

**ENERGY LITERACY AND BEHAVIOR. THE CASE OF UPPSALA UNIVERSITY,  
CAMPUS GOTLAND.**

Dissertation in partial fulfillment of the requirements for the degree of

BACHELOR OF SCIENCE WITH A MAJOR IN SUSTAINABLE ENERGY TRANSITION



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## ABSTRACT

Energy is one of the most critical elements that support societies in the modern world. As with anything else, energy is a limited resource, and saving it is essential for a fossil-free future where one is aware of their energy consumption and knows what is needed to save it. Recently, Europe has been faced with severe energy shortages where Sweden for example was under the threat of blackouts in 2022/2023. As a way to mitigate the problem, The EU introduced a law that obliges individuals and institutions to reduce their energy consumption during peak hours. In Sweden, this was translated into “Varje kWh räknas” or every kilowatt-hour counts campaign in order to promote energy saving in society. Uppsala university is one of the institutions that had to reduce the energy consumption where students play a role in this energy saving. On the other hand, energy literacy is defined as the way people understand energy, how it is being used, and the attitudes regarding saving it. Previous research (such as Cotton et al., 2015; DeWaters and Powers, 2011; Blasch et al., 2017) about energy literacy tended to focus on various societal groups when investigating the three different domains of energy literacy: cognitive, attitude, and behavior. The cognitive domain is defined as the knowledge related to energy basic rules and concepts, while the affective domain is defined as the attitudes toward energy such as beliefs, values, feelings, etc. Behavioral literacy is the intentions, involvement, and decisions one makes in relation to energy and energy saving. This study aims to explore themes and opinions in energy behaviour, perception, and literacy among students in order to understand the current ways energy literacy is being promoted and taught at Uppsala University and the ways to improve it. This was done by providing answer to the research question: What cognitive, behavioural, and affective knowledge do students have about the nature and role of energy in their daily lives?

In this study, students at Uppsala University, Campus Gotland were interviewed and asked questions about energy and their energy-related attitude and behavior. The data was collected via interviews and then analyzed thematically. The discovered themes varied from students covering the cognitive domain elements to the difference in themes in relation to affective and behavioral domains. Students in general talked about energy in relation to factors that would affect energy behavior and would in turn contribute to saving energy like education. Students also covered various forms of feelings related to energy like anger, fear, and hopefulness. Additionally, various factors showed different patterns when talking about energy-related behavior, energy-saving

attitudes, and the general perception of the relation between knowing about energy and the attitude and behavior domain. When covering the role of Uppsala University, all students have illustrated the importance of introducing energy-related education to the official curriculum, as well as other methods related to Uppsala University to increase energy knowledge amongst students.

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## 1. Introduction

Sweden, as well as many other European countries, face a severe energy situation where the prices of all energy forms, especially electricity, have dramatically increased ever since 2022 (Svenska kraftnät, 2023; Swedish energy agency, 2022; Energicentrum Gotland, 2022). Many factors come into the scene when assessing the reasons for the increased energy prices such as the shared European electricity market where all countries are connected in one extensive electricity grid system, which in turn means that the increasing demand for Swedish electricity in Europe means higher prices for electricity in Sweden, as well as everywhere else (Strandlund, 2022). This came in correlation with many other aspects recently, such as the increased natural gas prices due to the ongoing war in the east of Europe, high costs of power produced from fossil fuels due to the emission trading systems in Sweden and Europe, and the recently closed nuclear reactors in many countries like Germany and France (Strandlund, 2022).

In order to mitigate the energy crises in Europe, the EU on the 30th of September 2022, introduced a new law that oblige European countries to reduce energy consumption by 5% during the peak hours and to voluntarily reducing the overall electricity consumption by 10% (European Council of the European Union, 2022). This in turn resulted in the Swedish energy agency to launch its campaign Varje kWh räknas or every kilowatt-hour counts in order to reduce electricity consumption, demand and prices, and to ensure all day around electricity supply (Energimyndigheten, 2023). The recommendations the energy agency gave to the public in order to reduce their electricity consumption were mainly to move their energy-using activities, like laundry washing, to the time where energy consumption is the lowest like during the nights and weekends (Energimyndigheten, 2023). Another recommendation is to reduce the overall consumption around the week, like lowering the indoor temperature, and using less hot water (Energimyndigheten, 2023). Behavioral-related considerations and recommendations were also apparent, so one would reflect on the way they consume energy and consider what everyone could do to fulfill their part (Energimyndigheten, 2023). Lastly, adopting permanent changes that could reduce the overall energy consumption, such as improving the insulation in homes and buildings, and changing typical light bulbs to LED (Energimyndigheten, 2023). On the other hand, this law was not only for private consumers. It also targeted governmental agencies (Uppsala University,

2022). Uppsala University was required to reduce its energy consumption by 10% during the 2022-2023 winter which in turn meant implementing many energy-saving measures such as changing the lighting times and lighting patterns, switching to LED lights, reducing the ventilation usage, and reducing the in-door temperature (Uppsala University, 2022). Similar measures targeted individuals (students) to reduce their energy usage when being in the university (Uppsala University, 2022). These measures included turning off the lights when they are not being used, closing windows to reduce thermal exchange, and not leaving chargers plugged when they are not being used (Uppsala University, 2022).

