, Young SL, Woolley JL. Opportunities and institutions: A co-creation story of the king crab industry. *J Bus Ventur.* 2015 Jan;30(1):95–112.
24. York R, Bell SE. Energy transitions or additions?: Why a transition from fossil fuels requires more than the growth of renewable energy. *Energy Res Soc Sci.* 2019 May 1;51:40–3.
25. Steg L, Perlaviciute G, van der Werff E. Understanding the human dimensions of a sustainable energy transition. *Front Psychol* [Internet]. 2015 [cited 2023 Apr 26];6. Available from: <https://www.frontiersin.org/articles/10.3389/fpsyg.2015.00805>
26. Araújo K. The emerging field of energy transitions: Progress, challenges, and opportunities. *Energy Res Soc Sci.* 2014 Mar 1;1:112–21.
27. Zero Energy Project. Select Energy Efficient Appliances and Electronics for Zero Energy Homes [Internet]. Zero Energy Project. [cited 2023 Apr 27]. Available from: <https://zeroenergyproject.com/build/twelve-steps-affordable-zero-energy-home-construction-design/select-energy-efficient-appliances-electronics-zero-energy-homes/>
28. Reinders AHME, Vringer K, Blok K. The direct and indirect energy requirement of households in the European Union. *Energy Policy.* 2003 Jan 1;31(2):139–53.
29. UNEP Annual Report: Letter from the Executive Director - 2019 in review [Internet]. UNEP - United Nations Environmental Program; 2020 May [cited 2023 May 14]. Available from: <https://www.unenvironment.org/annualreport/2019/index.php>

30. Ritchie H. What are the safest and cleanest sources of energy? [Internet]. Our World in Data. 2020 [cited 2023 Apr 27]. Available from: <https://ourworldindata.org/safest-sources-of-energy>
31. Griffiths S, Sovacool BK, Kim J, Bazilian M, Uratani JM. Industrial decarbonization via hydrogen: A critical and systematic review of developments, socio-technical systems and policy options. *Energy Res Soc Sci*. 2021 Oct 1;80:102208.
32. Gill M, Livens F, Peakman A. Nuclear Fission. In: Letcher TM, editor. *Future Energy - Improved, Sustainable and Clean Options for our Planet*. 3rd edition. Elsevier Science & Technology; 2020. p. 135–49.
33. 7 ways to power your home with renewable energy | E.ON [Internet]. Eonenergy.com. 2022 [cited 2023 Apr 27]. Available from: <https://www.eonenergy.com/our-blog/ways-to-power-your-home-with-renewable-energy.html>
34. U.S. Department of Energy Office of Energy Efficiency & Renewable Energy. Efficient Home Design [Internet]. Energy.gov. [cited 2023 Apr 27]. Available from: <https://www.energy.gov/energysaver/efficient-home-design>
35. EnergySage. How to Conserve Energy: 15 Everyday Tips to Save Electricity | EnergySage [Internet]. energysage.com. 2023 [cited 2023 Apr 27]. Available from: <https://www.energysage.com/energy-efficiency/101/ways-to-save-energy/>
36. Gao Y, Kenworthy JR, Newman P, Gao W. 2.2 - Transport and Mobility Trends in Beijing and Shanghai: Implications for Urban Passenger Transport Energy Transitions Worldwide. In: Droege P, editor. *Urban Energy Transition (Second Edition)* [Internet]. Elsevier; 2018 [cited 2023 May 18]. p. 205–23. Available from: <https://www.sciencedirect.com/science/article/pii/B9780081020746000255>

