WHAT IS THE WILLINGNESS TO PAY FOR GREEN ELECTRICITY IN NORWAY? A PERSPECTIVE ON GUARANTEES OF ORIGIN (GO).

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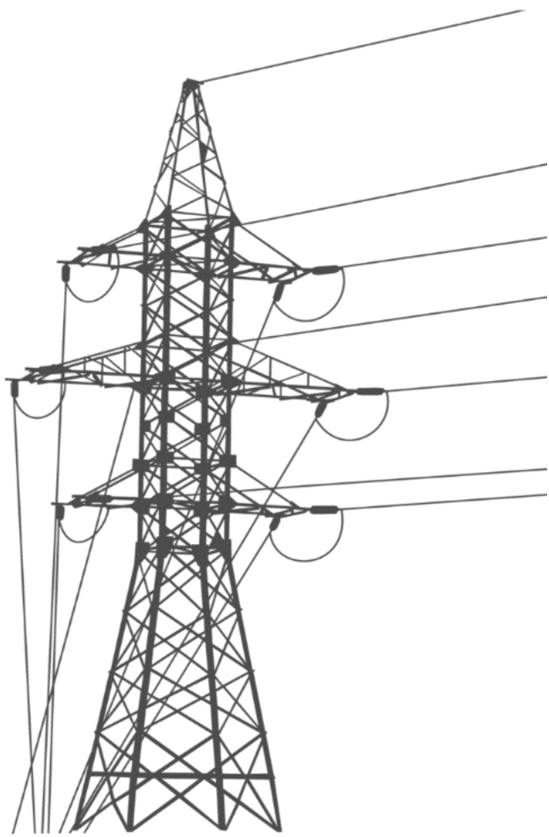

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What is the willingness to pay for green electricity in Norway? A perspective on Guarantees of Origin (GOs).

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Abstract

Norway is one of the only countries in the world producing its electricity from almost only renewable resources. The Renewable Energy Directive 2001/77/EC (2001) introduced a system of Guarantees of Origin (GOs) as an incentive system for power producers and a tracking system of the renewable electricity consumption in Europe. It is mandatory to purchase GOs to be able to claim any renewable electricity consumption. A low demand for GOs results in only 18 percent (2019) of the renewable electricity being purchased in Norway and the remainings being exported in Europe making Norway the largest exporter of GOs. Consequently, the electricity consumed by Norwegians is not as renewable as believed.

Thus, in this thesis we tried to figure out if the low demand has roots in low knowledge about GOs or not. Furtheremore, we aimed to estimate their maximum willingness to pay and factors affecting it. In order to achieve these aims, we used contingent valuation method survey.

The survey introduces GOs through a scenario and simplified example, followed by a payment card as the elicitation method. The data is further analyzed by Logistic Regression, Ordinal Logistic Regression, and Interval Regression to gain more in-depth insight about factors affecting willingness to buy (WTB) and willingness to pay (WTP).

The results show that most respondents are neither aware of Norway's green electricity production nor GOs. Nevertheless, after being informed about GOs, most of the respondents without prior knowledge were willing to buy these with an average WTP of 5 to 9 percent of their electricity bill. The most critical factors affecting respondents' WTB are gender, age, heating source, social media behavior, beliefs and behaviors toward the environment, car type, and prior knowledge about GOs. The models regarding WTP indicate that the most vital factors are education, heating source, employment status, beliefs and behavior toward the environment, social media behavior, and satisfaction with the electricity provider.

Keywords: Guarantees of Origin, GOs, Green Electricity, Willingness to Pay, WTP, Contingent Valuation, Renewable energy, Environmental Economics, Electricity Market

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List of abbreviations

AIB	-	Association of Issuing Bodies
CC	-	Climate Change
CE	-	Choice Experiment
CV	-	Contingent Valuation
DV	-	Dependent Variable
EECS	-	European Energy Certificate System
GOs	-	Guarantees of Origin
HL	-	Hosmer-Lemeshow
IPCC	-	Intergovernmental Panel on Climate Change
NOAA	-	National Oceanic and Atmospheric Administration
PC	-	payment card
RP	-	Revealed Prefrences
SP	-	Stated Prefrences
TEV	-	Total Economic Value
TGCs	-	Tradable Green Certificates
WTA	-	Willingness to Accept
WTB	-	Willingness to Buy
WTP	-	Willlingness to Pay

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1. Introduction

This section discusses the necessity of moving toward renewable energy and provides a summary of the importance of this research. A brief summary of the main topics of the thesis is presented, and the research questions are introduced.

1.1 Transitioning to renewables

Based on the latest report from the Intergovernmental Panel on Climate Change (IPCC), a reduction of 45% of net human-caused carbon dioxide (CO_2) emissions by 2030 will limit temperature rise to 1.5 degrees Celsius instead of 2 degrees (IPCC, 2018). In 2019, 41% of global greenhouse gas (GHG) emissions came from electricity generation. In consequence, the power sector has experienced a transition to renewable energy sources (RES) with the mission of reducing emissions. However, fossil fuels, mostly represented by gas and coal, still account for 58% of global electricity production, which should prompt further action (IEA, 2020). IPCC has reported that renewables, especially wind- and hydropower, are key to reducing GHG emissions.

Although the definition varies, it is acceptable to define “green” or “renewable” electricity as electricity produced from RES. The share of green electricity is around 26% of global power and increasing drastically because of new policies around the world (Ritchie, 2020). Nuclear energy, accounting for 10.4% of global electricity production according to the International Energy Agency (IEA), is seen as low-carbon energy and one of the means for carbon emission reduction but not a renewable resource. In this master’s thesis, RES will not include nuclear energy.

The transition to RES has been a relevant and much-discussed topic for several decades and continues to be debated today. Environmental awareness began in the 1960s, leading to the first debates about nuclear energy vs. fossil fuels. Renewables came into use in the mid-1970s because of the “energy crisis” caused by a lack of oil supply and general price increase of fossil fuels (Gan, Eskeland, & Kolshus, 2007). As a result of consumers acquiring pro-environmental preferences, both willingness to pay (WTP) and consumption of renewable electricity increased. Therefore, in the early 1990s, concrete and futuristic policies and investment plans were introduced globally to preserve the planet.

The UN Framework on Climate Change in Rio (1992), Kyoto Protocol (1997), REN21 (2005), RE100 (2014), and Paris Climate Agreement (2016) are examples of global, regional, and industrial renewable energy policies and commitments. These gave rise to new motives enhancing the transition to renewable energy production and consumption. As an example, the United States (US) Environmental Protection Agency, under Barack Obama's presidency, developed a Clean Power Plan that aims for a 30% reduction of US carbon emissions from electricity generation, relative to 2005 levels, by 2030. Such programs appear to be effective for increasing the awareness and knowledge of the general public. Additionally, they make it easier for people with pro-environment interests to act and fulfill their need to contribute to fighting climate change.

Since 2009, all member countries of the European Union have pledged to achieve the goal of a 20% overall share of renewable energy by 2020 given by the Renewable Energy Directive 2009/78/EC. RE100 is also a global commitment from the world's most influential companies with the goal of operating based on 100% renewable electricity. Consequently, the demand for guarantees of origin (GOs) has increased drastically.

The latest results show that in 2019, RES represented 19.7% of energy consumption in the EU-27 (Eurostat, 2020). As an example of extreme change, from 2015 to 2021, Britain's coal plants transitioned from producing a quarter of the country's electricity to only 2% (The Economist, 2021).

1.2 Guarantees of origin (GOs)

Norway is known for being the only country in Europe and one of the only countries globally to produce almost 100% "green" electricity, which means electricity is produced from renewable sources such as hydro, wind, and thermal energy (Energy, 2016). The electricity produced from fossil fuels or renewables is blended when connected to the grid and traded to foreign countries, making it impossible for consumers to track the source of production. In this situation, consumers would not know if the power purchased is green. Therefore, the European Energy Certificate System (EECS) has standardized an instrument called GOs, which are guarantee certificates sold by most of the power producers in Europe (members of the Association of Issuing Bodies (AIB) to retailers or consumers in parallel for trading electricity through trading platforms like Nord Pool.

In addition to the AIB, RE100 is a global commitment from the world's most influential companies to follow the transition to 100% renewable electricity, which enhances the trade of GOs drastically. This unique financial instrument is used as a power-consuming tracker and an accounting system (1). The seller of such a certificate guarantees the type of renewable source for the exact amount of electricity (in Kilowatt-hour) traded. This system counts as additional income for renewable power producers and an incentive for producers who use fossil fuels to change their energy sources.

After researching, we discovered that 67% of the power produced in Norway is financially exported to European countries with the use of GOs. Therefore, the electricity purchased by Norwegians is not as green as believed.

1.3 Aim of the study

In 2019, 134.6 TWh of electricity was produced in Norway.[1] Renewable electricity accounted for 131.9 TWh (98%) of the production mix. The remaining 2% of electricity production came from fossil energy. According to the AIB, in 2020, Norway was the largest exporter of GOs, while Germany was the largest importer (see Figure 1).

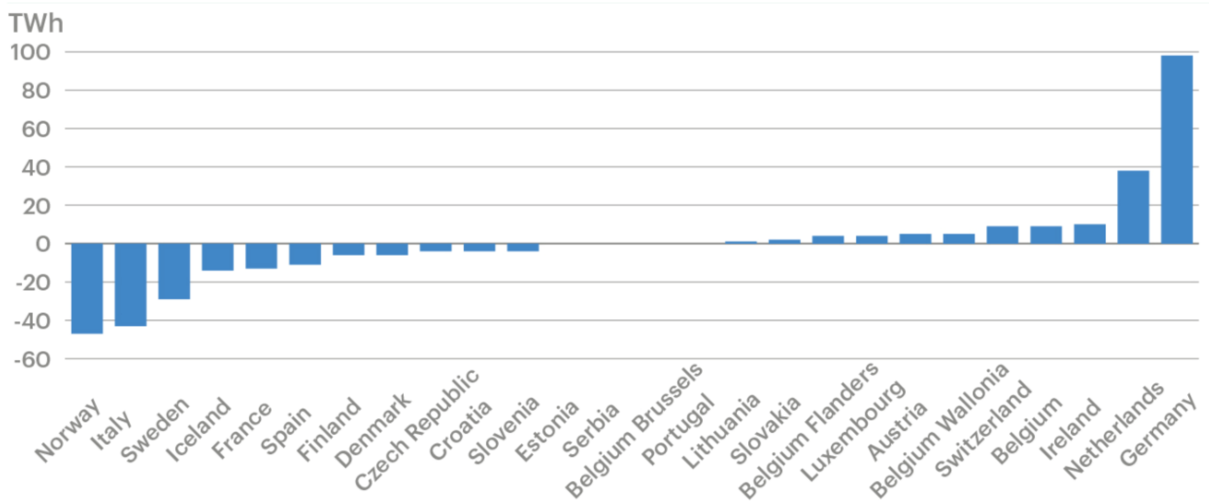

Figure 1. Net transaction imports and exports of GOs in 2020 in Europe (Source: AIB)

During the same year, only 18.4% of the renewable electricity produced was sold within Norway through GOs, meaning that the remaining 81.6% of the electricity consumed in Norway was based on the residual mix, which was constituted of 52% fossil, 39% nuclear, and 9% renewable energy (NVE, 2020). The distinct difference between production and consumption is rooted in the introduction of the 2009/28/EC directive, also known as the GO system. As a

[1] The data presented in this sub-section refer to the latest information disclosure published in 2019. The data is published by the Norwegian Water Resources and Energy Directorate (NVE), responsible for approving production plants for the GO system.

result, the demand for GOs in Norway is low, and the electricity purchased is not as green as the general public believes it to be. Hence, we wish to study the public's attitudes toward GOs and discover how much they are willing to pay to buy green electricity through GOs.

1.4 Research questions

This master's thesis questions the low demand for GOs in Norway with the hypothesis that the low demand is a result of consumers not being sufficiently informed about GOs and their effect. Our study employs three main research questions:

1. Do Norwegians have prior knowledge about the GO system?
2. Would Norwegians be willing to buy (WTB) GOs after being educated about them?
3. How much is the average WTP for GOs?
    a. How much is the WTP of society as a whole?
    b. How much is the WTP of the respondents with positive WTP?
4. What are the factors influencing WTB and WTP?

We believe that informing Norwegian consumers about GOs will increase the demand for GOs. Therefore, the results of this thesis can be used by authorities to further understand people's behavior toward GOs and set policies more efficiently to increase the demand for them. Furthermore, it helps researchers become more knowledgeable about the drivers of green electricity demand through GOs.

2. Background

This section discusses the background topics related to environmental studies and GOs. We begin by defining GOs and different aspects of their existence and then move to environmental economic theories that are the foundation for the credibility of our method of work and estimated WTP.

2.1 GOs

2.1.1 Introduction

Guarantees of origin (GOs or GoOs) are electronic certificates documenting the environmental attributes of the generation of 1 MWh of electricity. These certificates enable accurate tracking of renewable electricity consumption.

The term “green electricity” denotes electricity generated from RES, in particular hydro, wind, solar, geothermal, aerothermal, biomass, landfill gas, sewage treatment plant gas, and biogas. This term can lead to confusion and debate because of the generality of the definition. One of many candidates as a representative of green electricity as a valuable and specific market good is GOs. It is important not to confuse GOs with the tradable green certificates (TGCs) issued by some European countries as a mandatory program for people living in such countries. In contrast to the GO system, governments mandate consumers to buy a certain number of TGCs to fulfill a quota. Our study does not concern TGCs but the GO system in the European electricity market, in which Norway plays an important role due to its high supply of this instrument.

2.1.2 Introducing GOs to the European electricity market

As a result of liberalizing of the electricity market with the 1996/72/EC directive and increasing the focus for adopting RES during the 1990s, GOs were introduced by the European Commission with the 2001/77/EC directive (also called the RES directive). It was only eight years later, during the directive’s replacement with Directive 2009/28/EC, that GOs were defined. The definition states:

> “an electronic document which has the sole function of providing proof to a final customer that a given share or quantity of energy was produced from renewable sources as required by Article 3(6) of Directive 2003/54/EC”; (Council Directive 2009/28/EC, 2009, Article 2(j), p. 27).

Article 3(6) of the Directive 2003/54/EC titled “Public service obligations and consumer protection” must be considered when defining GOs. The article explains the common rules for the internal European electricity market.

Creating GOs and applying them to the internal European electricity market helps electricity retailers document their share of renewable electricity sold to customers, which enhances the supplier’s obligation of disclosure of all energy sources, hence increasing market transparency.

Jaap Jansen published a report in 2017 for the Centre for European Policy Studies (a top-ranked leading think tank on EU affairs) and evaluated whether the EU’s renewable energy sector still needed the GO market. He argues that GOs can increase the renewable share in the national and EU energy mix under certain regulatory conditions by empowering consumers. GOs have the potential to become “a welcome consumer-driven financing complement to render renewable energy projects viable, notably after 2020” (as cited in Jansen, 2017, p. 5).

He suggests applying the following actions to achieve the stated claim:

1. EU-wide adoption of GO standards such as the EECS standard.
2. Issuing “support GOs” (GOs benefiting from a support scheme) to national authorities instead of generators.
3. Limiting the period of GO issuance possibility for generators, for example to 25 years (Jansen, 2017).

2.1.3 GOs as a tracking system in Europe

Surprisingly, Directive 2001/77/EC, responsible for creating GOs, did not mention details about the design of the GO system, nor how large of a role GOs would have in electricity disclosure and consumption statistics. This issue was brought up in 2007 with the help of a study conducted at the European level. Lise et al. (2007) argued for the importance of a standard tracking system for power generation attributes. This way, the implicit tracking system already established based on diverse statistics by electricity retailers could be replaced by an explicit tracking system described as a “de-linked tracking system.” A significant difference in applying this system is that GOs can be transferred independently to electricity sales instead of being transferred alongside electricity contracts, as with a “contract-tied tracking system” (Snoeck, 2019).

As a result of the repeal of the 2001/77/EC in favor of the 2009/28/EC directive, GO holders can transfer GOs freely. Consequently, the unit of physical electricity sold linked to the certificate cannot be claimed as renewable electricity (Council Directive 2009/28/EC, (52)). In other words, each unit of electricity comprised of 1 MWh and produced from RES creates one GO, which can be sold independently to end consumers and accounted for as additional income for the producer. Each GO can only be issued once. The AIB is responsible for supervising and maintaining the EECS standard for all members of the AIB. One of the founding members for the AIB is Statnett, a governmental energy company owned by the Norwegian state through the Ministry of Petroleum and Energy.

To this date, the GO system is the most used system for renewable energy tracking. Additionally, the GO system empowers customers by providing them with the freedom to choose and support their preferred energy source (AIB, 2015), thus increasing awareness and investor interest in green electricity.

2.2 Theory of environmental benefits

Mathematically, the total value of an ecological good is the present value of its benefits from now to infinity (Dugstad, 2018). Based on Perman et al. (2011), the value of goods for individuals can be experienced in many manners other than direct consumption. Barbier (2007) also believes that an asset's economic value is in the role it plays in helping people obtain their objectives regardless of its form, whether it constitutes an aesthetic pleasure, spiritual enlightenment, or a market commodity (Barbier, 2007 as cited in Laurila-Pant et al. 2015). Thus, economists have defined a broader concept in value of total economic value (TEV). TEV is a concept referring to the total value people perceive from a natural resource.