Individuals' comprehension of energy is an essential determinant of their energy consumption where energy literacy works as a foundation upon which individuals build their awareness, consumption practices, and responsibility (Sayarkhalaj and Khesal, 2022; Setyowati et al., 2019; Cotton et al., 2021). Many studies highlight the correlation between energy literacy and energy-related behaviors (Lee et al., 2015; Sayarkhalaj and Khesal, 2022; Broek, 2019; Golebiowska, 2020). This, in turn, makes energy literacy a critical factor to assess in order to understand the current situation of energy consumption behavior, and to understand what should be done in order to improve it. Notably, energy and energy savings are some of the factors that appear in the majority of the climate agendas since the energy used for the purpose of electricity, transportation, industry and heat accounts for 73% of the greenhouse emissions globally (Ritchie, Roser and Rosado, 2020; Khuc et al., 2023). This, in turn, mean saving energy is a requirement to reduce greenhouse emissions, enhance sustainable development, and improving the energy system (IEA, 2019; IRENA, 2019; Swedish energy agency, 2023).

As one could see previously, energy knowledge or energy literacy is a factor that affects several important aspects, such as energy transition and sustainable development on a local and global scale. It also effects the personal energy consumption and attitudes that in turn can impact energy prices, flatten the peak hours curves, and ensure all day around energy supply on a local level. According to Khuc et al. (2023), the younger generation, like students, are the leaders of the future and are the ones who will head the net-zero transition journey. This, in turn, highlights the importance of assessing energy literacy among students. Doing that will help improve the understanding of the gaps in the students' energy knowledge. Understanding and addressing the gaps will leave its trace on different societal scales and different periods of time. Consequently, increased energy literacy will positively influence energy-related behavior on the local scale



leading to enhance regional development of energy, and reduced energy prices, particularly during times like the current energy crises in countries like Sweden and Europe. At the global level, energy development, sustainable energy transition, and climate change mitigation are some of the side effects of increased energy literacy (Khuc et al., 2023). Additionally, understanding how students perceive, and think about energy, one can develop and improve the current ways energy literacy is being promoted and taught at Uppsala University which can help lay the foundation for more studies about energy literacy in Sweden in general and the Swedish educational system.

## **2. Aim and research question**

Focusing on the case of Uppsala University, Campus Gotland, this study aims to explore energy literacy (knowledge), perception and behavior among students, with a specific attention to what is being thought and promoted by the University. The question this study is trying to address is: What cognitive, behavioural, and affective knowledge do students have about the nature and role of energy in their daily lives?

Identifying these themes, patterns, beliefs, and attitudes regarding energy literacy will help to better understand the student's perception of energy and will lay the foundation for future studies assessing energy literacy at Uppsala University and Sweden.

Additionally, this can lead to a better understanding of the student's perception of energy, energy literacy, and energy issues, which in turn will help institutions such as Uppsala University to better understand the way students perceive energy-related subjects, thus, help set a plan to reduce, mitigate and adapt energy consumption in practice.

### **3. Literature review**

#### **3.1. The concept of energy literacy**

Historically speaking, energy was the core of the development of human societies, and the development of various sources of energy was associated with the human's ability to harvest and gather this energy (DeWaters and Powers, 2011). This development, through a large part of energy history, was associated with the usage of fossil fuel, which in turn has created many and various forms of problems, such as inequalities between people, wars, and environmental crises (DeWaters and Powers, 2011). According to DeWaters and Powers (2011), a successful transition to a better future does not only rely on the development of the fields of technology, science, and professional expertise, but also on the ordinary people's ability to make their energy-related decisions with the necessary awareness to the bigger energy picture. Similarly, many studies support the claim that knowledge about energy is an essential aspect that is needed in order to make informed decisions in people's life (Brounen, Kok, and Quigley, 2013; Trotta, Kazukauskas, and Kalmi, 2017; Blasch et al., 2018). Studies about energy-related knowledge among people have been conducted in many places and times, such as in Europe (Birula, Makiela, and Mamica, 2022; Golebiowska, 2020; Brounen, Kok, and Quigley, 2013; Trotta, Kazukauskas, and Kalmi, 2017; Cotton et al., 2015; Blasch et al., 2017), Asia (Lee et al., 2019; Lee et al., 2015; Setyowati et al., 2019; Khuc et al., 2023; Tsai et al., 2013; Filippini, Kumar, and Srinivasan, 2020), North America (Moore et al., 2013; DeWaters and Powers, 2011; DeWaters et al., 2012), The middle east (Sayarkhalaj, and Khesal, 2022; Razi, Ranjpour and Azad, 2021; Alghamdi and El-Hassan, 2019), Oceania (Bielschowsky et al., 2017; Bielschowsky et al., 2018), and Africa (Owusu-Manu et al., 2022; Force and Longe, 2022).