37. Darby S. The effectiveness of feedback on energy consumption: A Review for DEFRA of the Literature on Metering, Billing and direct Displays. *Environ Change Inst - Univ Oxf.* 2006;486.
38. Government of Canada SC. Direct and indirect household energy use and household greenhouse gas emissions [Internet]. 2018 [cited 2023 Apr 28]. Available from: <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810011501>
39. Vringer K, Blok K. The direct and indirect energy requirements of households in the Netherlands. *Energy Policy.* 1995;23(10):893–910.
40. Kok R, Benders RMJ, Moll HC. Measuring the environmental load of household consumption using some methods based on input–output energy analysis: A comparison of methods and a discussion of results. *Energy Policy.* 2006;34(17):2744.
41. Abrahamse W, Steg L. How do socio-demographic and psychological factors relate to households' direct and indirect energy use and savings? *J Econ Psychol.* 2009 Oct 1;30(5):711–20.
42. Whitmarsh L, Seyfang G, O'Neill S. Public engagement with carbon and climate change: To what extent is the public 'carbon capable'? *Glob Environ Change.* 2011 Feb 1;21(1):56–65.
43. Baird JC, Brier JM. Perceptual awareness of energy requirements of familiar objects. *J Appl Psychol.* 1981;66:90–6.
44. McCaffrey MS, Buhr SM. Clarifying Climate Confusion: Addressing Systemic Holes, Cognitive Gaps, and Misconceptions Through Climate Literacy. *Phys Geogr.* 2008 Nov 1;29(6):512–28.

45. Madsen J, Gerhman E, Ford D. How Much of the Science of Climate Change Does the Public Really Understand? Evaluation of University Students' Ideas on the Carbon Cycle. AGU Fall Meet Abstr. 2007 Dec 1;2007:ED23C-07.
46. Rule AC. Elementary Students' Ideas Concerning Fossil Fuel Energy. J Geosci Educ. 2005 May 1;53(3):309–18.
47. de Groot J, Steg L. Value Orientations to Explain Beliefs Related to Environmental Significant BehaviorHow to Measure Egoistic, Altruistic, and Biospheric Value Orientations. Environ Behav - Env BEHAV. 2008 May 1;40:330–54.
48. Steg L, De Groot JIM. Environmental values. In: Clayton S, editor. The Oxford handbook of environmental and conservation psychology. New York: Oxford University Press; 2012. p. 81–92.
49. Steg L, Perlaviciute G, Van Der Werff E, Lurvink J. The Significance of Hedonic Values for Environmentally Relevant Attitudes, Preferences, and Actions. Environ Behav. 2014 Feb;46(2):163–92.
50. EU: monthly electricity prices by country 2023 [Internet]. Statista; 2023 Feb [cited 2023 Mar 1]. Available from: <https://www.statista.com/statistics/1267500/eu-monthly-wholesale-electricity-price-country/>
51. Netherlands: monthly electricity prices 2023 [Internet]. Statista; 2023 Feb [cited 2023 Mar 1]. Available from: <https://www.statista.com/statistics/1314549/netherlands-monthly-wholesale-electricity-price/>
52. Carley S, Konisky DM. The justice and equity implications of the clean energy transition. Nat Energy. 2020 Aug;5(8):569–77.

53. Mullen C, Marsden G. Mobility justice in low carbon energy transitions - ScienceDirect. *Energy Res Soc Sci.* 2006;18:109–17.
54. Mitra S, Buluswar S. Universal Access to Electricity: Closing the Affordability Gap. *Annu Rev Environ Resour.* 2015;40(1):261–83.
55. Chan G, Evans I, Grimley M, Ihde B, Mazumder P. Design choices and equity implications of community shared solar. *Electr J.* 2017 Nov 1;30(9):37–41.
56. Balta-Ozkan N, Davidson R, Bicket M, Whitmarsh L. Social barriers to the adoption of smart homes. *Energy Policy.* 2013 Dec 1;63:363–74.
57. Wada K, Akimoto K, Sano F, Oda J, Homma T. Energy efficiency opportunities in the residential sector and their feasibility. *Energy.* 2012 Dec 1;48(1):5–10.
58. Reames TG, Reiner MA, Stacey MB. An incandescent truth: Disparities in energy-efficient lighting availability and prices in an urban U.S. county. *Appl Energy.* 2018 May 15;218:95–103.
59. Corbin J, Strauss A. *Basics of Qualitative Research (3rd ed.): Techniques and Procedures for Developing Grounded Theory* [Internet]. 3rd edition. SAGE Publications, Inc.; 2008 [cited 2023 Mar 24]. Available from: <https://methods.sagepub.com/book/basics-of-qualitative-research>
60. Edmondson AC, Mcmanus SE. Methodological fit in management field research. *Acad Manage Rev.* 2007 Oct;32(4):1246–64.
61. Frankfort-Nachmias C, Nachmias D. *Research Methods in the Social Sciences.* 5th edition. London: Edward Arnold; 1976.