A common confusion in the valuation literature, based on Bateman et al. (2011), is using cost and value equivalently. The authors select walking in a park as an example. Using parks is free but brings value to the users. Therefore, they argue that economists' responsibility is to estimate the value of goods and services based on the welfare they produce rather than their market price (Bateman, Mace, Fezzi, Atkinson, & Turner, 2011). This is especially important for environmental goods, as most of them are free of charge and do not have a market value. Accordingly, TEV focuses on the value and considers a broad type of value proposition mainly grouped as non-use values and use values.

Use values are related to the direct and indirect consumption of a resource and are categorized into two groups, consumptive and non-consumptive. However, some academics add another group to use values, option values. Non-use values, on the other hand, are not related to physical interaction with the resource. Non-use value considers that an individual might receive satisfaction from a resource apart from consuming it. Non-use values are also categorized into three different groups. A summary of TEV and its components can be seen in Figure 2.

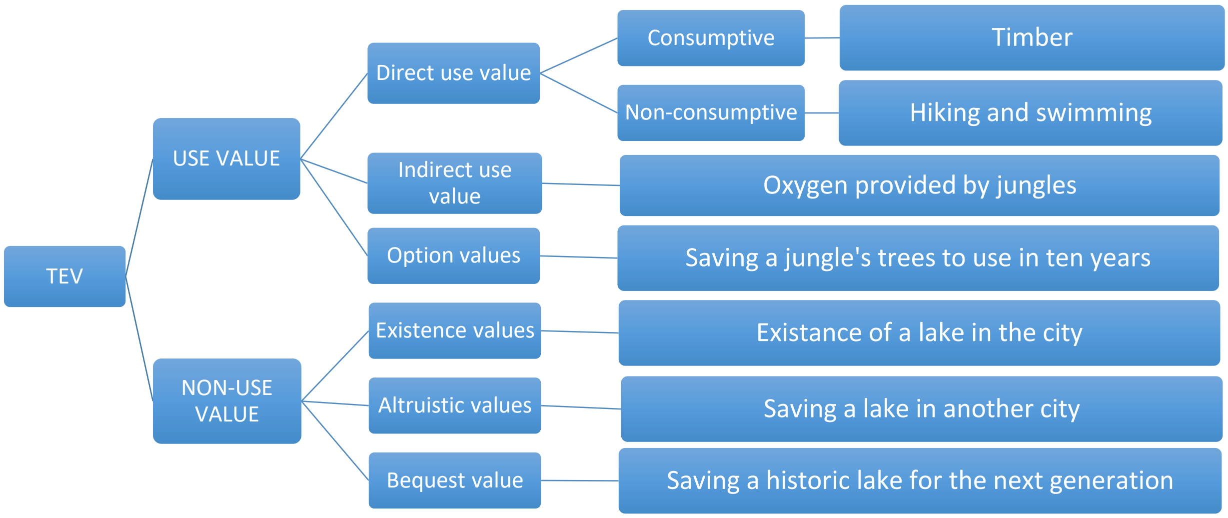

Figure 2. Different types of values based on Perman et al. (2011)

Based on Pascual et al. (2010), the ecosystem's cultural services and provision are called direct use value, and they can be divided into consumptive or non-consumptive uses. Provisioning goods such as timber from forests or drinking water from rivers are examples of consumptive use. Recreational activities such as hiking, surfing, or swimming are non-consumptive direct uses or cultural services, based on Pascual et al. (2010).

Indirect use values are the benefits the environment supplies (Pascual et al., 2010)—for instance, oxygen is an indirect value of Amazon rainforests. Option values are defined as the value associated with the future use of a resource. For instance, a farmer might be willing to pay a premium for the opportunity to withdraw water from a river in ten years («3. Total economic value | Ministry for the Environment», n.d.).

Non-use values are the second component of TEV. Non-use values originate from the satisfaction of knowing an ecosystem service is maintained and accessible to others at their will (Kostlad et al. 2000 as cited in Pascual et al., 2010). Non-use values do not have any market value or, subsequently, market price. Their value is related to people's experiences and beliefs stemming from religious, moral, and aesthetic properties. Therefore, non-use values are more difficult to evaluate (Pascual et al., 2010).

The first type of non-use value is existence value. Existence values originate from knowing that an ecosystem service exists (Pascual et al., 2010). The second type is altruistic value, which is the welfare from knowing that an environmental quality or quantity helps other people (Perman et al., 2011). The last component of non-use value is the bequest value. Bequest value is the utility of knowing a natural resource will be preserved so that the next generation can also use it (Laurila-Pant, Lehikoinen, Uusitalo, & Venesjärvi, 2015).

As an energy source, green electricity has the same characteristics and use values as electricity generated from fossil fuels. The main difference between these types of electricity is their impact on the environment. The emphasis of advertisements for green electricity consumption, based on Zhang and Wu (2012), has always been on environmental issues. Based on the characteristics of the environment, which makes it non-excludable and non-rivalrous, the benefit of green electricity can be seen as resource efficiency and ecosystem protection, which are non-use values. To define the terms non-rivalrous and excludable, the former means no one can be excluded from using a good, and the latter means consumption of the good by one person does not stop others from using it. An excellent example of such good is light coming from the sun.

Furthermore, the worth of GOs as a green electricity purchase guarantee for households is mainly related to protecting the environment, increasing the amount of green electricity purchased by the country, and enhancing the country's residual mix. Therefore, we argue that the non-use values of green electricity outweigh its use values. However, the existence of use values cannot be wholly rejected. These value types play an important role in the choice of survey method and are the foundation for our task in Chapter 4.

2.3 The theory of environmental valuation[2]

This research aims to determine the value and demand of an environmental good, namely GOs, for Norwegian households. The main assumption is the same as for microeconomics. We consider that consumers are rational and attempt to maximize their utility. Any increase in the consumption of private goods, a higher level of renewable sources in energy, or any other type of increase in environmental quality levels (e.g., better lighting in a park) is assumed to increase respondents' utility (Dugstad, 2018).

[2] The unreferenced parts in this section are based on a mixture of the knowledge gained by reading (Braden & Kolstad, 1991, Chapter 2; Freeman III, Herriges, & Kling, 2014, Chapter 2; Mitchell & Carson, 1989; Nicholson & Snyder, 2008, Chapters 4 and 5; Perman, Yue Ma, Michael Common, David Maddison, & James McGilvray, 2011, Chapter 11, and 12)

The monetary value of the utility changed by an environmental good can be measured with different methods. Figure 3 depicts four methods of measuring the value. The vertical axis shows the income, and the horizontal axis represents the utility.

For the first scenario, we consider that there is no GO and 98% of the electricity bought is considered green. The customer is at point B with utility level U_1. They are receiving a G_1 level of environmental good (98% green electricity) with a B_1 level of budget. After the introduction of GOs, the electricity purchased without GOs cannot be considered green. Therefore, the consumer's use of environmental good shifts to G_0, and the consumer loses $G_1 - G_0$ levels of environmental good (green electricity in this case). Everything else held constant, consumers move to point A on the U_0 indifference curve. To bring the consumer back to their previous utility level (U_1), we need to ensure they will reach the budget point B_2. The difference between B_1 and B_2 (AD) is the maximum willingness to accept (WTA) a decrease in environmental good.

Next, we consider the customer to be at point A with a G_0 level of environmental good. Their status quo utility level is on the U_0 indifference curve with budget B_1. If the government introduces and distributes an environmental good to the entire population, consumers will move to point B, where they consume a G_1level of environmental good for the same spending. To bring the consumer back to their initial utility level (compensate for the change in their purchase power), we need to examine point C, which is also at a G_1level of environmental good consumption but on the U_0 indifference curve. The distance between $B_1$and B_0 (BC) is the maximum WTP for the increase in environmental good. BC is also called the compensating surplus for the rise in the level of environmental good.

The WTA and WTP we mentioned in previous part are grouped with the name "compensating surplus" and are used for the changes that has happened. There is also a further measurement group referred to as "equivalent surplus". Equivalent surplus is used for the change in environmental good when the change will not happen. Thus, equivalent surplus calculates the maximum WTP to prevent a negative change in environmental quality or calculates the maximum willingness to accept for a positive change in environment that will not occur. They are irrelevant to our case and are thus not expanded upon.

According to Freeman et al. (2014), the choice of measurement type depends on the property rights of the scenario (Freeman III, Herriges, & Kling, 2014). If the property rights are defined based on a positive change (i.e., increase in the use of green electricity), then WTP is a suitable method for calculating the value of GOs for respondents. If property rights are based on the first scenario and decreased green electricity purchase, the best approach would be WTA. Currently, at the time of the research, respondents purchase electricity without GOs, which cannot be deemed as green. Thus, respondents are at point A on Figure 3. GOs are some kind of improvement in environmental quality (increase in GE share) which takes respondents to point B. Thus, we choose to calculate the WTP.

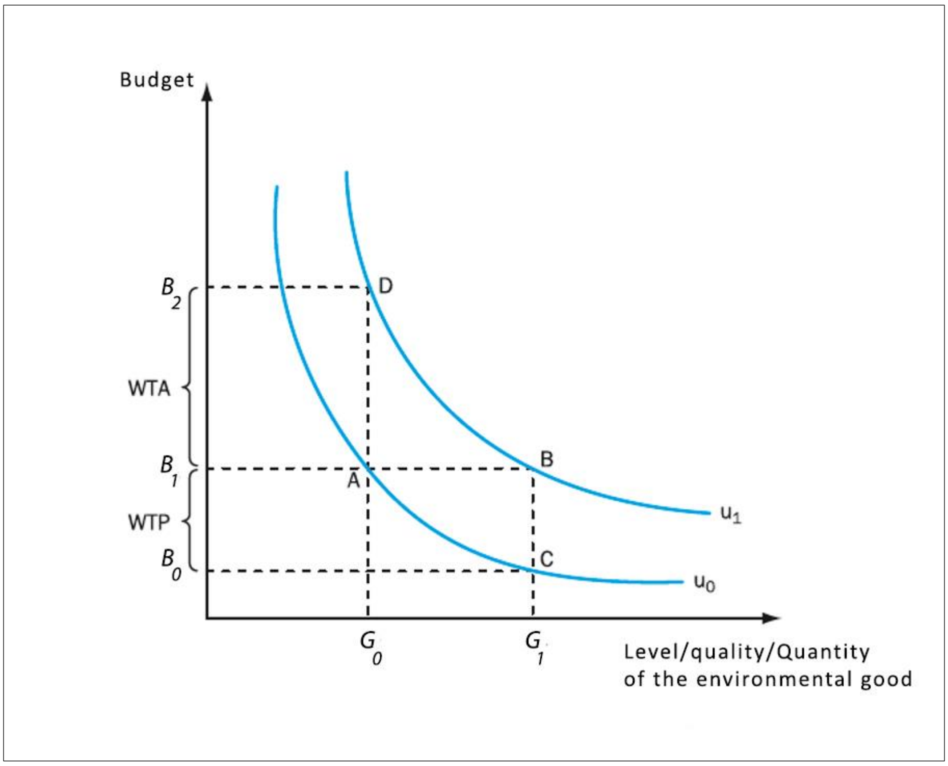

Figure 3. willingness to accept and WTP based on utility status quo

The more detailed reasoning can be explained this way: If the government would distribute GOs free, consumers would move from point A to point B. To calculate the value of GOs to consumers, we needed to take consumers back to their initial utility level (U_0) on point C. Consumers budget difference between points B and C is the WTP for GOs. Therefore, we chose to use a WTP elicitation format and designed the scenario concerning WTP property rights.

3. Literature review

This chapter reviews the previous research conducted on green electricity. A summary of the articles can be seen in Table 1 by the end of chapter. This section attempts to provide an overview of the general worldwide attitudes toward supporting the transition to renewable energy and renewable electricity. These attitudes can be positive or negative. Then, factors affecting WTP for renewable electricity are presented before indicating their monetary values as identified in previous studies. Additionally, the GO system is briefly explored by answering when, why, and how it was introduced to the European power market. Finally, we dive into the situation in Norway concerning businesses' and consumers' attitudes toward and WTP for GOs.

3.1 Attitudes toward renewable energy resources (RES)

In the last decade, there has been a substantial increase in research about attitudes toward and determinants for replacing conventional energy with renewable energy. Sovacool and Ratan (2012) compare the acceptance of wind power between Denmark and India in addition to residential solar panels between Germany and the US. Their findings show three dimensions affecting embracement and acceptance: sociopolitical, community, and market. In other words, if governmental information increases, the general public's awareness will increase, which lead to an increase in investments in renewable energy infrastructure. A relatively high number of published studies (e.g., Vand et al, 2019; Sundt & Rehdanz, 2015; Salmela, 2006) emphasize the importance of government information and public awareness for increasing enthusiasm toward RES.

Murakami, Ida, Tanaka, and Friedman (2015) and Soon and Ahmad (2015) compare attitudes toward RES in North America and Asia. The first group conducted a choice experiment gathering primary data, whereas the latter conducted a meta-analysis including 31 studies. Both papers concluded that the majority of both populations felt positively toward and were willing to support the transition. However, urban residents and North American households seemed to be more supportive than their Asian counterparts. Soon and Ahmad (2015) argue that this is potentially due to differences in terms of knowledge, information, and awareness.

A meta-analysis by Sundt and Rehdanz (2015) reveals that acceptance of renewables depends on the level of information provided to the public about plans, alternatives, and the status quo. Vand et al. (2019) confirm this finding by demonstrating that increased awareness about the issue of non-renewable products by Chinese consumers convinced 97% of them to adopt a positive attitude toward changing their electricity source entirely or partly to green sources.

In Europe, several studies have also investigated this topic. The first attitudinal study from Scandinavia was by Ek (Ek, 2005), who reviewed the case of Swedish wind power. According to her results, the Swedish public has a positive attitude toward wind power, and the "not in my back yard" (NIMBY) hypothesis is not supported. Two years later, Navrud and Grønvik Bråten (Navrud & Grønvik Bråten, 2007) showed similar results about attitudes toward wind power in Norway. In contrast to the Swedish study, they found a NIMBY effect for wind farms. The acceptance among those living in turbine-farm-free regions was much higher than those living next to wind farms. Greece, as a developed country economically affected by crisis since 2009, still showed positive attitudes toward the expansion of renewables, even with a lack of awareness. Based on Ntanos et al. (2018), the economic recession has worked as a motivator for Greek citizens to install cost-effective energy choices reducing household expenses.

One of the only articles presenting a counterargument to previous findings about positive attitudes was by Kowalska-Pyzalska (2017), who concluded that Polish citizens had opposing opinions and low WTP for RES. A significant reason for such a low interest in RES seems to be the lack of people's WTP for a premium over what they already pay, which may have been correlated to the low gross domestic product (GDP) per capita in Poland.

3.2 Willingness to pay (WTP) for green electricity

Wiser et al. (1998) name customer support as an essential factor in expanding renewable generation sources. They state that consumers' support is achieved by purchasing energy produced from green sources (Wiser, Pickle, & Goldman, 1998). Roe et al. (2001) argue that, normally, undifferentiated products have high price sensitivity. However, the impact of adding environmental characteristics to undifferentiated products on customer support is not completely understood. Therefore, it is vital to estimate people's WTP for green energy before supplying it to the market (Roe, Teisl, Levy, & Russell, 2001).

3.2.1 Factors affecting WTP

Many studies conclude that consumers are generally willing to pay a premium for green electricity (Salmela & Varho 2006). Based on several studies (e.g., Sundt & Rehdanz, 2015; Knapp, O'Shaughnessy, Heeter, Mills, & DeCicco, 2020; Kowalska-Pyzalska, 2019; Dogan & Muhammad 2019), age, income, and education are the most significant demographic and financial factors affecting consumers' WTP for green electricity programs. Nonetheless, these factors' significance levels vary by country and study design.

Sundt and Rehdanz (2015) used a meta-analytical approach for 18 studies worldwide to evaluate which factors significantly impacted WTP. Their findings showed higher estimates of WTP when choice experiments were used compared with other study designs. This may seem confusing, partly because Soon and Ahmad (2015) concluded the opposite. Among demographic factors, both articles agreed on income and education being the most significant factors for increasing WTP. Despite these similar findings, with the help of a contingent valuation method, Anna Kowalska-Pyzalska (2019) showed that WTP in Poland decreased with age and increased with income to a higher degree than education. Her findings are in contrast with those of Sundt and Rehdanz (2015), Soon and Ahmad (2015), and Zoric and Hrovatin (2012). All of the mentioned studies were univocal on younger generations having higher levels of willingness to support environmentally friendly products and higher WTP adjusted to purchasing power. Additionally, all reviewed studies argued that increasing awareness and knowledge was key to increasing WTP.

3.2.2 WTP for green electricity

Estimates for WTP for green electricity vary across studies. Roe et al. (2001) showed a WTP of USD 6 per year for every 1% increase in renewable electricity in the consumption mix. On the other hand, many studies present their results as a budget increase in percentage or as an additional cost per selected period. One example of such studies is that by Grilli et al. (2015), which showed that Italian respondents were willing to increase their energy bill by 13%, corresponding to 5.1€ per month, for a 100% renewable energy subscription plan. Using a similar estimation method, Dogan and Muhammad (2019) concluded that the mean WTP per Turkish household was estimated at around USD $1 per month per household.