However, in order to understand energy literacy, one must define it, and that has been done through different attempts to provide a valid definition of energy literacy. Energy literacy as a term has been popular in the scientific community in recent years (Lee et al., 2019). Many studies claimed that energy literacy shapes consumers' energy behaviour, and being one of the main factors that affect sustainable electricity consumption (Blasch et al., 2018; Birula, Makiela, and Mamica, 2022). According to Cotton et al. (2020) energy literacy is an essential factor in ensuring achieving the goals of sustainable development in the coming years. One definition of energy literacy

describes it as the general knowledge, or literacy level, regarding energy and the issues related to it (Golebiowska, 2020). These related aspects cover a wide range of subjects such as energy sources, energy production, price, environmental impact, etc. (Golebiowska, 2020). As mentioned previously, energy literacy as a concept has been defined in different ways across the literature. DeWaters and Powers (2011) definition of energy literacy is the basic knowledge about energy in combination with an understanding of the environmental impact of energy production and usage, knowledge of how energy is being used in daily life, and knowing/implementing energy-saving behavior along the daily activities. Similarly, energy literacy in different literature was defined as the ability to understand energy's nature and the role it plays in the world, as well as people's daily life (Office of energy efficiency and renewable energy, 2017). What identifies an energy literate person, according to the Office of energy efficiency and renewable energy (2017), is understanding energy flows and energy systems, knowing what energy is used for and the source that energy can come from, the ability to communicate about energy, and to evaluate the credibility of energy-related information. Additionally, possessing the ability to make informed energy-related decisions based on understanding the impact, consequences, and different effects that energy has is also an important criterion in energy literacy (Office of energy efficiency and renewable energy, 2017).

Despite the different definitions that energy literacy has, it usually shares three different domains that are traditionally distinguished in the energy literacy framework: Cognitive literacy, affective literacy, and behavioral literacy (DeWater and Powers, 2013; Wang et al., 2021; Martins, Madaleno, and Dias, 2019). According to DeWaters et al. (2012), the cognitive domain is understanding the basic concepts of energy in relation to energy's rules and theories. The understanding of what energy is, the role it plays in society, in addition to energy's effects on the ecosystem and the environment, are also a part of the benchmarks that identify the cognitive domain of energy literacy (DeWaters et al., 2012). The affective domain is defined by DeWaters et al. (2012) as the beliefs and attitudes that individuals have regarding energy. Behavioral literacy is connected to the individual's day-to-day life and evaluates the awareness on a personal level in relation to the impact that daily actions cause (DeWaters et al., 2012). Additionally, behavioral literacy is also connected to the responsibility that individuals have in relation to the world and commitments (DeWaters et al., 2012). Table 1 shows the different domains of energy literacy and the explanatory characteristics of every one of them.

**Table 1:** The domains of energy literacy and their characteristics. Adapted from DeWaters et al. (2012), DeWaters, Powers, and Graham (2007), and DeWaters and Powers (2013).

Energy literacy domain	Domain's characteristics
Cognitive domain:	<ul style="list-style-type: none"> <li>- Knowledge related to basic energy rules, concepts, definitions, sources, issues, and importance</li> <li>- Understanding energy flows, different sources, and the impact of it on the environment and societies</li> </ul>
Affective domain:	<ul style="list-style-type: none"> <li>- Attitudes toward energy like concerns, values, and beliefs, and feelings</li> </ul>
Behavioral domain:	<ul style="list-style-type: none"> <li>- Intentions and willingness to engage in energy saving actions</li> <li>- Involvement in activities and behavior related to energy saving</li> <li>- Effective decision making where energy saving behavior and advocating for behavior change is at the core</li> </ul>

### 3.2. Variables affecting and being affected by energy literacy.

Using energy literacy as an overall approach that works on assessing the three different domains (cognitive, affective, and behavioral) is commonly used waysto examine energy literacy (Cotton et al., 2015; DeWaters and Powers, 2011; Blasch et al., 2017). The term energy literacy was used in various studies and for many different reasons. Examples of the topics that have been connected to energy literacy are e.g. assessments of energy literacy among university students (Setyowati et al., 2019), school students (Lee et al, 2015; Tsai et al., 2013), teens (Toth et al., 2013), children (Bielschowsky et al., 2017), in household settings (Blasch et al., 2017), in an environmentally related knowledge and carbon reduction behavior (Olsthoorn et al., 2023), and local communities (Miszczuk et al., 2021). Some of these groups were also used to illustrate energy related problems where e.g., Brounen, Kok, and Quigley (2013) study used the energy literacy concept in order to highlight and address the underlying issue of energy consumption in the housing sector in the Netherlands. The study found that 56% were aware of their energy

consumption and attitudes toward energy saving is one of the main variables that affect energy behavior.

Another example of the different implications of energy literacy is Moore et al. (2013) study. This study aimed to distinguish the differences in energy literacy and opinions between elite groups in society (policy makers, leaders, business owners, etc.) and the non-elite (average citizens). The study was conducted to assess the differences between these two groups and to examine elites' opinions since their opinions are deemed to have a large and substantial influence on policies and the policies' decision-making processes. One of this study's findings is that energy for the "elite" group is often seen as a part of other sectors, rather than as self-standing sector with connections to other sectors.