62. Patton MQ. *Qualitative evaluation and research methods*, 2nd ed. 2nd edition. Thousand Oaks, CA, US: Sage Publications, Inc; 1990. 532 p. (Qualitative evaluation and research methods).
63. Bell E, Bryman A, Harley B. *Business research methods*. 5th edition. Oxford University Press; 2019.
64. Ghauri PN, Grønhaug K. *Research Methods in Business Studies: A Practical Guide*. 3rd edition. Pearson Education; 2005. 286 p.
65. Yin RK. *Case Study Research: Design and Methods*. 3rd edition. Thousand Oaks CA: SAGE; 2003. 204 p.
66. Thompson J. A Guide to Abductive Thematic Analysis. *Qual Rep*. 2022 May 20;27(5):1410–21.
67. Williams G. Thomas Hobbes: Moral and Political Philosophy [Internet]. IEP: Internet Encyclopedia of Philosophy. [cited 2023 May 17]. Available from: <https://iep.utm.edu/hobmoral/>
68. Elgaaiied-Gambier L, Mandler T. Me trying to talk about sustainability: Exploring the psychological and social implications of environmental threats through user-generated content. *Ecol Econ*. 2021 Sep 1;187:107089.
69. Carpenter SR, Society for Philosophy and Technology. Sustainability and Common-Pool Resources Alternatives to Tragedy. *Soc Philos Technol Q Electron J*. 1998;3(4):170–83.
70. Aras G, Crowther D. What Level of Trust is Needed for Sustainability? *Soc Responsib J*. 2007 Jan 1;3(3):60–8.

71. Liu Y, Liu MT, Pérez A, Chan W, Collado J, Mo Z. The importance of knowledge and trust for ethical fashion consumption. *Asia Pac J Mark Logist.* 2020 Jan 1;33(5):1175–94.
72. Zhang J, Liu H, Sayogo DS, Picazo-Vela S, Luna-Reyes L. Strengthening institutional-based trust for sustainable consumption: Lessons for smart disclosure. *Gov Inf Q.* 2016 Jul 1;33(3):552–61.
73. Corsini F, Laurenti R, Meinherz F, Appio FP, Mora L. The Advent of Practice Theories in Research on Sustainable Consumption: Past, Current and Future Directions of the Field. *Sustainability.* 2019 Jan;11(2):341.
74. Mont O, Plepys A. Sustainable consumption progress: should we be proud or alarmed? *J Clean Prod.* 2008 Mar 1;16(4):531–7.
75. Eurostat. Housing in Europe - House or flat – owning or renting [Internet]. Eurostat; 2023 Oct [cited 2023 May 17]. Report No.: ILC_LVHO02. Available from: <https://ec.europa.eu/eurostat/cache/digpub/housing/bloc-1a.html>
76. Mariotti T. Homeowners vs. Renters Statistics 2023 [Internet]. RubyHome.com. 2022 [cited 2023 May 17]. Available from: <https://www.rubyhome.com/blog/homeowners-vs-renters-stats/>
77. Collier D, Mahoney J. Insights and Pitfalls: Selection Bias in Qualitative Research. *World Polit.* 1996;49(1):56–91.
78. Cerri J. Social desirability bias in green consumerism: its causes, consequences and some potential remedies. [Internet] [PhD]. [Pisa, Italy]: Sant’Anna School of Advanced Studies; 2018 [cited 2023 May 17]. Available from:

https://dta.santannapisa.it/theses/available/etd-09202018-230854/unrestricted/PhDThesis_20Sept2018.pdf

79. Graeff TR. Response Bias. In: Kempf-Leonard K, editor. Encyclopedia of Social Measurement [Internet]. New York: Elsevier; 2005 [cited 2023 May 17]. p. 411–8. Available from: <https://www.sciencedirect.com/science/article/pii/B0123693985000372>
80. Wickson F, Carew AL, Russell AW. Transdisciplinary research: characteristics, quandaries and quality. *Futures*. 2006 Nov 1;38(9):1046–59.