On average, European countries appear to be positioned at the middle range of estimated WTP for green electricity. The WTP of metropolitan households is 60% higher than the WTP of those living in rural areas. The awareness of people in metropolitan households is assumed to be higher because of their frequent exposure to pro-environmental marketing. Finally, the average estimate of the monthly WTP to shift to RES is USD $7.16 more than what consumers are paying for conventional energy (Soon & Ahmad, 2015).

Navrud and Bråten (2007) conducted a choice experiment that elicited Norwegians' preferences and WTP for various energy sources used for electricity generation and found that Norwegian households had a WTP of 1087 NOK per year if the premium was spent on the expansion of domestic wind power and replacing Danish coal power. On the other hand, expanding hydropower was expressed as a negative WTP of 2036 NOK per year with the same purpose. Similarly, Sundt and Rehdanz (2015) have argued that WTP decreases with the share of hydropower in the national energy mix. One potential explanation might be the extensive use of land for hydropower consumption, leading to it having a more significant environmental impact than other renewables.

In a study from Greece, Ntanos et al. (2018) found WTP to be 26.5€ per quarter per household, which was a moderate increase from the estimated WTP eight years earlier of 16.33€, according to Zografakis et al. (Zografakis et al., 2010). Unexpectedly, 60% of respondents used RES in everyday life, mainly solar water heaters. The authors argued that a connection may exist between the historical economic recession and motivation among citizens to undertake cost-effective energy choices.

On the low end of WTP estimates among European countries, Kowalska-Pyzalska (2019) argued that Polish citizens do not seem to have positive attitudes toward green electricity. The reason is mainly rooted in the low GDP per capita and also a lack of knowledge about RES effects resulting from the state's low level of support and marketing. Consequently, she found the WTP among households to be USD 3.5 per month for a 100% green electricity plan.

As has been shown, the degree of WTP varies between studies. Ma et al. (2015) used a meta-regression analysis to uncover the reason for this difference. They concluded that WTP variations were primarily due to study designs and the type of renewable resource instead of actual differences between respondents' preferences.

3.3 The case of Norway

Thus far, little attention has been paid to the disclosure of GOs in Norway, and only a small amount of literature about Norwegians' attitudes toward GOs exists. We attempt to shed light on the lack of knowledge about the GO system, the WTB, and the WTP for GOs in Norway.

3.3.1 Business views

Aasen et al. (2010) examined the effectiveness of the disclosure scheme to inform and engage businesses to buy green electricity products represented by the GO system. They found that more than half of small- and medium-sized enterprises were interested in the disclosure but not willing to buy GOs. Not a single large company was interested, resulting from a lack of trust in GOs' environmental impact. They simply did not have GOs as their environmental strategy. One reason for these findings was the availability of the disclosure information provided to the respondents as a link on electricity bills. Many of the companies did not open or see the link, which was seen as a failure by the authors. Aasen et al. (2010) therefore suggested using easy-to-access and understandable disclosure of information in future studies. Their recommendation was seriously considered in designing the survey for this paper.

Another weakness in the disclosure efforts in Norway was the lack of specifications regarding the share of electricity matching the export of Norwegian GOs. This share of electricity was disclosed simply as "unknown origin." Doubts and a lack of trust were observed among respondents, weakening the effectiveness of educating and neutralizing attitudes toward GOs.

Finally, respondents expressed a general distrust of the GO system. Because of the nearly 100% share of renewable electricity produced in Norway, they did not see any potential increase in utility in promoting a green product to the Norwegian power market, primarily if it resulted in additional income only for the producers. They believed that energy savings should be focused upon instead.

3.3.2 Household views

Regarding the attitudes and awareness of Norwegian households toward GOs, to the best of our knowledge, there has been only one study attempting to investigate this subject. In 2013, Tanja Winther and Torgeir Ericson published a study in collaboration with a Norwegian power company. Respondents were divided into five groups of 1000 receiving different types of information about the certificate. The disclosure was framed differently for each group to evaluate the difference of perception. Highly similar to the findings of Aasen et al. (2010), respondents showed low interest in reading the information disclosure and a challenging distrust of electricity suppliers, who were believed to be nothing other than profit-maximizing firms. With such opinions, most customers assumed all information provided would be promotional, hence their negative attitude toward the whole system.

Both businesses and households shared a similar confusion about the information disclosure, even as far as explicitly stating it was unreliable. Considering Norwegians' awareness about their country's 98% renewable electricity production, it is understandable that consumers found it hard to accept that they would need to purchase certificates to obtain renewable electricity (Winther & Ericson, 2013). They recognize their electricity to be renewable as is, which is true at least nominally, but not financially, due to Directive 2009/28/EC. Concerning this matter, the authors suggested that Norwegian authorities:

1. Publish easier-to-understand information about GOs and their role in the electricity market.
2. Improve the promotion campaigns of renewable programs (Winther & Ericson, 2013).

Furthermore, Winther and Ericson expressed concerns about the GO system failing because of the double-counting phenomenon. The problem stems from foreign consumers purchasing Norwegian GOs and claiming their electricity consumption to be renewable, while Norwegian consumers having strong awareness about their nominally renewable electricity consumption results in them not buying GOs. This phenomenon still seems to play a role today, given the low GO demand among Norwegians.

3.4 Our contribution

The GO concept is very new, and GO-related literature is in its infancy. Therefore, more research on this subject is needed. In addition, most previous studies asked people about their WTP for green electricity in different ways. However, they have not introduced a vehicle that ensures the greenness of electricity. Thus, introducing GOs to respondents could bridge this gap and provide more tangibility to the concept of buying green electricity.

Table 1. Summary of the literatures reviewed in chapter 3

#	Article	Research Period	Data Gathering Method	Sample Size	Study Location	Survey type	Research Goal	Main Findings
1	Aasen et al (2010)	2007	Qualitative	18	Norway	Face to face	Attitudes towards GO	- Small and medium size firms are interested but not willing to pay for GOs. - Larger firms are not even interested and distrust to system.
2	Dogan & Muhammad (2019)	2017	Contingent Valuation	2500	Turkey	Face to face interviews	WTP and factors affecting WTP	- Positive effects from income, membership in environmental groups, home ownership. Age, education and females have negative effects.
3	Ek Kristina (2005)	2002	Choice experiment	547	Sweden	Mail	Attitudes towards wind power	- Positive attitudes towards wind power. - Negative effect from age and income
4	Grilli et al (2015)	2014	Contingent Valuation	74	Italy	Face to face	WTP estimates	- 5.1€ per month per household (13% increase in e-bill)
5	Knapp et. al (2020)	2013-2017	Secondary data from US NREL and University of Michigan	4122 - 7827	USA	Phone	Factors affecting WTP	- Income, homeownership and home value have largest effect on WTP
6	Kolb et al (2020)	2014-2018	Secondary data on complete historic auctions from "Day Ahead Spot"	N.A.	Germany	N.A.	RES' impact on electricity prices	- 2.89ct/kWh – 8.89 ct/kWh price reduction. - €40 Billions national savings
7	Kowalska-Pyzalska (2017)	2016	Simple agent-based model	151	Poland	Internet-based	Attitudes towards green electricity	- Negative attitude - Low WTP.
8	Kowlaska-Pyzalska (2019)	2017	Contingent Valuation	502	Poland	Phone	WTP and factors affecting WTP	- 3.5 USD WTP per month per household. - Lack of knowledge. - Age, income, education and environment attitudes have largest effects on WTP.

9	Ma et al (2015)	1999-2013	Meta-regression	29 studies	World	N.A.	Variations in WTP	- Study design seems to be the largest cause for variations in WTP.
10	Murakami et. al (2015)	2015	Choice experiment	4202	USA Japan	Internet-based	WTP nuclear & RES	- USA: 0.71$ and Japan: 0.31$ per month for 1% increase in RES use. - General positive attitudes in both countries.
11	Navrud & Bråten (2007)	2005	Choice Experiment	189	Norway	Face to face interviews	WTP and preferences	- Negative WTP for expanding hydropower plants. - Positive WTP for windpower. - NIMBY-effect for windfarms.
12	Ntanos et. al (2018)	2016	Contingent Valuation Method	400	Greece	Face to face interviews	WTP RES and attitudes	- 26.5 € per quarter for 10% increase RES share.
13	Roe et. al (2001)	2000	Choice Experiment	835	USA	Face to face	WTP estimate	- 6$ per year per 1% increase in renewable electricity use
14	Salmela & Varho (2006)	2002-2003	Qualitative	25	Finland	Interviews	Barriers for GE adoption	- Lack of information exposure among the general public.
15	Soon & Ahmad (2015)	1996-2011	Meta-Regression	30 studies	Global	N.A.	WTP and factors affecting WTP	- 7.16 $ per year per household globally. - General positive attitudes.
16	Sovacool & Ratan (2012)	2004-2009	Qualitative	149	USA, Denmark, Germany, Indonesia	Interviews	Factors affecting acceptance of GE	- Socio-political (Information) increasing market (investments) and increasing community (attitudes and image).
17	Sundt & Rehdanz (2015)	1996-2013	Meta-regression	25 studies	Global	N.A.	WTP and factors affecting WTP	- General positive attitudes. - Information is necessary to increase WTP. - Negative correlation between hydropower share and WTP. - Mean avg WTP per household per month per continent: 14.5$ Europe, 15.5$ Americas, 7.5$ Asia.

18	Vand et. al (2019)	2017	Survey Containing Open Questions	232	China	Internet-based	Attitudes towards GE	- Increasing awareness convinced 97% to use GE.
19	Winther & Ericsson (2013)	2009-2011	Choice Experiment	5000	Norway	Mail	Disclosure effect on WTP	- Lack of interest and low WTP due to incomprehensible information.
20	Zografakis et. al (2010)	2006	Contingent Valuation	1440	Greece	Interviews	WTP and acceptance for RES	- 16.33€ per quarter per household. - Income, residence size, information exposure and awareness have largest positive effect.
21	Zoric & Hrovatin (2012)	2008	Choice Experiment	450	Slovenia	Internet-based and Field	Attitudes towards RES and factors	- Age, household income, education and awareness have largest effect on attitudes.

4. Methodology

In this section, we elaborate upon the available data gathering methods for environmental goods. Then, our method of work and the reasons behind our choice of method for data gathering are discussed. Lastly, the steps for survey design are presented.

Typically, an environmental product's actual value cannot be calculated directly, and proxies are needed. Proxies are especially useful in the absence of a formal market. Even in some cases with a formal market, the real value of a product for people, and subsequently the customer surplus, is unknown. Two main methods used as a proxy to calculate the valuations are revealed preferences (RP) and stated preferences (SP) (Daniel Norton, Dip, & Hynes, 2018).

The RP method's primary use is when the real value of a resource or good can be estimated from individuals' actual behavior. The drawback of the RP method is its inability to calculate non-use values. The SP method, on the other hand, is helpful when choices cannot be observed. Moreover, it can calculate non-use values. The basis of SP valuation is usually hypothetical markets and scenarios (Perman et al., 2011).

The main RP methods are the travel cost method, hedonic pricing, avoided costs, and production function. The SP methods are contingent valuation (CV) and choice experiment (CE) (Daniel Norton et al., 2018). Based on Bateman et al. (2002), CV is most useful when the total WTP for a good or service is needed. The authors further argue that it is best to use CEs when the value of a product's attributes is required.

As previously mentioned in Section 2.2, GOs are highly nested with non-use values. Even though the electricity received with GOs is not different from the electricity received with without GOs, the electricity purchased without GOs cannot be claimed to be "green electricity." Thus, non-use values are a prominent component of the concept of GOs. By purchasing GOs, consumers do not obtain any different physical product or quality. They only receive the assurance of buying green electricity, and subsequently, they can feel that they are helping the environment. Furthermore, obtaining GOs will escalate the country's green electricity purchase.

Moreover, the GO market is still premature, and Norway has a low GO purchase ratio (around 9% of the whole electricity in the country is purchased with GOs (NVE, n.d., data for year 2019)). This low demand makes the RP method an unsuitable option for studying GOs. Thus, we chose the SP method for this research. Among the available SP methods, we have selected the CV method because of the attributes of GOs. When a product has several attributes such as size, quality, boxing, etc. the most suitable method is CE method. However, GOs do not contain several attributes. They only guarantee 100% renewable electricity. Therefore CV method is most suitable method.

4.1 Contingent valuation

The survey method used for this research was the contingent valuation method (CVM). In CV surveys, the value of a change in an environmental good's quantity or quality is elicited. The first use of the CVM was in Davis (1963), and from 1975, use of the CV method began to increase; today, 400–500 studies are performed using this method each year (Carson & Hanemann, 2005). Perman et al. (2011) state that CV is the most commonly used method in environmental studies (Perman et al., 2011).

In CV surveys, the change in environmental goods is described through a hypothetical scenario in which the intended change, the market, and a payment vehicle are introduced. The scenario presents the status quo level, explains the target levels of environmental good, and describes how the change is possible. The main contents of the constructed market are the feasibility and timing of the plan. Lastly, the payment vehicle introduces how the money will be gathered (voluntarily or coercively) (Bateman et al., 2002). It should be noted that the former is not incentive compatible (Carson & Groves, 2007). The payment vehicle should specify whether the payment is on an individual or household basis as well as the intervals between payments.

The CV surveys capture the value of change in two ways: WTP and WTA. WTP is the amount of money people would pay for an improvement in environmental goods. WTA is the monetary value that people would need as compensation for a deterioration in the quality or quantity of ecological goods. Theories show that there is a slight disparity between WTP and WTA. However, based on empirical research, the divergence is higher. Therefore, it is crucial to choose the proper method. As Perman et al. (2011) have argued, WTP is the most suitable method for positive environmental changes (Bateman et al., 2002; Perman et al., 2011). The purchase of GOs leads to an increased level of green electricity purchase for the entire country. Thus, we have used WTP instead of WTA. The scenario was also designed with this point in mind.

In past decades, several formats for elicitation of WTP have been developed and used. Today, the most common payment methods are discrete choice and payment cards. Different elicitation formats, their benefits and drawbacks, and the chosen elicitation form for our survey are further discussed in this chapter.

4.2 Survey design

Our survey was mainly designed based on the general procedures and guidelines provided by Bateman et al. (2002) and Alberini and Kahn (2006) and the recommendation of the National Oceanic and Atmospheric Administration (NOAA) written by Arrow et al. (1993). Aberini and Kahn (2006) strongly advised using similar questionnaires for inspiration and using their experiences during the survey design process. They emphasized that previous studies should be used only for inspirational purposes. Each study area is different, and CV surveys must be carefully tailored to their specific area. Environmental, political, and social situations in each country, region, and city are different and should be considered in the design (Tyrväinen, 2001).

To design our survey, we took as much inspiration from previous surveys as possible. Due to the lack of GO-related studies, we developed the majority of our survey from scratch. However, several surveys, such as those used by Bae and Rishi (2018), Muhammad et al. (2021), and Vand et al. (2019), were inspirational for ours.

4.2.1 Preliminary questions

CV designs usually begin with preliminary questions about the respondent's behavior toward the environment. These questions help develop scenarios and typically target the environment in general and respondents' behavior toward the ecosystem. In line with the literature, we began with simple demographic questions such as age and location, and after five questions, we moved to behavioral questions. In this manner, we could make respondents comfortable with the survey and then proceed to more complex questions.

Attitudinal or preliminary questions play the role of a warm-up for respondents before moving to complex problems. They are relatively easy to answer, and respondents feel comfortable answering them. Furthermore, they are helpful in the analysis of WTP to validate answers. A person who is not concerned about the environment is expected to have lower WTP; if they show a high WTP, then the answer should be treated with caution.

For the first part, the questions were mainly about non-sensitive demographic factors, respondents' attitudes toward the environment, their knowledge of the intended good, their understanding of green electricity, and their social media behavior. The complete survey is attached in the appendices for reference.

4.2.2 Scenario design

Based on Alberini et al. (2006), a plausible and understandable scenario should be brief, pragmatic, and straightforward (Alberini & Kahn, 2006). This way, respondents can deliver reliable responses even though they have not experienced certain aspects of the scenario (Mitchell & Carson, 1989). Alberini et al. (2006) also noted that the scenario should explicitly define the product being valued. They further explained that the scenario should allow for adding different variables to create multiple versions.

To create the scenario for this survey, we initially attempted to arouse respondents' curiosity by demonstrating the difference between green electricity production and purchase. The GO is a complicated concept. To make it more understandable for readers, we used a simplified concept by creating an example and using a picture. Furthermore, the reason behind GOs was explained briefly.

Our approach for the scenario was to keep it as brief and straightforward as possible while not omitting any necessary information. Thus, we first noted all the necessary information and then designed the scenario based on it. Afterward, we wrote several alternatives for each paragraph to consider how we could make them simpler or shorter. Finally, to ensure that the scenario was realistic, no necessary information was missing, and it did not contain any excessive information, it was reviewed by an expert from Energi Norge, a Norwegian national non-profit electricity organization. Then, the scenario was rewritten based on the feedback.