The economy is an example that energy is seen to be a part of. The previously mentioned economy aspect, in turn, is an example that brings the additional domain of energy literacy into the light in recent years. The term financial literacy in the context of energy has been popular in recent years (Blasch et al., 2018; Filippini, Kumar, and Srinivasan, 2020; Golebiowska, 2020; Martins, Madaleno, and Dias, 2019; Olsthoorn et al., 2023). What is meant by financial literacy is the knowledge and the skills that are related to the decision making in financial related investments (Birula, Makiela, and Mamica, 2022; Martins, Madaleno, and Dias, 2020; Miszczuk et al., 2021; Filippini, Kumar, and Srinivasan, 2020). On the other hand, Blasch et al. (2018) refer to financial literacy in their study by energy-related financial literacy. In their study, Blasch et al. (2018) describe energy-related financial literacy as knowing about energy and having the ability to make decisions related to financial investments. Blasch et al. (2018) explain that financial literacy means possessing the necessary skills in order to process information and perform calculations in a financial context. However, what was shown in many various studies about financial literacy, or energy-related investment literacy, is that participants who score high numbers on the energy-related investment literacy scale, have more realistic and accurate perception of energy in general, and higher potential of saving energy in their daily activities (Blasch et al., 2017; Blasch, Filippini, and Kumar; 2019; Blasch et al., 2017a). This, according to the previous studies, indicates that more knowledge, awareness level, and adequate skills to perform calculations are needed to make informed financial energy-related decisions.

### **3.3. Energy literacy in an educational setting**

Energy literacy among students is one of the largely studied subjects (Birula, Makiela, and Mamica, 2022). Many of the studies are focused on assessing the energy literacy among students and in many cases, rank it in different levels like poor state of knowledge, low level of energy literacy, high level of energy knowledge etc. (Birula, Makiela, and Mamica, 2022; DeWaters and Powers, 2011; Lee et al., 2019). A study conducted in Vietnam where students of 48 different Vietnamese universities surveyed concluded that students in general are willing to participate in activities that will help them improve their energy literacy (Khuc et al., 2023). Another study was conducted on secondary level students in Greece that showed that attitudes and energy habits are highly correlated and changing the behavioral patterns will require a major change on the individual level which in turn require more empowerment to the role that education plays in this change (Natona, Arabatzis, and Kyriakopoulos, 2015).

Similarly, Keller et al. (2022) emphasis that education playas a major role in improving energy literacy among students in terms of behavior, energy related attitudes, and the general cognitive knowledge they have, and improving the education system will mean improved energy literacy among students. Through studies, many variables were revealed to play a role in energy literacy among students. Age is a variable where the younger the person is, the more pro-environment behavior they would have (Chiu, and DeWaters, 2018; Raymond and Brown, 2011). Gender is another example of a factor that was shown to affect people's behavior and attitude toward energy where females are more likely to adapt an energy-saving and energy aware attitudes and behavior in comparison with males (Martines, Madaleno, and Dias, 2020; DeWaters and Powers, 201; Rätty, and Carlsson-Kanyama, 2010).

## **4. Methodology**

In order to explore cognitive, behavioural, and affective knowledge about energy, primary research using interviews as a data collection method was conducted. This data was analyzed using qualitative systematic thematic analysis in order to provide an answer to the research question: what cognitive, behavioural, and affective knowledge do students have about the nature and role of energy in their daily lives?.

This study was conducted with a constructivist worldview as a base for its philosophy (Creswell and Creswell, 2023). This philosophy explains the worldview in Creswell and Creswell (2023) book as an important and usually used worldview in studies where the human way of perceiving reality is what identify and make reality. What is meant is that while humans interact with reality, they construct it at the same time (Creswell and Creswell, 2023). This in turn means that it is important to access the human-surrounding interactions and the way people perceive these interactions in order to deepen the current understanding of the reality from a social perspective (Creswell and Creswell, 2023).

### **4.1. Participants**

The focus for this study is students that are actively studying at Uppsala University, Campus Gotland. The students at Campus Gotland (CG) are divided between different disciplines that sums up to 29 programs divided between bachelors and master programs (Uppsala University, 2023). The students at CG are, while this study is ongoing April- May 2023, at least in the second semester of their respective program which means they, at minimum, had the chance to study 30 credits. The reason that CG was chosen for this study was based on the fact that students at CG are geographically accessible population for the researcher and for the best of the research knowledge, no studies have been done about energy literacy at CG. The interviewed sample was chosen using a non-probability sampling where the interviewed students were chosen purposively using the maximum variation sampling method that helps to interview students that are diverse in relation to their program for example in order to gain as much insight to the study as possible (Schreuder, Gregoire, and Weyer, 2001; Nikolopoulou, 2022). The reason the interviewees were purposively chosen is because they need to fulfill specific criteria in order to participate in this study. The first



criteria is the students should have been studying at Uppsala University for at least 30 credits (one semester). This is so the students have had the opportunity to be integrated into the education system and had the chance to participate in a couple of the educational courses in their program.

Additionally, the interviewed students should not be studying at any program where their major is in the field of energy like sustainable energy transition and wind energy. This criterion is important in order to avoid bias in the study result. People who are majoring in an energy related program study mainly energy and energy transition and including them in the sample would not provide an actual picture of the energy literacy at CG more generally. The last criteria that were used when choosing the participants is that students should feel comfortable doing the interview in English in order to avoid any misunderstandings or losses in the translation between other languages and English.

The students that were interviewed in this study were randomly approached at different times during weekdays (Monday to Friday, from 08:00 to 17:00) and in different places at campus Gotland. The decision to interview every student was made after the students filled the previously mentioned criteria and were ok with being interviewed.

## **4.2. Interviews**

In this study, the used method to gather data was structured interviews where all participants were asked same, and pre-determined questions in a fixed order (Creswell and Creswell, 2023). The interview questions are open-ended questions with pre-determined follow-up questions (see table 2 in appendix). The questions were developed after different studies that are about energy literacy like Birula, Makiela, and Mamica (2022), DeWaters, Powers, and Graham (2007), and DeWaters et al. (2012). The students were asked for their opinions, thoughts, and perceptions about different aspects related to energy literacy domains: cognitive, affective, and behavioral aspects. They were also asked about the way they perceive energy in relation to the role Uppsala University plays in promoting energy knowledge, and their opinions on the ways Uppsala University can adopt in order to increase this energy knowledge. It was important to develop the questions about the role of Uppsala University because knowing the way people think and behave in energy related topics by itself would not give an answer to the ways students think regarding increasing energy literacy. In other words, not having questions about the role of

Uppsala University would result in biased and one-sided assessment to students' opinions and thoughts about Uppsala University's role in increasing energy literacy. In order to ensure that the interview questions are understandable, two pilot interviews were conducted with an expert in the field (i.e., a person who have been studying energy transition and sustainability for three years), and with an average student. Every interview was transcribed after each interview using Microsoft transcription tool. After that, the transcription was revised for every interview by the researcher to insure that the transcription is accurate, and correct.

In this study, 11 students from CG were interviewed. These students were spread over 7 different majors: Sustainable destination development, Game design, archeology, cultural heritage and sustainability, business administration, information systems, cultural geography, and urban planning. The interviewed students were at minimum, in their second semester (i.e., were about to finish 60 credits), and they spread all the way up to 180 credits. The participants are divided between 6 self-identified females, and 5 self-identified males and all of which are under the age of 30. The interviewees were from different countries and continents. 4 of them were from Sweden, 5 from the EU, and 2 from countries outside the EU. On average, the interviews took 15 minutes per person.

One of the concerns is the researcher biasness where the way the research interact with the data on a different scales might interfere with the study result. An example is determining the research questions where the way the interview questions were asked could affect the result of the study. Another example is the analysis of the data were marginalizing some aspects of the data and focusing on the other can also miss with the integrity of this study. In order to avoid that, the interview questions were designed in a way that does not direct the interviews answers toward a certain direction. Integrity and personal information are one of the ethical aspects this study took into consideration. The risk of traceability where certain opinions and answers could be traced back to the actual person is one of the concerns in all interviews-based studies. In this study, this was mitigated by avoiding connecting any opinion, answer, or analysis to more demographic information beside gender and age. Since the age of all participants was similar (younger than 30 years), the issue of traceability was naturally mitigated. The gender aspect was used in a way where no personal information or traceable information could be used to trace opinions and answers back to a specific person. Additionally, the personal data that was collected (i.e., the interviews

recordings) were immediately deleted after the transcription phase, thus making it impossible to trace information back to people.

### **4.3. Method of analysis**

This study aims to discover the themes and patterns related to energy literacy and see what the cognitive, behavioral, and affective knowledge students have about energy and the nature and the role it plays in their daily lives. All the data that was collected in this study (the interviews) was analyzed using thematic analysis method, described by Braun and Clarke (2006). Thematic analysis is a multi-stage process where the first step is to become familiar with the collected data (Braun and Clarke, 2006). Conducting the interviews in person, transcribing them, and then reading the transcriptions are all steps that helped the researcher to become familiar with the data. The second step of thematically analyzing the data is to generate initial code (Braun and Clarke, 2006). The initial codes were generated in two ways. The first way is by coding the same question along the interviews (i.e., analyzing the first question in all the interviews, then moving to the second question, etc.). The second way is by analyzing the interviews one at a time (i.e., analyzing the first interview, then moving to the second, etc.). Along the analyzing process, different features of the data were noted like general understanding of the role energy has in the student's daily life, and the emotions that were related to energy. After that, the initial codes were organized after their common themes and sub-themes (ex: various types of feelings related to energy literacy like fear, anger, hope, looking forward) (Braun and Clarke, 2006). The third and last step is to review, develop, and define the founded themes in the initial codes (ex: uncertainty, hopefulness) (Braun and Clarke, 2006).

## 5. Results

In this study, students were asked different questions that aim to discover different topics related to energy literacy and the way energy is being perceived and used in the student's daily life. Through the analysis of the gathered materials, several common themes emerged. While some of them were common among students, there were some themes that differed. Additionally, gender differences in relation to energy literacy in different domains were also noticed.

### 5.1. Energy literacy perception

While exploring the way students perceive energy literacy, several themes and sub-themes were discovered. While the majority of the students expressed not knowing what the term “energy literacy” is for example “*no clue*” (6, female) and “*I don't know*” (11, male), some of the students could guess what it was like for instance student 2 and 7: “*I think it is some kind of power to make things move*” (2, female) and “*I guess someone who doesn't really know much about energy transition ... I guess something related to sustainable energy*” (7, female).