4.2.3 Payment vehicle

As a standard procedure of the CVM, the survey or scenario should introduce a payment method for the resource allocation change called a payment vehicle. Payment vehicles vary based on the good's nature; however, payment on bills, increase in prices, and taxes are the most common types. The determinants of a suitable payment vehicle are their degree of being realistic, their neutrality, and their believability. For instance, a payment vehicle with the mentioned characteristics for a change in the quality of drinking would be billing, while billing would not be suitable for preservation of a lake.

Furthermore, Bateman et al. (2002) have categorized payment vehicles into two groups, coercive and voluntary. They argue that the former leads to freeriding; meaning that people try to demonstrate a high WTP in the survey while not intending to pay such an amount in real life. The latter leads to an intentional decrease in stated WTP, since people think their answer is the baseline for pricing or taxation. Therefore, the authors suggested using the actual payment method that will be used in reality. A payment vehicle that is not precisely chosen is argued by Alberini et al. (2006) to lead to bias in the WTP estimation.

The payment vehicle for this research was chosen in line with the factors mentioned above. Purchasing the GOs is a voluntary act through the electricity provider. Therefore, taxation or an increase in electricity price were not suitable choices. Paying through electricity bills was used as our method. Moreover, since GOs affect households' electricity labels on top of the country's residual mix, we believed that the intention to freeride would be reduced. Freeriding is observable with public goods such as road pavement or park construction.

4.2.4 Valuation question (elicitation format)

After the scenario has been presented, the main question is respondents' WTP or WTA. Several methods have been developed for this purpose. The first elicitation format to be used in CV was open-ended questions; however, in the early 1990s, it was changed due to the NOAA's 1993 recommendation. The NOAA's suggestion was a simple dichotomous choice, but it soon attracted much criticism (Spash, 2008). The main methods for asking the bidding question are 1) open-ended questions, 2) bidding games, 3) payment cards, 4) single-bounded dichotomous choices, and 5) double-bounded dichotomous choices. These types are presented shortly in the next two paragraphs.

Based on Bateman (2002), the elicitation format must have a low non-response rate, which is the main problem with open-ended questions. Furthermore, the high outlier rate makes the open-ended question unpopular among researchers. The bidding game method begins with a price, raises the number for each "yes" response, and lowers it for each "no" response until the researcher finds the respondent's WTP. The main problems with this method are the yea-saying and anchoring effects (Bateman et al., 2002).

Single- or double-bounded dichotomous choices are more realistic. In the real market, people face a defined price and choose to pay or not. The main positive points of these two methods are reducing non-respondents and avoiding outliers; nevertheless, they are relatively inefficient. A single-bounded dichotomous choice provides shallow information about the WTP since it only asks one question: "Are you willing to pay X amount?" and requires a large sample of at least 700–800 respondents at its lowest. The double-bounded dichotomous choice asks a follow-up question of "If Yes/No, how much is your highest WTP?" Even though it provides more information, it faces an anchoring effect based on the first amount provided (Bateman et al., 2002).

The payment card (PC) option reduces the problems of dichotomous choice. It provides respondents with a list of possible options and asks them to choose the highest amount they are willing to pay. By using this method, respondents experience the relative place of bids compared with other expenses. This method reduces outliers and non-respondents as well as the yea-saying and anchoring biases. The drawback of this method is that it cannot be used for phone interviews (Bateman et al., 2002).

For this thesis, the PC elicitation format was chosen. The main advantages of the PC in our study can be defined as follows. First, it provides the highest accurate WTP value directly from the original data. Second, the PC respondents tend to state more realistic and confident WTPs compared with other methods (Ready et al., 2001). Finally, the PC approach estimates more robust WTPs than the dichotomous choice method (Ready et al., 2001).

In the WTP question, we took a two-step approach. First, we asked if the respondent was interested in buying GOs, and then we asked about their WTP. This way, no protest vote would decrease the actual WTP. Protesters would answer "no," and they would be distinguished from respondents with zero WTP in the follow-up questions. Protest votes are the respondents with higher than 0 WTP who answered zero because of protesting against government policies or subjects not related to the main questions. They decrease the average WTP and consequently cause a bias in estimated value of the environmental good.

The WTP question in the survey used a percentage of the electricity bill instead of the monetary value of GOs for respondents. The reason behind this design is the nature of GOs. The customers' payment for the GO is based on their electricity consumption. GOs are issued for each 1 MWh, and most people do not use precisely one MWh in a month. Asking the WTP for GOs without clarifying the MWh, KWh, or an average household's consumption is likely to create bias. On the other hand, describing the mentioned subjects would add to the scenario's length and complexity. Therefore, we designed the question as a percentage of the electricity bill.

As Kowalska-Pyzalska's (2017) research showed, respondents are willing to pay between 0% to 25% of their electricity bills. Therefore, the options for the card were chosen to be within this interval. Furthermore, the 25% interval is already a high amount based on the market price of GOs. If someone is willing to pay 25%, they are paying as high as 5 times of a GO price. Therefore, closed our choice intervals at 25%. However, if someone was keen on paying more, they could indicate their WTP of more than 25% through the more than 25% option.

According to Snoeck (2019), the price of GOs for industrial users is 3–4 Euros (equivalent to about 30–40 NOK based on exchange rates on April 13, 2021), less than 5% of the price of 1 MWh electricity in Norway. SSB (Statistisk Sentralbyrå Norge) reports the average electricity price for each KWh in Norway to be 0.84 NOK, making each MWh 840 NOK («2021-02-15», n.d.). Therefore, the price of GOs was set to be about 5% of the electricity price.

The options for the question were inspired by an example named EFTEC in Bateman et al., (2002) using an exponential increase. The increments start at 2% until 10% and then are raised by 2.5% increments until they reach 25%. As was mentioned before, we also added an alternative of choosing more than 25% as an open-ended question at the end of our payment card.

4.2.5 Substitutes and other uses for money

Economic theory hypothesizes that there will be a significant effect from income, budget constraints, and complement or substitute goods on respondents' surplus and presumes it essential that respondents consider these factors (Bateman & Mawby, 2004). In line with this theory, the NOAA (1993) also argues for the importance of reminding respondents about their budget constraints and other uses for the money spent on the good being studied.

However, Loomis et al. (1994) studied the effect of a budget reminder, and their results contradicted the NOAA's suggestion. Bateman et al. (2002), therefore, argue that there are uncertainties nested with the impact of highlighting the budget constraint. Thus, it is not strictly necessary to use it. Our survey design notifies respondents about their budget constraints and the possibility of using the money on other substitutes. However, we did not devote a question to asking respondents to calculate their budget constraints.

4.2.6 Demographics

As most CV surveys do, we also added demographic questions. These responses can be of use in three ways. First, they help identify non-legitimate answers. Based on Bateman et al. (2002), some theories assist researchers in their analysis. For instance, higher income leads to higher WTP. A respondent with a low income is expected to have a low WTP. If they show high WTP, then their response needs more consideration. Second, demographic questions help identify how WTP varies across different groups. Third, the demographic questions can be of great help for checking whether the sample was sufficiently representative of the population (Bateman et al., 2002).

Our survey's demographic questions targeted respondents' general knowledge of the studied subject, their living environment, and their technology use and used typical socioeconomic questions such as income and household size. We attempted not to focus on socioeconomic questions in one part of survey to prevent respondent fatigue. Therefore, we divided these questions into two groups, sensitive and non-sensitive. We asked the non-sensitive questions in the preliminary question section and the sensitive questions, such as income, at the end of the survey.

5. Data

This section describes the data gathering process, followed by the descriptive results, and in the next chapter, we analyze the data. The survey was designed based on the CVM, and a pilot study preceded the primary survey. The pilot was conducted among friends and families to confirm if it was understandable.

5.1 Survey and data collection

Between April 15th–21st, 2021, the professional polling agency Ipsos published the survey among its panelists in Norway to obtain a sample representing all regions in Norway. Respondents were selected to be at least 18 years old and should have paid electricity bills themselves, either directly or indirectly through rent. Respondents living with their parents could not continue the survey.

The English version of the survey is available in Attachment 5. The main goal of the survey design was to present a questionnaire that could help explain the lack of interest and demand for GOs in Norway. As covered in the literature, many countries fail to disclose understandable information about green electricity systems, resulting in a lack of knowledge and low WTP among consumers (Sundt & Rehdanz, 2015).

The questionnaire was published in Norwegian and covered several topics, such as attitudes toward climate change, behaviors related to the environment, knowledge about the Norwegian electricity market and production, respondents' preferred renewable energy source, their satisfaction with their electricity provider, and demographics.

Respondents who showed no interest in buying GOs were asked a follow-up question asking their reason for such a choice. The follow-up question was later used to spot protest answers. Protest answers are not helpful in such studies, since the product's real value for the respondent cannot be calculated. Some protest answers in our case were, for instance, "The Norwegian provider should take more responsibility and not transfer the burden of fighting climate change to customers" or "I do not like how the government approached this topic." After excluding all of the unqualified answers, we were left with a sample size of 678 out of 700 initial respondents. Among these 678 responses, we had 15 missing value for town size. Based on the size of the missing values, we decided to impute them with "mice method" to prevent data loss.

5.2 Survey variables

The following table presents the variables observed during the survey and variables used in the analysis. Some variables in the table are original variables from the survey, and some were created based on the original variables. The original variables of the survey are specified with an asterisk. In the column "Type," "C" denotes a categorical variable, "O" denotes an ordinal variable, "B" denotes binary, and "N" denotes numeric or continuous.

In the table below, some of the variables have subsets specified with the numbers 2 and 3. Such variables were created by the authors for the purposes of analysis. The reason behind the creation of these variables was the high number of categorical and ordinal variables leading to a loss of degrees of freedom. To manage this issue, we created binary variables for ordinal variables.

Creating binary variables is not always straightforward, as there is no easy method to show which group respondents answering 3 in a 5-point Likert scale belong to. To address this problem, we created two subsets for each original variable and numbered them as "2" and "3." One subset groups variables as responses of 1, 2, and 3 versus responses of 4 and 5, while the other groups variables as responses of 1 and 2 versus responses of 3, 4, and 5. Since we use several models with different dependent variables (DVs), this method allows us to test the effects of different groups on each DV separately. For instance, the effect of people who answered "3" to the question on environmental care might have a significant effect on one DV but not have a significant effect on another DV.

Table 2. Variables in the dataset and used in the models

Variable	Description	Type	Components
*Age	Age	C	From 18 to 92
Age_group	Age, grouped in intervals of 5 ye ars	O	18–25, 26–30, 31–35, …, 76+
*Gender	Gender	C	0 = Male, 1 = Female
*Location 1	Geographical location	C	North and Trøndelag, Westside, Agder and Rogaland, Southeast, Oslo and its vicinity
*Location 2	Geographical location	C	North, South, East except Oslo, West, Oslo
*Town_size	Size of town	C	Rural areas, cities or large urban areas, towns/suburbs/small urban area

*Educ	Education level	O	Starting from primary school to higher than master's
Higher_educ	Binary variable for having finished higher education	B	0 = Not having a bachelor's degree 1 = Having a bachelor's degree or higher
*Dwelling	Type of house respondent lives in	C	Apartment, House, Collective, Farm, Terraced House
*Family number	A range of possible family sizes	N	1 to 6+
Single	Whether the person is single	B	0 = No, 1 = Yes
Child	Whether the person has a child	B	0 = No, 1 = Yes
*Heating_type	Main heating source of the hous e	C	
*Who_pays	Person responsible for electricity bill payment	C	1 = Myself 2 = My partner 3 = Included in the rent
Who_pays2	Binary subset of Who_pays	B	0 = Not the respondent 1 = Respondent
Male_pays_bill	If the person who pays the bill is male	B	0 = Female pays/unknown 1 = Male pays the bill
*More_invst_on_environment	If government should invest more in reducing GHG emissions	O	5-point Likert scale (1 = completely disagree, 5 = completely agree)
More_invst_on_environment2	A binary subset of More_ invst_on_environment	B	0 = Likert levels 1 and 2 (not more effort) 1 = Likert levels 3, 4, and 5 (more effort)
More_invst_on_environment3	A binary subset of More_ invst_on_environment	B	0 = Likert levels 1, 2, and 3 (not more effort) 1 = Likert levels 4 and 5 (more effort)
*Econ_vs_environment	If economic growth is more important than fighting climate change	O	5-point Likert scale (1 = completely disagree, 5 = completely agree)
Econ_vs_environment2	A binary subset of Econ_vs_environment	B	0 = Environment is more important (levels 1, 2, and 3) 1 = Economy is more important (levels 4 and 5)
Econ_vs_environment3	A binary subset of Econ_vs_environment	B	0 = Environment is more important (levels 1 and 2) 1 = Economy is more important (levels 3, 4, and 5)
*Environment_care	Being concerned about environment and climate change	O	5-point Likert scale (1 = completely disagree, 5 = completely agree)
Environment_care2	A binary subset of Environment_care	B	0 = Likert levels 1 and 2 (Do not care) 1 = Likert levels 3, 4, and 5 (Care)
Environment_care3	A binary subset of Environment_care	B	0 = Likert levels 1, 2, and 3 (Do not care) 1 = Likert levels 4 and 5 (Care)
*Using_disposables	Using disposable products	O	5-point Likert scale (1 = completely disagree, 5 = completely agree)
Using_disposables 2	A binary subset of Using_disposables	B	0 = Use (level 4 and 5) 1 = Do not use + middle group (levels 1, 2, and 3)
Using_disposables3	A binary subset of Using_disposables	B	0 = Use + middle group (levels 3, 4, and 5) 1 = Do not use (levels 1 and 2)

*Trash_sort	Sorting trash	O	4-point Likert scale (1 = always)
Trash_sort2	A binary subset of Trash_sort	B	0 = Do not sort, 1 = Sort
*Socmed_share	Sharing ideas on social media	O	5-point Likert scale (1 = never, 5 = always)
Socmed_share2	A binary subset of Socmed_share	B	0 = Do not share (levels 1 and 2) 1 = Share (levels 3, 4, and 5)
Socmed_share3	A binary subset of Socmed_share	B	0 = Do not share (levels 1, 2, and 3) 1 = Share (levels 4 and 5)
*Socmed_follow	Following environmental pages on social media	C	0 = Not on social media 1 = Do not follow 2 = Follow
Socmed_follow2	A binary subset of Socmed_flw	B	0 = Not on social media or do not follow 1 = Follow
*Checking_el_bill	Checking electricity bill	O	5-point Likert scale (1 = never, 5 = always)
Checking_el_bill2	A binary subset of Checking_el_bill	B	0 = Never or rarely 1 = Occasionally, mostly, and always
Checking_el_bill3	A binary subset of Checking_el_bill	B	0 = Never or rarely, occasionally 1 = Mostly or always
*GE_knowledge	Knowledge of Norway's GE pr oduction	B	0 = Not knowledgeable 1 = Knowledgeable
*Car_gasoline	Having a conventional car	B	0 = No, 1 = Yes
*Car_electric	Having an electric car	B	0 = No, 1 = Yes
*Car_EL_or_hybrid	Having a hybrid or electric car	B	0 = No, 1 = Yes
*GO_knowledge	Having prior knowledge about GOs	B	0 = No, 1 = Yes
*Elec_reduction	Endeavor to reduce electricity consumption	O	5-point Likert scale + I don't know (1 = a lot, 5 = no effort, 6 = I don't know)
Elec_reduction2	A binary subset of Elec_reduction	B	0 = No effort (levels 3, 4, 5, and 6) 1 = Reduce actively (levels 1 and 2)
Elec_reduction3	A binary subset of Elec_reduction	B	0 = No effort (levels 4, 5, and 6) 1 = Reduce actively (levels 1, 2, and 3)
*Bill_burden	How much of a burden electrici ty bill is	O	5-point Likert scale + I don't know (1 = a lot, 5 = nothing, 6 = I don't know)
Bill_burden2	A binary subset of Bill_burden	B	0 = No burden (levels 3, 4, 5, and 6) 1 = Burdensome (levels 1 and 2)
*Elec_bill_range	Interval of electricity price	O	9 options from less than 500 to +3000 NOK, and I don't know
Elec_bill_avg	The midpoint of every interval	N	
*GO_buy	Willingness to buy GOs	B	0 = No, 1 = Yes
*GE_type	Preferred renewable source for GO (only asked from GO_buy = 1)	C	6 renewable sources 1 gray source (nuclear)

*WTP	WTP	O	11 options from 2% to more than 25%
*Provider_sat	Satisfaction with electricity provider	O	5-point Likert scale (5 = completely satisfied, 1 = completely unsatisfied)
Provider_sat2	A binary subset of Provider_sat	B	0 = Not satisfied (levels 1 and 2) 1 = Satisfied (levels 3, 4, and 5)
Provider_sat3	A binary subset of Provider_sat	B	0 = Not satisfied (levels 1, 2, and 3) 1 = Satisfied (levels 4 and 5)
*Employment	Respondent's employment status	C	7 different variables
*Income	Yearly income of the responden t's household	O	7 options from less than 100k NOK to + 2 million NOK
Income_avg	Midpoints of income intervals	N	
L_WTP	Lower intervals of WTP (for interval regression)	O	
U_WTP	Higher intervals of WTP (for interval regression)	O	

5.3 Demographics and socioeconomic status

Comparing the average of respondents' demographic and socioeconomic characteristics can provide an overview of the robustness of the sample as far as whether it is a sufficient representation of the intended population. The population of interest was Norway's residents who were over 18 years old. The population's data was retrieved from the central bureau of statistics in Norway SSB ("2021-02-15," n.d). The results of the comparison are summarized in Table 3.

As shown in Table 3, our population sample was an adequate representation of the Norwegian population. Gender and age, represented in Table 3, were well balanced, with 48% of the respondents being male and 52% female. A binomial test done on the gender failed to reject the null hypothesis of no significant difference between the sample and the population's percentage of women. This means that there was no significant difference between our sample's female respondents and the population. The sample's age was consistent with the population in most groups, except for a 6% difference in the age group of 35–44 years. Similarly to the Norwegian population, our respondents were well distributed around the country, with the highest share of 50% in East Norway.

The average household income in the sample was 718,000 NOK, which is higher than the average yearly income in Norway. The mean revenue was estimated based on the midpoint of the range respondents chose. Similarly, respondents' education was also higher than the average in Norwegian society. Based on national statistics, this was almost twice as high as the actual situation in Norway, where in 2019, higher-educated citizens represented only 34% of the population (SSB, 2020). The result of these higher means in the sample might result in a higher WTP than the actual WTP of society.

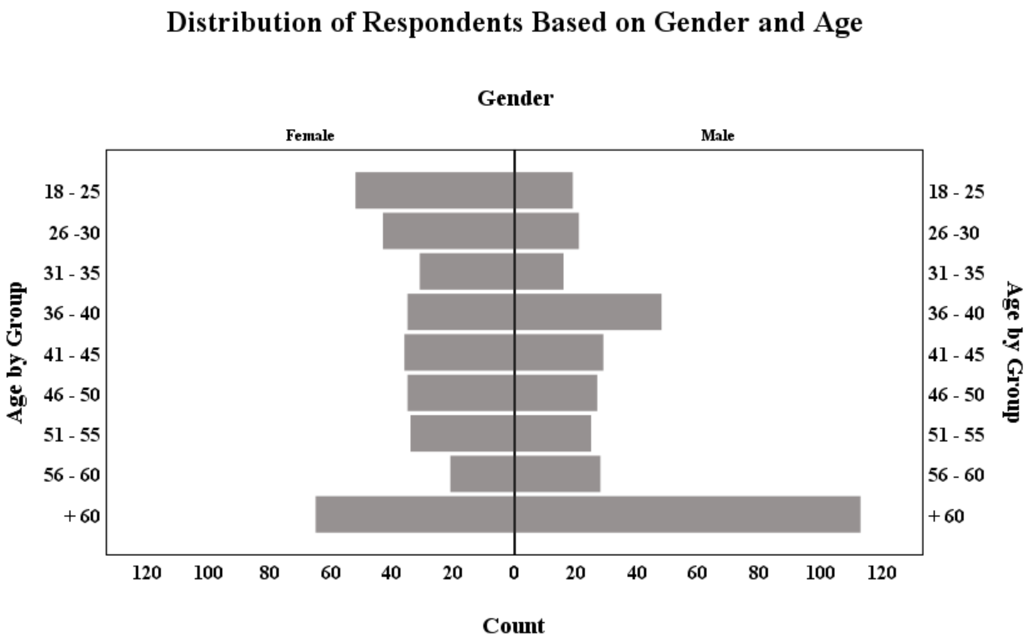

Figure 4. Respondents' distribution based on gender and age

Table 3. Comparison of sample and population's demographics

Variable		Sample	Population
Gender			
	Male	48.1%	50.2%
	Female	51.9%	49.8%
Income			
	Average household income	718,000	585,000
Age			
	18–24	8.1%	10.9%
	25–34	16.1%	17.5%
	35–44	22.5%	16.5%

	45–54	18.4%	17.4%
	55–64	12.6%	15.2%
	65–74	14.5%	12.6%
	75+	7.8%	9.9%
Education			
	Elementary school (Ungdomskole)	5.8%	25%
	High school (Videregåendeskole)	32.7%	37%
	Bachelor	37%	24%
	Master/Ph.D.	22%	10%
	Other	1.2%	4%
Geographical			
	North Norway	9.7%	9.1%
	West Norway (plus Agder)	22.9%	26%
	East Norway (except Oslo)	40.9%	38%
	Mid-Norway	14%	13.7%
	Oslo region	13%	13.2%

Regarding employment status, half of the respondents were unemployed, students, part-time workers, or retired, while the other half was working full time, including 3% who were temporarily laid off due to the COVID-19 pandemic (see Table 4).

The majority, 88%, lived alone or with a partner in a house or an apartment. Households of three or more persons categorized as families accounted for 30% of the sample. Among the answers, 79% of respondents had at least one car, with the following distribution for the type of car: 79% had a conventional car, 16% had an electric vehicle, and 17 % had a hybrid vehicle. The people who had either an electric or hybrid car comprised 31% of the population. Note that people could have more than one car; therefore, the percentages would not add up to 100.

Table 4. Respondents' employment status

Employment Status	Percentage
Full-time job	46.61%
Part-time job	9.29%
Temporarily laid off because of COVID-19	2.80%
Student	7.52%
Unemployed	12.39%
Pensioner	21.39%

5.4 Environmental attitudes and behavior

We asked our respondents to choose a number between 1 and 5, with 1 corresponding to "I do not agree at all" and 5 to "I totally agree," for the following four statements:

1. The government should put in more effort to reduce greenhouse gas emissions.
2. Economic development is more important than the challenges of climate change.
3. I am concerned about climate change.
4. I use disposable products.

The great majority agreed or completely agreed that the Norwegian government should put in more effort to reduce GHG emissions. However, the average agreement for statement 2 was in the middle range, slightly weighted toward supporting climate change rather than economic development. Results from statement 4 concerning the use of disposable products were very similar to those for statement 2. Additionally, based on the data, 3.63% claimed to be concerned or very concerned about climate change.

Sorting is common in Norway, as 90% of respondents sort most or all of their leftovers. Only 1% of respondents responded that they did not sort their trash. Finally, when respondents were asked if they were trying to reduce their electricity consumption, 74% claimed to do so to a high or very high degree, and only 1% answered "not at all." Among the respondents, 40%

claimed that the price they were paying for electricity was not a burden, while 21% said it was a minor burden, and the same amount answered that it was somewhat burdensome.

5.4.1 Social media

In the literature, there are not any papers showing the effects of social media on attitudes and WTP for environmental goods. Therefore, we implemented this improvised social experiment to check if it would be possible to discover any factors of significance toward WTP for GOs. Results show an exceptionally high share, with 91% of respondents being subscribed to social media. Among these, only 37% claimed to follow any pages or groups promoting pro-environmental information. Cumulatively, 85% of respondents showed low interest in sharing their ideas and behavior on social media, with a mode of “I rarely share something.”

5.5 Electricity characteristics

5.5.1 Awareness and budget

Most of our respondents (78%) were the ones in their households paying electricity bills. However, only 50% used electricity as their energy source, which is a lower share than in national statistics. In 2012, 80% of Norwegian households consumed electricity as their energy source (SSB, 2014).

Among the six options for checking electricity bills, ranging from “I do not get the bills” to “I always check the bills,” 39% always checked their bill, 3% never checked, and 11% did not receive an electricity bill. The last option was offered for those who paid the bill through other means, such as electricity being included in the rent or sharing the payment with another person. The mean among those who received a bill was 4.01 (i.e., usually checking the bill). The mode was “always checking.” This leads us to the conclusion that respondents were aware of their electricity consumption, which is useful for our purposes. Respondents who are aware of their electricity bills can properly evaluate their WTP for green electricity.

Among the respondents, 40% claimed that the price they were paying for electricity was not a burden, while 21% of the respondents expressed it as a minor burden, and the same amount answered that it was somewhat burdensome. Cumulatively, electricity bills were not a significant burden for our respondents’ private economies.

The price respondents paid for their electricity is distributed as shown in Figure 5. The mean was 1212 NOK, and the mode was 1050 NOK. The bill cost was calculated as the midpoint of the intervals respondents chose: 18% paid 1050 NOK for electricity, followed by 15% paying

1350 NOK and 13% paying 1750 NOK. Eight people stated that they paid more than 3000 NOK for their electricity bill, and the highest price recorded was 6000 NOK.

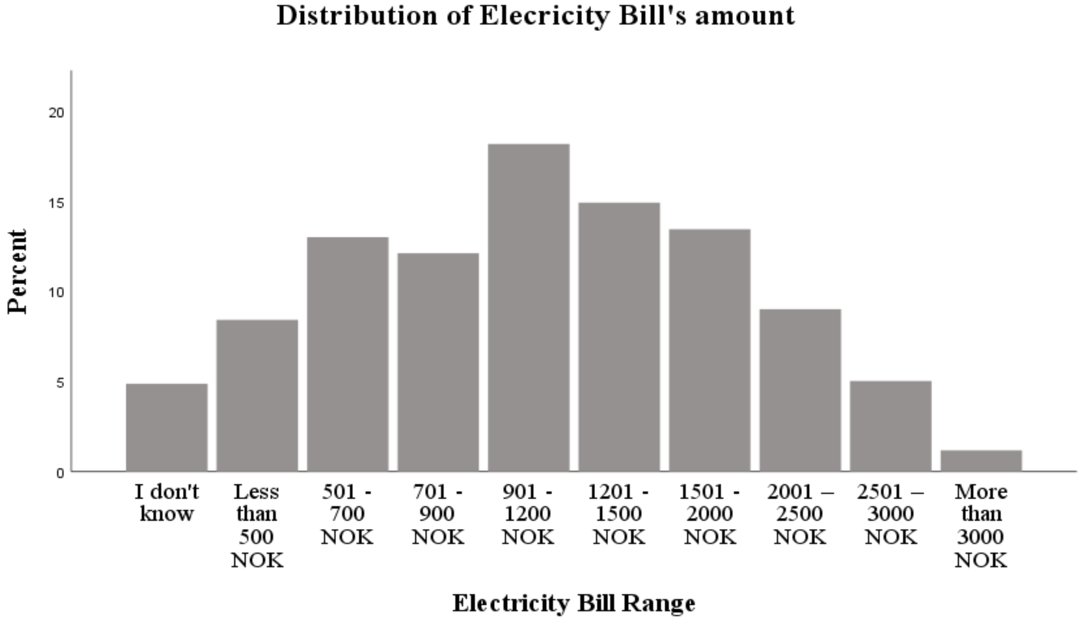

Figure 5. Sample's electricity consumption budget

5.5.2 Knowledge about green electricity and GOs

Based on the previous literature, one of the hypotheses for the low WTP for GOs was the high awareness among Norwegians about the unusually high share of renewable energy in their country's electricity production mix.

One of the most shocking findings we observed was the extensive lack of knowledge about the Norwegian electricity production mix among our respondents. Only 15% chose the correct amount of electricity that was produced from renewable sources in Norway, while 21% admitted that they did not know, and others chose incorrect intervals.

Among the 678 valid respondents in the sample, only 25% had heard about GOs. After the survey educated respondents about GOs, most of the participants showed interest in buying GOs, with a rate of 70% "yes" and 30% "no" answers.

Respondents who were willing to buy GOs were further asked about their preferred source of energy. The results of this question are presented in Table 5. With a share of 41%, hydropower was by far the most popular renewable resource among the population sample. Furthermore, 36% did not care which energy source was used as long as it was renewable.

Table 5. Distribution of preferred RES type

Electricity Source	Percentage
It is not important as long as it is green	35.64%
Hydro	41.09%
Solar	12.16%
Wind	6.29%
Bioenergy	2.94%
Fuel cell	1.05 %
Gray electricity	0.84%

5.6 Willingness to buy (WTB) and willingness to pay (WTP) for GOs

5.6.1 WTB

Based on the information disclosed in the scenario section, respondents were asked if they were willing to buy GOs given a reasonable personal price, which was also perceived as a willingness to adopt. As seen in the figure below, 71% of the participants agreed to adopt GOs in their electricity plan.

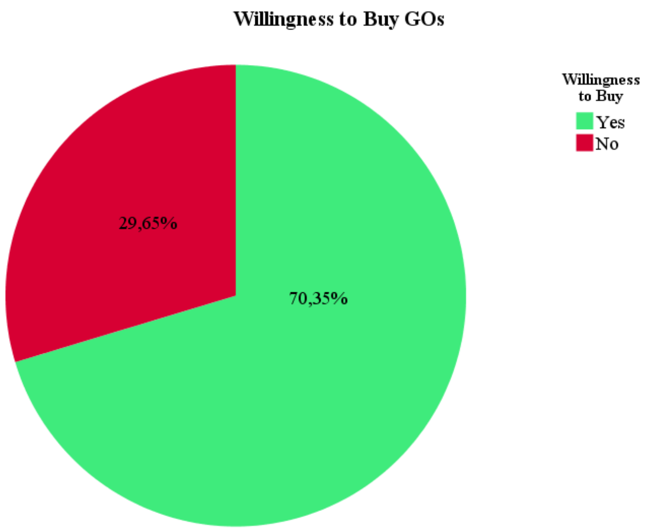

Figure 6. Percentage of participants' willingness to adopt GOs

5.6.2 WTP

Finally, we asked our respondents who were willing to adopt GOs about the maximum amount they would be willing to pay for GOs as an addition to their electricity bills. The results are summarized in the tables below. In Table 6, the third column shows the average WTP based on the maximum percentage respondents were willing to pay. In Table 6, the fourth column considers the midpoint of each interval for the mean.

The two most chosen answers were 2% and 10%. The mean WTP for maximum willingness, including people with 0 WTP, was 5.2%, with a standard deviation of 5.7%. When those with 0 WTP were excluded, the maximum WTP mean was 7.4%, with a standard deviation of 5.5%.

Table 6. WTP including and excluding 0

Condition	N	Mean max WTP	Mean midpoint WTP	Std. Dv. max	Std. Dv. midpoint
Including 0 WTP answers	678	5.2%	4.5%	5.7%	5.4%
Excluding 0 WTP	477	7.4%	6.4%	5.5%	5.4%

Except for 2%, round numbers such as 10%, 15%, and 20% were typically chosen more than their adjacent numbers, such as 12.5% or 17.5%. The distribution of the positive responses is shown in Figure 7 and characterized as a bimodal distribution.

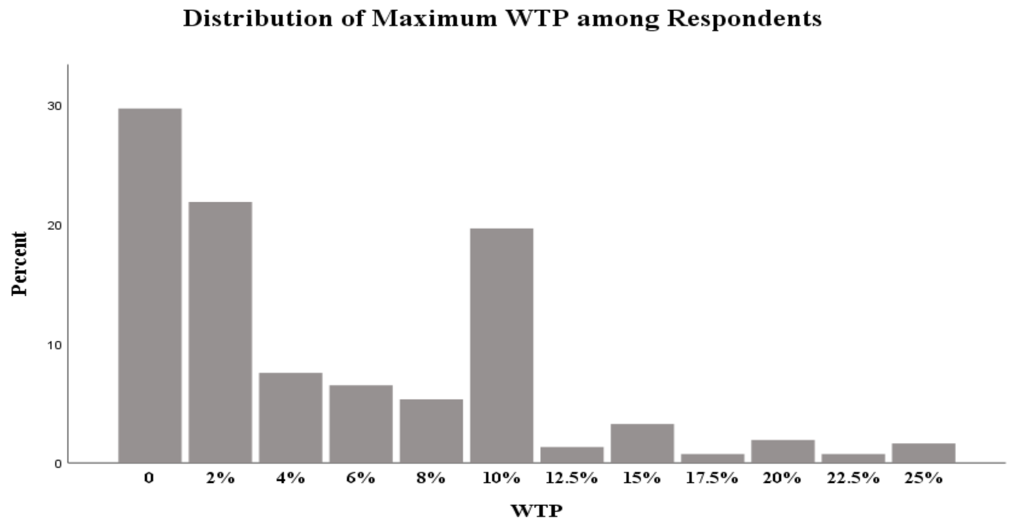

Figure 7. Sample's maximum WTP distribution

Regarding the 29% of respondents not willing to pay for GOs, we asked them if they could choose between arguments summarizing their attitudes. Approximately half expressed a lack of trust in the GO system, considering it an ineffective course of action. Around one-third could not afford to buy GOs, and 9% did not think climate change was a real phenomenon.

6. Results

This chapter presents the results of our regression analyses in three sections. The model for each section was developed independently from the other models. To keep each section streamlined, we have only reported the most critical variables in a table. The complete tables are accessible in the appendix. The correlation matrix table is also included in the appendix. We base our discussion on findings with a 5% significance level or below.

Firstly, we performed a logistic regression where the DV was the willingness to buy GOs. This model analyzes the impact of independent variables on respondents' acceptance of GOs after being educated about them (see Table 7). The model's preciseness was then tested using a confusion matrix (see Table 8). In summary, the model had precise predictive power for "yes" answers, with 90% correct predictions. However, the results were not as accurate for "no" answers, with an accuracy of 45%. Overall, the model's predictability was 77%, compared with a random model with 50% accuracy.