Energy knowledge and sustainable development is also one of the topics that were covered, and it was illustrated that they have a strong connection where energy knowledge and sustainable development correlated. One of the students stated “*big connection [meaning the connection between sustainable development and energy] ... I would say it goes very well hand in hand because obviously we cannot keep doing [using] coal and with the great emission from [using] both coal and oil, it is obviously a bad idea for sustainable development*” (3, male). Another two student illustrated this connection as “*both of them [referring to energy and sustainable development] are kind of sustainability for me ... and they go hand by hand*” (9, male) and “*Sustainable development is the broader term and energy ... is a sub-term*” (11, male).

### 5.2. Energy literacy domains

When talking about the different domains of energy literacy, many themes have emerged illustrating the way cognitive, behavioral, and affective literacy is perceived by the students.

### 5.2.1. Cognitive domain

When asked about different aspects related to the cognitive domain of energy, students covered many different features such energy is something to be consumed “... *it [energy] need to be generated and to be consumed*” (1, female), and as something connected to sustainability, society, and different aspect of life:

*” [energy] is one of the base foundations for our society today”* (3, male)

*”we need it [meaning energy] for running and eating”* (9, male)

*”... is [meaning energy] a very hot topic in and for sustainability”* (11, male).

Added to that, energy knowledge was also illustrated as something with a constructive effects on energy saving like “*well, we have to know where it [energy] come from and what you are using it for ... to be able to save it*” (8, male), and “*... the more we know about energy, the better we get at saving it*” (7, female). Additionally, students also connected the usage of energy to many aspects of their daily life. They also connected it to many energy saving measures in relation to their daily activities like for example, consuming less energy “*... don’t want to have all the light on*” (10, male), and considering choices related to energy “*...buy food when it come to transport [referring to food transportation consume energy] ... restricting myself to locally produced food*” (1, female).

The environmental impact of energy was discussed, and the dominant themes were that all forms of energy has various impact on flora, fauna, and future generations:

*“... traditional energy is not very environment friendly like oil and coal”* (2, female)

*“... they [renewable energy sources] have affects on birds or ocean or fishing”* (1, female)

*“nuclear has a positive impact I would have to say at the moment, but we will have to manage it [meaning residues] for a very long time, so maybe it is not the safest compromise”* (4, female).

Another theme students illustrated is the importance of energy knowledge:

*“To possess knowledge about energy, it is important, I would say so”* (8, male)

*“I think it is [energy knowledge] definitely important just by the fact that we consume a lot of energy, and we are not so aware ... so yes, I think it is important”* (1, female).

The importance of knowing about energy was motivated by various reasons through the interviews. One student stated “... *if we know more knowledge about energy, we would know how to save it*” (2, female) meaning that having more energy knowledge would correlate with pro-energy saving behavior. Another student illustrated that the humankind is trying to move away from fossil fuel, and possessing knowledge about energy would help with this process:

*“I would say it [meaning energy knowledge] is quite important, especially today when we are in a situation where we are trying to move on from fossil fuel”* (3, male).

### **5.2.2. Affective domain**

Affective literacy, just like the other domains, came with different patterns and these patterns were in most cases a mixture between many different aspects. When looking at the feelings related to energy, various themes emerged. It was correlated with positive emotions for some, e.g. *“I would say it [energy] is positive emotions ... mainly associated with moving toward something more sustainable”* (4, female), while for others, emotions were correlated mixed emotions like *“A little bit of fear ... a little bit of hope ... and anger”* (1, female).

However, students expressed mixed views on the effects energy knowledge would have on attitudes. Two different trends were referred to during the interviews where one of them is that energy knowledge would mean better attitudes toward energy like for example *“I think the more knowledge you have, the more you are able to make conscious decisions about your own energy consumption”* (7, female). As for the other trend, students associated energy literacy with negative attitudes toward energy like for example *“... [energy] is seen as something negative and scary and is going to hurt our pockets”* (8, male), and *“It [energy] is a very iffy subject I would say very polarized subject I would say and it is a very society splitter”* (3, male).

Gender differences in the themes of the answers were also seen in relation to the affective domain. As one can see previously, energy knowledge was associated with energy saving, and attitudes supporting energy-saving, which was seen in female students. On the other hand, male

students correlated energy with negative aspects such as increasing division and polarization in society, and something will affect people negatively.

### 5.2.3. Behavioral domain

The behavioral aspect of energy literacy generally was referred to by students in various ways like for example when talking about the way they use energy in their daily activities, the measures that are used to save energy, and the connection they see in their energy consumption and their knowledge. When looking at the daily usage of energy students showed a general understanding that energy is connected to the majority of their daily activities such as cooking, showering, illumination and heating *“All the time ... we people use energy in everything”* (7, female) and *“...[referring to the way they use energy] by lights, cooking, boiling water, making coffee, charging, electricity like laptops, phone”* (11, male) and *“I use electricity for everything ... drink water. Water is kind of energy [meaning consume energy]”* (2, female). Additionally, energy and the student’s behavior related to it was covered through the interviews and it was mainly discussed in two ways: as something students would react upon like:

*“yes maybe being aware of light and water consumption at home, also being aware of cooking more efficiently meaning that if I cook, maybe I cook bigger portions ... isolating the house properly or putting proper windows”* (1, female)

*“like switching off the light when you don’t use the room, and even like when you boil the pasta you just like let it boil on the stove for half of the time and then cover the pot with the lid and you turn off the stove”* (4, female)

and something that they would not consider changing like:

*“I would say not really [referring to changing behavior to save energy] ... because I am living in a first world country and therefore we don’t really have to save it [meaning energy]”* (3, male).