Secondly, we analyzed the crucial variables and their magnitude of impact on WTP (see Tables 10 and 11). In this case, we mainly used three models. We initially used an ordered logistic regression model for all of the observations (including respondents who were unwilling to buy GOs; i.e., WTP = 0). After that, we used two other models to identify the differentiating factors among respondents with positive WTP. For this section, we developed two new models using interval regression and ordinal logistic regression for respondents with positive WTP.

6.1 Willingness to buy

After performing the analysis, we identified 12 variables that were significant at the 5% level. Table 7 shows the output of these variables, and Appendix 1 displays the entire table. The result is reported in two formats, coefficients and odds ratios. Both demonstrating the same effect from independent variables on dependent variable with different perspectives. As a general interpretation method, we use odds ratios throughout this section. However, in the following discussion, we will use a sample interpretation of the coefficients as well.

We begin with demographic variables, namely gender. The gender of the person who paid the bill had a coefficient of -0.72 and was statistically significant at a 0.01 level. This coefficient indicates that everything else held constant, the log odds of purchasing GOs for a male respondent is 0.72 less than for a female respondent. For the same variable, the interpretation of the odds ratio works a little differently.

Odds ratio cannot be negative. Odds ratios less than 1 have a negative effect, and odds ratios higher than 1 have a positive effect. Therefore, the interpretation is as follows: ceteris paribus, a male respondent was 51% less likely to buy GOs than females $(1 - 0.485 = 0.515)$.

Table 7. Logistic regression for GO acceptance (DV: WTB)

Variable	Coefficient	Odds Ratio
Male paying the bill	-0.721 (0.228)***	0.485 (0.111)***
Education (Base: Master's or higher)		
Bachelor	-0.645 (0.295)**	0.524 (0.154)**
…		
Dwelling (Base: Apartment)		
House	0.552 (0. 332)*	1.737 (0.578)*
Terraced house	0.161 (0.376)	1.175 (0.442)
Farm	2.630 (1.271)**	13.881 (17.653)**
Collective	0.482 (1.052)	1.620 (1.661)
Heating source (Base: Electricity)		
Wood burning	-1.081 (0.396)***	0.338 (0.134)***
…		
Sharing thoughts on social media (Base: Never)		
Rarely	0.682 (0.295)**	1.978 (0.584)**
Sometimes	0.717 (0.314)**	2.049 (0.644)**
…		
Following environment-related pages on social media (Base: Do not follow)		
Not on social media	0.950 (0.400)**	2.587 (1.036)**
Follow	0.987 (0.275)***	2.684 (0.739)***
Income in NOK (Base: Less than 100,000)		
100,000–299,000	1.126 (0.574)**	3.084 (1.772)**
…		
Government should invest more in reducing GHG emissions	0.582 (0.239)**	1.789 (0.428)**
Economy being more important than fighting climate change (CC)	-0.921 (0.237)***	0.398 (0.134)***
Having a diesel car	0.473 (0.235)**	1.604 (0.377)**
Reducing electricity consumption	0.624 (0.232)***	1.866 (0.433)***

Having prior knowledge about GOs	-0.609 (0.263)**	0.543 (0.143)**
Intercept	1.048 (1.120)	1.761 (1.841)

*Note: P < 0.001 = ***, P < 0.05 = **, P < 0.1 *, standard errors in parentheses. The "…" means that some levels of the variable are omitted in the report because they are insignificant.*

People with a bachelor's degree were less likely to buy GOs than those with a master's degree, which is significant at the 5% level. Compared with people living in an apartment, people living on a farm showed a higher acceptance of GOs.

Regarding heating type, only those burning wood showed significant differences compared with people who used electricity. Ceteris paribus, those who burned wood for heating were less likely to purchase GOs than people who used electricity. Additionally, people earning between 100,000 and 300,000 NOK were three times more likely to buy GOs than people earning less than 100,000 NOK yearly.

People's behavior on social media was represented and used in the model via two independent variables. Compared with people never sharing any content, people who shared content rarely or sometimes were more likely to purchase GOs. Surprisingly, respondents who shared content all the time did not have a significant coefficient. However, their coefficient was positive. This may have been caused by the low number of respondents who answered the alternative of always sharing (n = 40 compared to other four = 638).

As expected, following any environment-related pages on social media had a significant negative effect compared with those who did not follow environment-related pages. For example, everything else held constant, a person who followed any environment-related page was 2.6 times more likely to purchase GOs than a person who did not follow any. Furthermore, even those who were not on social media were more willing to buy GOs than people who were on social media without following any environment-related page.

If a person thought the government should make more efforts and investments to reduce GHG emissions, as expected, they were more willing to purchase GOs. In line with this finding, those respondents who favored economic growth over fighting climate change were less likely to adopt GOs.

Table 7 shows that respondents owning a conventional car were more likely to purchase GOs compared with those not owning a car. This finding could be explained by the fact that these respondents may have knowledge about emissions from their cars, leading to a higher willingness to compensate for them by adopting green electricity. Another reason might be that people with electric care might be thinking about high usage of electricity and consequently higher GO costs. Additionally, we observed that respondents making an active effort to reduce their electricity consumption had a higher likelihood of purchasing GOs.

Respondents were asked about whether they had heard of GOs before reading our information disclosure. Interestingly, those who claimed to know about GOs before reading our disclosure were less willing to purchase GOs than those who had no prior knowledge about GOs. This surprising result might be explained by the lack of accuracy in their previous knowledge of GOs and a lack of interest in precise reading of the information disclosure.

Surprisingly, variables such as income, electricity bill amount, sorting trash, employment status, family size, using disposables, or satisfaction with one's electricity provider were not significantly influential on WTB.

The goodness of fit for the model was tested via three tests. Firstly, we tested for the predictive power. Then, we tested for the goodness of fit using an ROC curve and Hosmer-Lemeshow (HL) test. We used the commonly used ten groups for the HL test.

The predictions provided by the regression seemed to be robust, with a ratio of 90.15% correct predictions for "yes" answers. On the other hand, the matrix showed a low forecast of 45.27% accuracy in predicting answers of not purchasing GOs. The overall prediction accuracy from the confusion matrix was 76.84%, which was sufficient, especially since our focus was finding variables affecting the acceptance of GOs.

There were several related factors in the literature on green electricity sources that we believed could affect the prediction of "no" answers. However, they were not the focus of our analysis. For instance, if we had asked about respondents' opinions on wind turbines being visually displeasing, we could have increased the prediction level. Furthermore, factors such as living near a wind farm or preferring offshore wind farms over onshore wind farms are variables that decrease people's life satisfaction and likely affect their WTB based on the results of several studies (Dröes & Koster, 2016; Gibbons, 2015; Jensen et al., 2014; Krekel & Zerrahn, 2016; Lang et al., 2014; Sunak & Madlener, 2016).

Returning to our tests, the area under the ROC curve had a value of 0.80, which showed that the model has a well performance. The diagonal line in the graph shows a completely random model (= 0.5), and the farther the curve is from that line, the more accurate the model is.

Table 8. Confusion matrix of the model's preciseness

		True Values		% Correct Prediction
		YES	NO	
Predicted values	YES	430	110	90.15%
	NO	47	91	45.27%
Overall predictive power				76.84%

Lastly, the results of the HL test showed insignificant goodness of fit, with a *p*-value of 0.98, which was a positive sign. A low *p*-value for the HL test indicates that the model is not a good fit. However, it should be highlighted that higher *p*-values do not indicate how much of a good fit the model is. They only show that the model is reliable, but not to what extent.

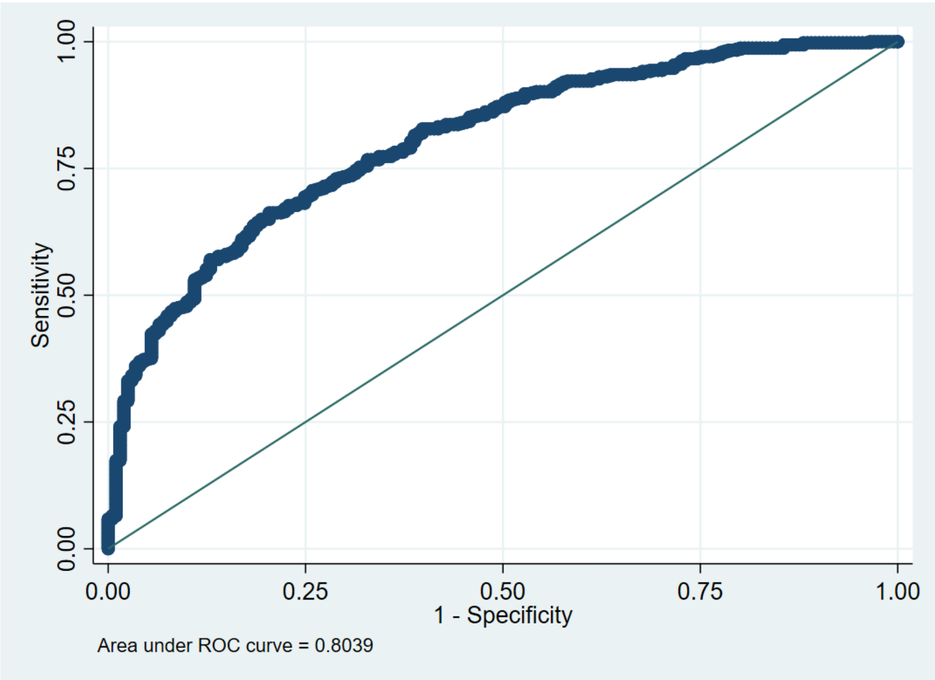

Figure 8. ROC curve for logistic models

Table 9. HL test results

HL Test results	Number of observations	=	678
	Number of groups	=	10
	Hosmer-Lemeshow chi2(8)	=	1.95
	Prob > chi2	=	0.9824

6.2 Willingness to pay

The general logistic regression in the previous section explains people's intention of purchasing or not purchasing green electricity through GOs. However, it does not consider the effect of different variables on the level of WTP. The influential variables for WTB are not necessarily the same as the variables for the WTP level. Therefore, other models were needed.

For the first part, we used an ordinal logistic model that included 0 WTP observations. This model could be a representation of the influential factors on WTP for society as a whole. For the second part, we deleted the respondents with 0 WTP and created two new models to explain the differentiating factors among respondents with positive WTP. The models used in this section were ordinal logistic regression and interval regression. Both models are designed for censored ordinal data without a precise value.

Regarding the interpretation of ordinal logistic model we should first clarify some definitions. The ordinal logistic model uses a cumulative probability distribution, a parallel lines assumption, and a latent continuous variable representing different groups of dependent variable ($we\ call\ it\ WTP^{*}$).

Cumulative distribution means that during the interpretations we always compare being in a specific WTP group or higher (e.g., 10% WTP or higher) with having lower WTPs. For example, we could say that the log odds of having at least 10% WTP is 0.34 lower in men.

The parallel line assumption points that the effect of variable X_i is same across all the WTP groups. For example, if we wanted to interpret having at least 20% WTP, it would be same as the previous example. We would say, the log odds of having at least 20% WTP is 0.34 lower in men.

Lastly, the latent variable is a proxy for different groups. Ordinal logistic regression is suitable for ranked DVs but it cannot be calculated directly. Therefore the WTP^* is calculated, and its value is used to define the WTP group a respondent belongs to. The differentiations is done by a term called thresholds available at the end of tables 10 and 11. The thresholds are the border between two groups of WTP.

Simply speaking, sum of all the effective factors multiplied by their coefficients ($\sum_1^i \beta_i X_i$) will provide us a value for WTP^*. The resulting value would be lower or higher than a threshold value in the table 10 or 11. If the value was lower than a threshold value, the respondent was willing to pay the low value written in the cut description and vice versa. For instance, our first cutoff value at table 10 is 0.548, and the second cutoff value is 1.718. If we calculate the WTP^* value of a respondent and it becomes 0.51, they have 0 WTP. If their WTP^* value was any value between 0.549 and 1.717, then they had 2% WTP.

6.2.1 Model with 0 WTP

We began with the results of the ordinal logistic regression including respondents with 0 WTP. Similar to the previous model, this model's output was also reported with both coefficients and odds ratios. The meaning and usage of coefficients and odds ratios in this model are the same as for the logistic regression. The interpretation of the effect, however, is a little different from that of the logistic regression. The sample interpretation for ordinal logistic regression is as the following:

The log odds of being in a specific WTP level or higher (e.g., having a WTP 15% or higher) compared with lower WTP groups for males were 0.35 lower than the log odds for women, with everything else held constant.

The same could be applied to the odds ratio. The odds of being in a specific WTP group or higher (e.g., having a WTP 15% or higher) compared to having lower WTPs, for a male respondent was 29% lower than for women when everything else was held constant. If we wanted to interpret having 20% WTP, it would be the same as 15%. The reason is because of the parallel lines assumption.

Table 10. The ordinal logistic regression for 0 and positive WTP (DV: WTP)

Variable	Coefficient	Odds Ratio
If male pays the bill	-0.346 (0.165)**	0.707 (0.116)**
Town size (Base: Cities/large urban areas)		
Rural areas	-0.453 (0.261)*	0.635 (0.166)*
Town/suburbs/small urban areas	-0.574 (0.248)**	0.563 (0.149)**
Education (Base: Master's or higher)		
High school diploma	-0.505 (0.217)**	0.602 (0.130)**
Bachelor	-0.710 (0.198)***	0.491 (0.097)***
…		
Heating source (Base: Wood burning)		
Electricity	0.858 (0.308)***	2.358 (0.727)***
Heat pump	0.561 (0.300)*	1.753 (0.526)*
Central heating	1.195 (0.416)***	3.305 (1.375)***
Other	1.039 (0.388)***	2.828 (1.097)***
Employment status (Base: Full-time job)		
Temporarily laid off because of COVID-19	1.180 (0.517)**	3.255 (1.683)**
…		
Reducing electricity consumption (Base: Not at all)		
To a high degree	1.479 (0.703)**	4.391 (3.089)**
To some extent	1.424 (0.678)**	4.154 (2.818)**
…		
Following environment-related pages on social media (Base: Do not follow)		
Not on social media	0.567 (0.270)**	1.764 (0.477)**
Follow	1.028 (0.175)***	2.796 (0.491)***
Sharing thoughts on social media	0.700 (0.233)***	2.014 (0.470)***
Government should invest more in reducing GHG emissions	0.634 (0.156)***	1.685 (0.294)***
Economy being more important than fighting climate change (CC)	-0.619 (0.156)***	0.530 (0.083)***
Caring about environment and CC	0.505 (0.246)**	1.658 (0.408)**
Satisfaction with electricity provider	0.633 (0.250)**	1.884 (0.471)**
Threshold 1 (between 0% and 2%)	0.548 (0.993)	
Threshold 2 (between 2% and 4%)	1.718 (0.995)	

Threshold 3 (between 4% and 6%)	2.106 (0.996)
Threshold 4 (between 6% and 8%)	2.451 (0.997)
Threshold 5 (between 8% and 10%)	2.750 (0.997)
Threshold 6 (between 10% and 12.5%)	4.367 (1.003)
Threshold 7 (between 12.5% and 15%)	4.559 (1.005)
Threshold 8 (between 15% and 17.5%)	5.166 (1.011)
Threshold 9 (between 17.5% and 20%)	5.351 (1.013)
Threshold 10 (between 20% and 22.5%)	6.019 (1.027)
Threshold 11 (between 22.5% and 25%)	6.428 (1.041)

*Note: P < 0.001 = ***, P < 0.05 = **, P < 0.1 *, standard errors in parentheses. The "…" means that some levels of the variable are omitted in the report because they were insignificant.*

The relationship between town size and WTP was negative, though it was not significant for all sizes. Only people living in small towns had lower WTP compared with people living in large cities. The other geographical measurements, such as cardinal directions or regions, were insignificant.

Regarding the effects of education, similar to WTB, people with a high school education or bachelor's degrees had significantly lower WTP compared with people with master's degrees.

The results for heating sources showed that compared with people who burned wood, people with almost all the other heating sources had a significantly higher WTP. There was only one exception: respondents with heat pumps had not significantly higher WTP.

The effect of employment status was significant for only one of the variable classes. Those who had been temporarily laid off because of COVID-19 had significantly higher log odds than the base group. Similarly, those who endeavored more to lower their electricity consumption had a greater likelihood of being in higher WTP levels as well.

Regarding social media behavior, people who shared their ideas on social media were two times more likely to have a higher WTP compared with those who did not share their ideas and beliefs. In line with this, following any environment-related pages on social media had a positive relationship with WTP.

As one might expect, people's behaviors and beliefs about the environment and climate change significantly affected WTP. The results showed that those who thought the government should invest more in fighting GHG emissions were more likely to be in higher WTP intervals. These results were significant at the 1% significance level. Similarly, people who thought environmental care and fighting with climate change was more important than economic growth and those who claimed to care about climate change had a higher WTP.

Unlike the previous model in Section 6.1, having a diesel car did not have a significant effect here. On the other hand, the level of satisfaction with the electricity provider was statistically significant. The log odds of WTP for those satisfied with their provider were 0.63 higher than unsatisfied people with everything else held constant.

6.2.2 Models without 0 WTP

This section focuses on identifying the essential variables that differentiated respondents with positive WTP. Since two types of regression models were suitable for this section, we used both and compared their results. The regressions used in this section were interval regression and ordinal regression.

As Table 11 shows, most of the variables were significant in both models, and the differences were few. Furthermore, the coefficients of the models cannot be compared with each other and should be interpreted differently.

The interval regression used the coefficients in the same way as the ordinary least squares method. The coefficient in a level-level model such as ours shows the effect of one unit change in the independent variables on DV. For instance, people who always sorted their trash had a WTP 0.04 higher than those who never sorted their trash when everything else was held constant. This result was significant at the 5% level.

Table 11. Models for positive WTP (DV: WTP starting from 2%)

Variable	Interval Regression (Coef.)	Ordinal Logistic (Coef.)
Town size (Base: Cities/large urban areas)		
Rural areas	-0.008 (0.007)	-0.405 (0.317)
Town/suburbs/small urban areas	-0.016 (0.007)**	-0.615 (0.308)**
Education (Base: Master's or higher)		
High school diploma	-0.019 (0.006)***	-0.638 (0.261)**
Bachelor	-0.019 (0.005)***	-0.617 (0.238)***

…		
Heating type (Base: Warming pump)		
Other/I don't know	0.019 (0.008)**	0.935 (0.368)**
Sorting trash (Base: Never sort)		
Sort always	0.042 (0.020)**	-
…		
Sorting trash (Binary)	-	0.836 (0.385)**
Following environment-related pages on social media (Base: Do not follow)		
Not on social media	0.022 (0.004)***	1.026 (0.346)***
Follow	0.024 (0.004)***	0.920 (0.209)***
Sharing thoughts on social media	0.024 (0.006)***	1.032 (0.271)***
Economy being more important than fighting climate change (CC)	-0.015 (0.004)***	-0.565 (0.198)***
Caring about CC	0.010 (0.008)	0.584 (0.233)**
Checking electricity bills	0.006 (0.004)	-0.177 (0.253)***
Reducing electricity consumption	-0.018 (0.008)**	-0.241 (0.230)
Electricity bill being a burden	-0.013 (0.005)**	-0.666 (0.233)***
Satisfaction with electricity provider	0.020 (0.007)***	0.940 (0.337)***
Preferred source of GE (Base: Source is not crucial)		
Solar	0.014 (0.007)**	0.506 (0.300)*
Wind	0.029 (0.009)***	1.171 (0.394)***
Hydro	0.011 (0.005)**	0.350 (0.206)*
Bio	0.055 (0.014)***	2.017 (0.613)***
Fuel cells	-0.007 (0.021)	-0.545 (1.205)
Gray electricity (Nuclear)	0.052 (0.023)**	2.333 (1.236)*
Employment status (Base: Full-time job)		
Temporarily laid off because of COVID-19	0.037 (0.013)***	1.979 (0.612)***
…		
Intercept	0.075 (0.050)***	
Threshold 1 (between 2% and 4%)		0.409 (2.076)
Threshold 2 (between 4% and 6%)		0.997 (2.078)
Threshold 3 (between 6% and 8%)		1.469 (2.080)
Threshold 4 (between 8% and 10%)		1.854 (2.081)
Threshold 5 (between 10% and 12.5%)		3.725 (2.085)

Threshold 6 (between 12.5% and 15%)	3.933 (2.085)
Threshold 7 (between 15% and 17.5%)	4.596 (2.087)
Threshold 8 (between 17.5% and 20%)	4.799 (2.088)
Threshold 9 (between 20% and 22.5%)	5.540 (2.090)
Threshold 10 (between 22.5% and 25%)	6.001 (2.093)

*Note : P < 0.001 = ***, P < 0.05 = **, P < 0.1 *, standard errors in parentheses. The "…" means that some levels of the variable are omitted in the report because they are insignificant.*

The main differences between the two models were the variables of sorting trash, caring about climate change, checking electricity bills, reducing electricity consumption, and hydropower as a GE source.

Our models disagreed on the meaningfulness of the relationship between electricity usage reduction and WTP. While the interval regression found this variable to be significant, no significance was observed in the ordered logistic model. On the contrary, the interval regression model did not confirm if there was any effect from checking electricity bills on positive WTP level. However, ordinal logistic models considered this variable to be influential at a 1% significance level.

Another interesting result was the effect of electricity sources. As both models show, wind and bio had the highest coefficient among available sources, and both were significant at the 1% level. Nuclear a.k.a. gray electricity was not one of the predefined answers; however, it appeared in several responses. Since it was not considered black (in contrast with green) or green, we decided to retain those respondents in the sample. Interestingly, one model found a significant positive relationship between nuclear electricity preference and WTP, and the other did not. Similar to nuclear electricity preference, electricity preference for hydro and solar energy were only meaningful in one of the models. As the results show, the highest WTP among significant sources came from those who would choose bioenergy as their resource.

Surprisingly, among the demographic variables, only town size, education, and employment were significant. Gender, location, family size, age, and income were not found to be influential in either model. Education, as expected, had a positive relationship with WTP. Respondents with a high school diploma or a bachelor's degree had a lower WTP than those with a master's degree. Furthermore, both models agreed that respondents who had been laid off due to the COVID-19 pandemic had a higher WTP than those working full-time.

As in the previous models, social media behavior was an influential factor in both models and was at the 1% significance level. However, people's beliefs and behavior toward climate change and the environment had different effects than in previous models. Believing that the government should invest more in reducing GHG emissions was not significant here. Moreover, the ordinal logistic model found the effect of caring about the climate change to be substantial, at 5%, and the other model saw it as insignificant. Respondents' views of the importance of economic growth over fighting climate change had significant positive relationship with WTP in both models.

Sorting trash can be seen as a latent variable of how people take care of the environment practically. The results showed that sorting trash had a positive effect on WTP. The only difference between the models was how they accounted for the impact of trash sorting. The interval regression model only considered "always sorting trash" as effective; therefore, the variable with four levels was used. The other model showed both "often" and "always sorting trash" to be influential. Hence, a binary subset of the same variable was used in the model for degree-of-freedom purposes.

An exciting factor differentiating people with positive WTP was how much of a burden their electricity bill was. This factor was not significant in any of the previous models but was significantly influential in this model. Satisfaction with the electricity provider, as expected, positively affected WTP in both models and at a 1% significance level.

7. Discussion

In this chapter, we further discuss and analyze the results from Chapter 6. We then compare our findings with previous findings in the literature and answer the research questions.

7.1 Research questions

With the first research question, we intended to satisfy our curiosity about Norwegian citizens' attitudes toward the environment and how educated they were regarding the GO system. Based on our hypothesis that most citizens did not know about this system, our second research question attempted to determine if educating the public with neutral information disclosure could convince them to purchase GOs. In the third research question, we wished to discover how much the public would be willing to pay. Finally, we explored which factors affected the willingness to buy and pay for GOs.

7.1.1 General attitudes and knowledge

Our results show that Norwegians have a positive attitude regarding caring for the environment, similar to what Soon and Ahmad (2015) claimed. Most of the households surveyed are making efforts to reduce electricity consumption and sort trash, prioritize the environment over economic growth, claim to care about the environment, and agree with the government investing more in fighting climate change. These factors have a significant effect on WTB and WTP.

7.1.2 Research question 1

Concerning the first research question, our results show that most of Norway's citizens are neither knowledgeable about GOs nor the share of renewables in the production mix. This indicates that even though Norwegians have environmentalist tendencies in their behavior, they have little knowledge about green electricity topics.

Many studies (e.g., Sovacool & Ratan, 2012; Sundt & Rehdanz, 2015; Soon & Ahmad, 2015; Vand et al., 2019; Salmela & Varho, 2006) emphasize the importance of informing and educating the general public about mitigation actions and environmental products to increase awareness, and, consequently, demand. When 75% of respondents have not heard about GOs, it is not surprising that the demand for GOs is low. We believe that public authorities need to invest more in educating the public about green electricity in general to increase the demand for GOs.

7.1.3 Research question 2

As an answer to the second research question, and in line with the claim in the previous section, we confirm that educating people had a significant effect on the demand for GOs. Table 12 shows the change in GO demand after people read the survey's scenario.

- Out of the 510 respondents who did not know about GOs previously, 368 (or 72%) were willing to buy GOs after reading the given information disclosed in the survey.
- Out of the 168 respondents with prior knowledge about GOs, 109 (or 65%) were willing to buy GOs.
- Out of the 678 respondents, 477 (or 70%) were willing to buy GOs.

Table 12. Relationship between prior knowledge about GOs and WTB

		Willingness to Buy		Total	Percentage Yes
		NO	YES		
Prior knowledge about GOs	YES	59	109	168	65%
	NO	142	368	510	72%
Total		201	477	678	

The table clearly demonstrates that most respondents were willing to buy GOs after being educated about them from a neutral source with correct information. Therefore, we could argue that the government and related organizations must increase their efforts to disseminate knowledge about GOs and green electricity in general. Based on our result, we can claim that a well-planned campaign will increase the demand for GOs.

Previous GO studies in the literature (Winther, 2013; Aasen, 2007) conclude their findings by expressing a surprisingly low demand and WTP for GOs. Arguments for this low demand vary between (a) fluctuation in electricity prices, especially in the coldest month of the year, (b) people's distrust in their retailers, or (c) because of the awareness Norwegians have about Norway's renewable share in the electricity production mix. Therefore, Norwegians do not see the benefit of purchasing GOs.

Based on our results, we can counterargue arguments (a) and (c). Our survey was conducted in mid-April 2021, soon after one of the highest electricity price fluctuations recorded since 2010 (E24, 2021, s. 24). Furthermore, previous claims that Norwegians are highly aware of Norway's renewable electricity production are, based on our findings, false. Only 15% of our respondents had correct knowledge about Norway's green electricity production share. Therefore, we cannot support this argument as the cause of the low demand.

However, based on our results, 15% of the total sample, equivalent to half of the respondents who were not willing to buy GOs, expressed distrust of the GO system and argued that it was only promotional. In line with previous conclusions, this problem can be solved with neutral information from an organization that does not benefit from GOs.

7.1.4 Research question 3

During the design process, we made great efforts to inform respondents with the correct information. Energi Norge also assisted us in ensuring the information disclosure was as neutral as possible and in line with market standards (see Appendix 4 and 5). This information resulted in a positive response rate of 70% being WTB with an average monthly WTP of 5–7.5% per household, depending on the calculation method. These numbers are higher than expected based on previous literature about Norway's situation.

The WTP for society as a whole (i.e., considering all respondents, including those with 0 WTP) was 5.2%. The average WTP among people with positive WTP was 7.5%. The most chosen payment values were also 2% and 10%, both of which are in line with the price of GOs. As was mentioned in Section 4.2.4, the cost of GOs based on the information at hand totals about 5% of the average electricity price.

Unfortunately, the numbers cannot be directly compared with those from other studies from Europe since those other studies used monetary terms instead of percentages. However, one similar study by Grilli et al. (2015) in Italy asked for people's WTP for green electricity in percentages. Their result showed 13% WTP, which was higher than our results. However, two points should be noted. First, the monetary value of 13% was 5 Euros in 2014, equivalent to 5.26 Euros in 2021 (calculated by inflationtool.com), corresponding to 54 NOK based on exchange rates on July 26th, 2021. This amount is less than the monetary value of Norwegian households' WTP. In our case in Norway, considering the mean WTP of 5% and the midpoint of the electricity bills, the monetary value of WTP was 65 NOK in the lowest case and 95 NOK in the highest case. Second, the method of survey by Grilli et al. was face to face, which might have led to upward bias in the announced WTP.

7.1.5 Research question 4

On WTB

As the results show, and as expected, the most important variables for WTB were gender, education, and income for the demographics of the respondents. Dwelling type and heating source, social media behavior, having a diesel car, and knowledge about GOs were the other significant and effective factors.

People's behavior and environmental attitudes were additional effective factors. What respondents thought about the government's investment plans as climate mitigation actions, the importance of economic growth compared with the preservation of the environment, and efforts to reduce private electricity consumption were factors affecting WTB.

The last factor was interesting since it could be interpreted in two ways: 1) whether people decreased their electricity consumption as a result of monetary goals or 2) whether they decreased their electricity consumption due to environmental concerns. However, based on the low correlation of 0.20 between the reduction of electricity consumption and the electricity bill burden, we can conclude that this reduction effort was not due to monetary value but to people's environmental care.

On WTP

Based on our findings, the variables affecting WTP are highly similar to those of previous studies (e.g., Sundt, 2015; Knapp, 2020; Kowalska, 2019; Dogan, 2019). Interestingly, we were able to recognize a few differences in our output in comparison with previous findings.

Demographics

Gender, education, employment, and environmental attitudes and care were among the significant independent variables. Environmental attitudes, like in other models, were meaningful in WTP models as well. As expected, based on previous studies, women were more likely to buy GOs and express higher WTP. However, this effect was only meaningful in the model with 0 WTP. In line with the literature, education and environmental awareness both positively correlated with WTP in all models. Unlike in the literature, we could not find any effect of age on WTP in any of the models related to WTP.

Zoric and Hrovatin (2012) emphasized the high coefficient of age, arguing that the younger generation was much more likely to have a higher WTP. Our models cannot support or reject this claim. None of our models found any meaningful relationship between age and WTP. This result becomes interesting when we have a population with a high proportion of respondents over 60 years old. Thus, if there was any adverse effect from age on WTP, we should have observed it.

The studies mentioned above found income to be a significant factor that decreased WTP. However, we could not find any meaningful influence from income on WTP. Part of the reason behind this finding might be the tax system of Norway, which attempts to reduce wealth inequality in society.

Lastly, regarding the NIMBY effect observed by Navrud and Bråten (2007) for wind farms, we observed a tendency to support these claims. Our WTP models showed that, compared with larger cities, people living in small urban areas or towns had lower WTP for GOs. One reasonable explanation for this effect is the more prominent exposure people living in smaller cities have to water- and windmills compared with people living in large cities. This leads to lower WTP for the wind farms and hydropower sites, which ruin the aesthetic view of nature.

Type of RES

One interesting finding in this study is the significance of the source of energy for GOs. Soon and Ahmad (2015) found that the type of RES did not significantly affect WTP. In line with their findings, Navrud and Bråten (2007) added that hydropower had a significant negative effect on WTP. Conversely, in our case, we observed that hydropower, surprisingly, showed a substantial increase in WTP at a 5% level in the interval regression model in Section 6.2.2. However, the ordinal logistic regression in the same section found the positive effect from hydro to be effective at 10%, which is unreliable. Therefore, it is difficult to definitively confirm or reject their findings.

As with the hydropower results, and contrary to Soon and Ahmad's findings (2015), we found most renewable sources to affect WTP at the 5% significance level in the interval regression model. However, the ordinal logistic regression did not agree with the interval regression model and only found wind power and bioenergy to affect the results.

Impact of social media

The output from our models concerning social media is also interesting. These findings are new to the literature and provide interesting insight for future research. In the model with 0 WTP, both the factors of following environment-related pages and sharing thoughts on social media were significant. Interestingly, the coefficient for following environment-related content on social media was higher than the coefficient for sharing ideas, and both were significant at the 1% level. In contrast, when excluding 0 WTPs, the coefficients were close to each other for the sharing and following variables.

Generally, we found strong evidence that people being active on social media and following and sharing environmental content were significantly more likely to have a higher WTP than people who did not follow environmental content, with a 1% significance level.

This finding becomes more interesting when we observe that people who did not have social media also had a meaningful, positive relationship with WTP. Descriptive statistics show that the majority of people are on social media, but only a minority follow or share environmental content. We believe social media has the potential to become a useful tool for further disclosure of environmental information in the future, and we would like to suggest further research be conducted about the effects of social media on people's attitudes toward the environment.

Other effective factors

In addition, some variables were significant only in the WTP models. Checking one's electricity bill, how much of a burden the electricity bill was, and sorting trash were these factors. Satisfaction with one's provider was another effective variable. All three WTP models found a meaningful effect from satisfaction on WTP. This could be rooted in the trust that satisfied respondents had with their providers.

8. Conclusion

8.1 Introduction

The world is rapidly transitioning toward using renewable energies. New instruments are being continuously introduced to assist countries in reaching their goals and combatting climate change. GOs are one of these instruments and guarantee 100% green electricity.

The popularity of GOs has been drastically increasing, and more GOs are traded every year. They provide green electricity producers with extra income. If GOs become widespread, they could be seen as an incentive for more investment in green electricity production.

The trade of GOs in Europe is rapidly increasing, with Germany as their largest buyer. As a result of Norway's high share in the supply of GOs in Europe, the low demand of GOs in Norway, and the scarcity of the literature on GOs, this research was done to broaden the limited knowledge base of literature related to GOs.

The literature about WTP for green electricity is vast. However, no past studies have used an instrument for guaranteeing green electricity. Therefore, this research also adds to the literature on WTP for green electricity.

8.2 Conclusion

The surprisingly low demand in Norway for a certificate guaranteeing consumers renewable electricity (i.e., a GO) was the primary motivation for this thesis. Through a valuation survey and using the CVM, we analyzed professionally collected data including 700 respondents to satisfy our curiosity about this market phenomenon.

We used several statistical methods and models, such as logistic regression, ordered logistic regression, and interval regression, to answer the following four research questions:

1. Do Norwegians have prior knowledge about GOs?
2. When correctly informed, are they willing to buy GOs?
3. What is their maximum WTP?
4. What factors influence their decision and WTP level?