During the analysis, the different patterns between female and male students’ answers were noticed. The previously mentioned examples shows that female students expressed willingness

and the thoughtfulness in working toward energy saving behavior. The male student showed the tendency of not being willing to change behavior, nor any willingness to work toward energy saving behavior.

### **5.3. The role of education**

The role of education in increasing energy knowledge was also a topic that was covered in the interviews. Students were asked about their perception of the role of their educational institution had in increasing energy knowledge among students, whether their program have contributed to teaching about energy in any way, and the way they think their university can be used to increase energy knowledge in their opinion.

As for their current education, it was seen that some of the students illustrated having some energy related education like:

*“we had a course last semester which was about games and society in general. One of the modules was about game development and energy consumption because traditionally ... game design is intensive kind of field because you have the massive computers running hours upon hours of the day”* (8, male)

*“yes especially when it comes to electricity and carbon dioxide footprint and sustainable choices over sustainable energy in some courses”* (10, male).

On the other hand, it was seen that not all had energy related education in their program:

*“no, not at all! there is only one teacher that did talk a little about it more”* (6, female)

*“no, we learned in our studies that technologies and believing in technology will eventually bring sustainability is a weak form of sustainability, which did not bring us much further into the topic [of energy]”* (1, female).

Additionally, while discussing the role and the ways that university can implement and adapt to promote and educate energy, students referred to two different themes in their suggestions. The first one is to engage students in formal education about energy by both teaching the field



related to energy, and the normal day-to-day life energy. The second one is by organizing voluntary activities such as seminars, workshops, and get together days that talk about energy:

*“think it would be nice to have a kind of workshop or some lessons where you learn about the place and the problems they have [referring to energy shortages on Gotland] and what you need to take care of [meaning how to save energy]” (1, female).,*

## 6. Discussion

When looking at the cognitive, behavioral, and affective literacy students have about the nature and the role of energy in their daily life, one can see many themes and patterns that can give a better and deeper view on the subject. When talking about the cognitive domain, students showed the ability to cover, and discuss the role, nature, flow, and the effects energy sources have on the environment and future generation. Additionally, students connected energy to many aspects of their daily life like cooking, showering, using electrical appliances, and driving. This pattern of understanding what energy is, the role it plays in society, and the effects it has on flora and fauna is consistent with many different previous like Lee et al. (2015) study, Yeh, Huang, and Yu (2017) and Toth et al. (2013). This is maybe not so surprising as students are at a university education level and this mean that they had many years of elementary, secondary, and high school education to learn about energy which in turn reflected in more exposure to energy related education. Another factor could be the age factor where all interviewed students are relatively young (younger than 30 years old) which in turn affects them on two different levels. The first one is the general tendency for younger generations to be concerned about environmental issues which are strongly connected to the topic of energy (Chiu, and DeWaters, 2018; Raymond and Brown, 2011). Additionally, the recent events in Europe where the whole continent was faced with the threat of energy shortages which could in turn increase the exposure of people and students to the subject of energy, therefore increasing their knowledge. The connection between sustainable development, environment, and energy literacy was seen to be positively correlated in the analysis of this study, where students linked knowledge about energy with its necessity and role in achieving sustainable development. This connection was seen in many other studies where Khuc et al. (2023) showed the connection between environmental concerns in students' and energy literacy. Further, it was shown that environmentally concerned students are more likely to adopt pro-environmental behavior, which in turn includes energy literacy (Khuc et al., 2023).

Additionally, students covered a variety of emotions from, for example, being excited, hopeful, and positive, all the way to being angry, and fearful. These feelings could have been influenced by many variables such as the recent events of energy shortages, the existential issue of climate change and global warming, all the way to the rapid development the humankind is doing on the scale of the renewable energy development. Birula, Makiela, and Mamica (2022)

study shows that regardless of the different attitudes and feelings energy is associated with for different students, it is one of the domains that is strongly connected with the cognitive domain. It means that developing attitudes about how one perceives, thinks, and feels about energy and energy-related topics is not a fixed process, and it can influence and get influenced by many factors (Birula, Makiela, and Mamica, 2022). According to the previous study, providing information about the topic of energy could shape and influence energy attitudes and related feelings.

However, it was seen that females associated energy knowledge with energy saving attitudes, energy saving behavior, and in general, less energy consumption. Male students, on the other hand, connected energy knowledge with attitudes such as division in society, no effects on energy consumption or energy saving behavior, and no willingness to change their lifestyle. This trend was seen in earlier studies where for example Martines, Madaleno, and Dias study (2020) found that the performance on the behavioral and affective domain was positively correlated with gender where females performed better than males on these two domains. Same trend was also seen in Golebiowska (2020) study where the researcher illustrated that women obtained higher result than men did when it comes to affective and behavioral literacy. This study could not measure energy literacy among students, but general theses were noted. When talking about the cognitive domain, no differences between gender were noticed, while, as mentioned earlier, females and males performed differently in relation to the affective and behavioral domains. Similar trends were seen where different studies showed that male students performed better than female students in relation to the cognitive domain (Khuc et al., 2023; Yeh, Huang, Yu, 2017). Similar to this study, the same studies showed that females are more likely to adopt pro-energy saving and pro-energy attitudes than male students, which can translate to better performance in the affective and behavioral domains.

On the other hand, when students were asked about their views of the role of Uppsala University, they illustrated that energy could be taught in school and all students expressed willingness to participate. This study showed that the role that Uppsala University can play is introducing energy related education in the official curriculum where students get exposed to energy related knowledge, especially when talking about cognitive and behavioral literacy. Many studies, like Lee et al. study (2019), showed that students rely heavily on their educational institution as a primary source of knowledge about energy which means that the role of all universities in general, and Uppsala University in this case, should be emphasized and improved

in order to provide adequate and sufficient knowledge about energy for the students. So, having an educational system that covers the basic principles, ideas and issues will help expose students to what energy is, and what are the challenges that are associated with it. In turn, this would direct students to get efficient and sufficient knowledge so they could make informed decisions when it comes to energy, energy consumption, and energy saving (Lee et al., 2015). Additionally, doing so will go in line with the previously mentioned law of Sweden and the EU of reducing energy consumption on the national and the local level.

## 7. Conclusion and limitations

The existence of modern society is mainly based on the existence of modern energy and energy is one resource that has shown many challenges lately. The recent events in Sweden and the EU showed the great need to consumption reduction on all levels, and scales. Energy literacy is one of the ways that, according to many scientists, could help reduce energy consumption. Therefore, this study was conducted to explore energy literacy among the students at Uppsala University, Campus Gotland. This study aimed to explore energy literacy (knowledge), perception and behavior among students, with a specific attention to what is being thought and promoted by the University. The results highlighted that student showed an understanding of concepts of energy and the nature of the role energy plays in their daily life. Moving to affective and cognitive literacy, students showed that education is an important factor that would affect energy behavior and would in turn contribute into saving energy. However, the gender aspect was found to be a factor that affect cognitive and behavioral literacy where female students showed a tendency to connect cognitive and attitude toward energy with themes that would contribute into increasing energy saving and energy awareness. Male students, on the other hand, adopted different views where cognitive literacy and behavior in a way that would not affect their energy consumption, therefore not saving energy. Male students also connected the topic of energy to different attitudes that were different than female students. Additionally, students illustrated the role of Uppsala University in promoting energy literacy. So, in order to improve energy literacy, it was suggested that Uppsala University increase energy education and introduce it to the curriculum where all students get to be a part of energy related education. This education could be implemented in two different ways where energy related education is taught both in relation to the student's major, as well as to the daily life and activities. Moreover, the role of out-side-class activity was also one of the covered topics where students suggested seminars, guest lecturer, and interdisciplinary activities.

Since this study only focused at Uppsala University, Campus Gotland students, it is limited in its representation ability. Future studies could use bigger samples and from different institutions in order to get more comprehend result that could provide answers on the national level. As one could see previously, education plays a significant role in shaping energy literacy, and researching energy literacy in relation to educational institutions is essential to assess the current situation and to assess the role different educational institutions plays. Moreover, studies that assess energy

literacy at a younger age are also necessary to conduct in Sweden since these studies are very limited. Qualitative, representative, and large-scale studies with larger populations are needed in the field of energy literacy in Sweden is also needed in order to understand the current energy literacy level.

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## 9. Appendix

Table 2: The interview questions

<b>The way students perceive energy literacy:</b>	<p>1: What does the term “energy literacy” mean to you?</p> <p>2: Do you think possessing knowledge about energy is important? Why?</p> <p>3: what is the connection between energy and sustainable development in your opinion?</p>
<b>Energy literacy:</b>	
<b>Cognitive domain:</b>	<p>4: what do you know about energy?</p> <p>5: is there any relation between energy knowledge and energy conservation in your opinion?</p> <p>6: have you used knowledge about energy in a decision you made?</p> <p>7: in what way energy knowledge could contribute into promoting sustainable development?</p> <p>8: in what way can energy affect the environment?</p>
<b>Affective domain:</b>	<p>9: what emotions the word “energy” is associated with for you?</p> <p>10: in what way do you think energy knowledge affects individuals’ attitudes toward energy?</p> <p>11: in what way do you think energy knowledge affects communities’ attitude toward energy?</p>
<b>Behavioral domain:</b>	<p>12: how do you use energy in your daily life?</p> <p>13: do you use any energy saving measures in your daily life? If yes: what are they? / if no: why not?</p> <p>14: do you think having more energy knowledge would affect your energy consumption?</p>



<b>The role of the educational institution perceived by students</b>	<p>15: in your opinion, does the program you are studying right now play a role into promoting energy knowledge?</p> <p>16: do you think it is important that Uppsala university increase energy knowledge among students? Why?</p> <p>17: in what way do you think Uppsala university can help students increase their energy knowledge?</p>