Descriptive statistics present a share of 75% of respondents having no prior knowledge about GOs. Among these, 72% were willing to buy GOs at a reasonable price after being correctly informed about such certificates. Furthermore, the average maximum WTP for GOs among Norwegians ranged between 5–7.5% of their electricity bill, which is higher than expected and similar to average European standards. In contrast to previous studies, only a small portion of the respondents were aware of the approximately 100% share of renewable energy Norway has in the electricity production mix. Additionally, analytical results show high distrust of the GO system, which arguably is one of the main arguments for the actual low demand in Norway, according to the literature.

The different models used in this research showed that gender, age, heating source, social media behavior, beliefs and behaviors toward the environment, car type, and prior knowledge about GOs were the most vital factors affecting the decision to buy GOs. The models regarding WTP indicated that the most important factors were education, heating source, employment status, beliefs and behavior toward the environment, social media behavior, and satisfaction with one's electricity provider.

Based on our findings, we believe that implementing educational marketing measures to Norwegian electricity consumers can increase the demand and WTP for GOs, resulting in a potential increase of taxable additional income for Norwegian power producers. These efforts should be operated from a governmental level so that end consumers' beliefs about GOs being promotional and distrust of the system are minimized. Based on the high significance of social media, we believe that using this channel for spreading knowledge could have high effectiveness.

Additionally, if more GOs are sold to Norwegian corporations and end consumers and fewer to foreign countries, the share of fossil fuel in Norway's residual mix share will decrease as well as its controversial image. Consequently, increasing prices for GOs will provide European conventional power producers with higher incentives to make renewable energy investments, which, in the end, is what our planet needs.

8.3 Limitations and future research

One of the limitations of this research was the timing. As this thesis's time frame was constrained by its requirements, there was no time to interview respondents. Using a broader scope of research using both surveys and interviews could shed more light on some of the reasons behind the low demand for GOs in Norway and the reasons behind the distrust of the GO system.

Furthermore, the respondents in our survey were asked to respond to the WTB and WTP questions immediately after reading the scenario. However, providing more time for respondents to consider the scenario and question could change the results. Therefore, performing similar research with a postal survey on paper could be beneficial.

It is also worth mentioning the time period of data collection for this study. Our survey was conducted in mid-April 2021, immediately after one of the highest electricity price fluctuations recorded since 2010 (E24, 2021, s. 24). We believe that the WTP values could potentially be higher if future studies collected data outside of time periods when electricity prices are unusually high.

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Appendices

Appendix 1. WTB full table

The full table of the willingness to buy GOs (DV : WTB)

Variable	Coefficient	Odds Ratio
Male paying the bill	-0.721 (0.228)***	0.485 (0.111)***
Age	-0.014 (0.010)	0.985 (0.010)
Location (Base: Agder and Rogaland)		
Nord-norge and Trøndelag	0.009 (0.393)	1.009 (0.397)
Oslo, Akershus, Hedmark and Oppland	-0.404 (0.347)	0.667 (0.232)
South East	-0.251 (0.384)	0.777 (0.298)
West side	-0.269 (0.387)	0.763 (0.295)
Area3 (Base: Cities/Large urban areas)		
Rural areas	-0.475 (0.344)	0.621 (0.214)
Towns or suburbs or small urban areas	-0.449 (0.285)	0.637 (0.182)
Education (Base: Master's or higher)		
Elementary school	0.060 (0.503)	0.941 (0.473)
High school diploma	-0.194 (0.320)	0.823 (0.263)
Folkeskole	1.012 (0.777)	2.751 (2.138)
Bachelor	-0.645 (0.295)**	0.524 (0.154)**
other	0.201 (0.989)	1.223 (1.211)
Dwelling (Base: Apartment)		
House	0.552 (0. 332)*	1.737 (0.578)*
Terraced house	0.161 (0.376)	1.175 (0.442)
Farm	2.630 (1.271)**	13.881 (17.653)**
Collective	0.482 (1.052)	1.620 (1.661)
Heating source (Base: Electricity)		
Heat pump	-0.006 (0.288)	0.993 (0.286)
Wood burning	-1.081 (0.396)***	0.338 (0.134)***
Central heating	0.113 (0.421)	1.119 (0.472)
Other	-0.065 (0.406)	1.068 (0.433)
Sharing thoughts on social media (Base: Never)		
Rarely	0.682 (0.295)**	1.978 (0.584)**

Sometimes	0.717 (0.314)**	2.049 (0.644)**
Often	0.740 (0.472)	2.097 (0.991)
Always	0.427 (0.539)	1.534 (0.827)
Following environmental-related pages on social media (Base: Do not Follow)		
Not on social media	0.950 (0.400)**	2.587 (1.036)**
Follow	0.987 (0.275)***	2.684 (0.739)***
Satisfaction with electricity provider (Base: Very dissatisfied)		
Dissatisfied	0.765 (0.654)	2.150(1.407)
Neither nor	0.802 (0.570)	2.230 (1.272)
satisfied	0.725 (0.582)	2.064 (1.203)
Very satisfied	1.100 (0.598)*	3.004 (1.797)*
Income in NOK (Base: Less than 100 000)		
100 000 – 299 000	1.126 (0.574)**	3.084 (1.772)**
300 000 – 499 000	-0.007 (0.488)	0.992 (0.484)
500 000 – 799 000	0.581 (0.496)	1.788 (0.887)
800 000 – 1 199 000	0.250 (0.527)	1.284 (0.676)
1 200 000 – 1 999 999	0.583 (0.614)	1.792 (1.100)
More than 2 000 000	0.886 (0.922)	2.426 (2.239)
Employment status (Base: Full-time job)		
Part-time job	0.231 (0.399)	1.260 (0.503)
Temporarily laid off because of Covid-19	0.100 (0.667)	1.106 (0.738)
Student	-0.357 (0.527)	0.699 (0.369)
Unemployed	-0.516 (0.365)	0.596 (0.217)
Pensioner	0.124 (0.381)	1.132 (0.431)
Number of household members	0.024 (0.112)	1.024 (0.114)
Government should invest more on reducing GHG emissions	0.582 (0.239)**	1.789 (0.428)**
Economy being more important than fighting climate change (CC)	-0.921 (0.237)***	0.398 (0.134)***
Caring about CC	0.401 (0.246)	1.493 (0.368)
Using disposable products	-0.211 (0.238)	0.809 (0.193)
Knowledge of Norwegian GE production	-0.548 (0.295)*	0.577 (0.170)*
Having a diesel car	0.473 (0.235)**	1.604 (0.377)**
Reducing electricity consumption	0.624 (0.232)***	1.866 (0.433)***
Having prior knowledge about GOs	-0.609 (0.263)**	0.543 (0.143)**

Sorting trashes	0.439 (0.338)	1.552 (0.525)
Average electricity bill	-0.0001 (0.0001)	0.999 (0.0001)
Electricity bill being a burden	0.313 (0.277)	1.368 (0.380)
Checking electricity bill	0.479 (0.269)*	1.615 (0.434)
Intercept	1.048 (1.120)	1.761 (1.841)

*Note : P < 0.001 = *** , P < 0.05 = ** , P < 0.1 *, standard errors in parentheses.*

Appendix 2. WTP with 0 values

The full table of the model with 0 and positive WTPs (DV: WTP with 0 WTPs)

Variable	Coefficient	Odd Ratio
If male pays the bill	-0.346 (0.165)**	0.707 (0.116)**
Age	-0.013 (0.007)*	0.986 (0.007)*
Number of family members	0.082 (0.076)	1.086 (083)
Location (Base: North Norway)		
Middle Norway	-0.343 (0.303)	0.709 (0.215)
West Norway	-0.237 (0.287)	0.788 (0.226)
East except for Oslo	-0.141 (0.277)	0.868 (0.240)
Oslo	-0.461 (0.357)	0.630 (0.225)
Town size (Base: Cities/Large urban areas)		
Rural Areas	-0.453 (0.261)*	0.635 (0.166)*
Town/Suburbs/small urban areas	-0.574 (0.248)**	0.563 (0.149)**
Education (Base : Master's or higher)		
Elementary school	-0.072 (0.363)	0.930 (0.337)
High school diploma	-0.505 (0.217)**	0.602 (0.130)**
Folkeskole	-0.199 (0.452)	0.819 (0.371)
Bachelor	-0.710 (0.198)***	0.491 (0.097)***
other	0.241 (0.668)	1.271 (0.851)
Dwelling (Base: Apartment)		
House	0.326 (0.228)	1.386 (0.316)
Terraced house	0.074 (0.271)	1.077 (0.292)
Farm	0.290 (0.621)	1.336 (0.831)
Collective	-0.333 (0.717)	0.716 (0.514)
Heating source (Base: Wood burning)		
Electricity	0.858 (0.308)***	2.358 (0.727)***
Heat pump	0.561 (0.300)*	1.753 (0.526)*
Central heating	1.195 (0.416)***	3.305 (1.375)***
Other	1.039 (0.388)***	2.828 (1.097)***
Employment status (Base: Full-time job)		
Part-time job	0.267 (0.268)	1.306 (0.350)
Temporarily laid off because of Covid-19	1.180 (0.517)**	3.255 (1.683)**

Student	0.120 (0.337)	1.128 (0.380)
Unemployed	-0.014 (0.258)	0.985 (0.254)
Pensioner	0.520 (0.293)*	1.683 (0.493)*
Reducing electricity consumption (Base: Not at all)		
To a high degree	1.479 (0.703)**	4.391 (3.089)**
To some extent	1.424 (0.678)**	4.154 (2.818)**
To an average extent	1.184 (0.690)*	3.269 (2.256)*
To a small extent	1.221 (0.729)*	3.393 (2.475)*
I don't know	0.522 (0.983)	1.685 (1.658)
Following environmental-related pages on social media (Base: Do not Follow)		
Not on social media	0.567 (0.270)**	1.764 (0.477)**
Follow	1.028 (0.175)***	2.796 (0.491)***
Sharing thoughts on social media	0.700 (0.233)***	2.014 (0.470)***
Government should invest more on reducing GHG emissions	0.634 (0.156)***	1.685 (0.294)***
Economy being more important than fighting climate change (CC)	-0.619 (0.156)***	0.530 (0.083)***
Caring about CC	0.505 (0.246)**	1.658 (0.408)**
Using disposable products	-0.207 (0.172)	0.812 (0.140)
Knowledge of Norwegian GE production	-0.265 (0.228)	0.766 (0.174)
Having prior knowledge about GOs	-0.260 (0.185)	0.770 (0.143)
Sorting garbage	0.493 (0.275)*	1.637 (0.451)*
Checking electricity bills	-0.097 (0.167)	0.907 (0.151)
Having a diesel car	0.313 (0.170)*	1.367 (0.233)*
Electricity bill being a burden	-0.083 (0.185)	0.919 (0.170)
Average electricity bill price	2.04e-06 (0.0001)	1.000 (0.0001)
Average income	1.69e-07 (2.06e-07)	1.000 (2.06e-07)
Satisfaction with electricity provider	0.633 (0.250)**	1.884 (0.471)**
Threshold 1	0.548 (0.993)	
Threshold 2	1.718 (0.995)	
Threshold 3	2.106 (0.996)	
Threshold 4	2.451 (0.997)	
Threshold 5	2.750 (0.997)	
Threshold 6	4.367 (1.003)	
Threshold 7	4.559 (1.005)	

Threshold 8	5.166 (1.011)
Threshold 9	5.351 (1.013)
Threshold 10	6.019 (1.027)
Threshold 11	6.428 (1.041)

*Note : P < 0.001 = *** , P < 0.05 = ** , P < 0.1 * , standard errors in parantheses.*

Appendix 3. WTP without 0 values

The full table of the models with only positive WTP (DV: WTP without 0 WTP)

Variable	Interval Regression (Coef.)	Ordinal Logistic (Coef.)
If male pays the bill	0.0006 (0.004)	-0.059 (0.206)
Age	0.0002 (0.0002)	-0.008 (0.009)
Number of family members	0.001 (0.002)	0.025 (0.090)
Location (Base: West)		
North	0.006 (0.008)	0.150 (0.352)
Middle	0.007 (0.007)	-0.372 (0.308)
West	0.011 (0.006)	0.335 (0.283)
East except for Oslo	0.00002 (0.008)	-0.128 (0.343)
Town size (Base: Cities/Large urban areas)		
Rural Areas	-0.008(0.007)	-0.405 (0.317)
Town/Suburbs/small urban areas	-0.016 (0.007)**	-0.615 (0.308)**
Education (Base : Master's or higher)		
Elementary school	-0.001 (0.010)	0.048 (0.433)
High school diploma	-0.019 (0.006)***	-0.638 (0.261)**
Folkeskole	-0.023 (0.012)*	-0.938 (0.569)*
Bachelor	-0.019 (0.005)***	-0.617 (0.238)***
other	0.006 (0.019)	0.442 (0.820)
Dwelling (Base: Apartment)		
House	0.001 (0.006)	0.117 (0.263)
Terraced house	0.006 (0.007)	-0.002 (0.328)
Farm	0.019 (0.017)	-0.644 (0.753)
Collective	-0.026 (0.020)	0.914 (0.861)
Heating source (Base: Warming pump)		
Electricity	0.008 (0.006)	0.471 (0.252)
Wood burning	0.002 (0.009)	0.173 (0.378)
Central heating	0.006 (0.010)	0.469 (0.419)
Other / I don't know	0.019 (0.008)**	0.935 (0.368)**
Sorting trash (Base: Never sort)		
Sort sometimes	0.027 (0.021)	-

Sort most of the times	0.030 (0.020)	-
Sort always	0.042 (0.020)**	-
Sorting trash (binary)	-	0.836 (0.385)**
Following environmental related pages on social media (Base: Do not follow)		
Not on social media	0.022 (0.004)***	1.026 (0.346)***
Follow	0.024 (0.004)***	0.920 (0.209)***
Sharing thoughts on social media	0.024 (0.006)***	1.032 (0.271)***
Government should invest more on reducing GHG emissions	0.003 (0.005)	0.348 (0.391)
Economy being more important than fighting climate change (CC)	-0.015 (0.004)***	-0.565 (0.198)***
Caring about CC	0.010 (0.008)	0.584 (0.233)**
Using disposable products	-0.004 (0.004)	-0.107 (0.212)
Knowledge of Norwegian GE production	0.011 (0.006)*	0.294 (0.284)
Having prior knowledge about GOs	-0.002 (0.005)	-0.037 (0.230)
Sorting garbage	0.023 (0.006)***	0.875 (0.267)***
Checking electricity bills	0.006 (0.004)	-0.177 (0.253)***
Having a diesel car	-0.002 (0.005)	0.016 (0.215)*
Reducing electricity consumption	-0.018 (0.008)**	-0.241 (0.230)
Electricity bill being a burden	-0.013 (0.005)**	-0.666 (0.233)***
Log of average electricity bill price	0.0002 (0.0003)	0.014 (0.014)
Log average income	-0.003 (0.003)	-0.045 (0.143)
Satisfaction with electricity provider	0.020 (0.007)***	0.940 (0.337)***
Preferred source of GE (Base: Source is not crucial)		
Solar	0.014 (0.007)**	0.506 (0.300)*
Wind	0.029 (0.009)***	1.171 (0.394)***
Hydro	0.011 (0.005)**	0.350 (0.206)*
Bio	0.055 (0.014)***	2.017 (0.613)***
Fuel cells	-0.007 (0.021)	-0.545 (1.205)
Gray electricity (Nuclear)	0.052 (0.023)**	2.333 (1.236)*
Employment status (Base: Full-time job)		
Part-time job	0.009 (0.007)	0.165 (0.326)
Temporarily laid off because of Covid-19	0.037 (0.013)***	1.979 (0.612)***
Student	0.001 (0.009)	0.109 (0.408)
Unemployed	-0.004 (0.007)	-0.161 (0.321)

Pensioner	0.011 (0.008)	0.516 (0.372)
Intercept	0.075 (0.050)***	
Threshold 1		0.409 (2.076)
Threshold 2		0.997 (2.078)
Threshold 3		1.469 (2.080)
Threshold 4		1.854 (2.081)
Threshold 5		3.725 (2.085)
Threshold 6		3.933 (2.085)
Threshold 7		4.596 (2.087)
Threshold 8		4.799 (2.088)
Threshold 9		5.540 (2.090)
Threshold 10		6.001 (2.093)

*Note : P < 0.001 = *** , P < 0.05 = ** , P < 0.1 * , standard errors in parentheses.*

Appendix 4. Published Survey (in Norwegian)

Seksjon 1 – Generelle spørsmål

1. Alder:

2. Kjønn:

- Mann
- Kvinne

3. Hvilket fylke er du bosatt i?

- Agder
- Innlandet
- Møre og Romsdal
- Nordland
- Oslo
- Rogaland
- Troms og Finnmark
- Trøndelag
- Vestfold og Telemark
- Vestland
- Viken

4. Hvilken type bolig bor du i?

- Leilighet
- Enebolig
- Rekkehus
- Gård
- Kollektiv
- OPEN: Annet, noter: ________

5. Hvor mange personer bor du sammen med (inkludert deg selv)?

- Jeg bor alene

- 2
- 3
- 4
- 5
- Mer enn 5

6. Hvilket oppvarmingssystem bruker du hjemme?

- Strøm
- Varmepumpe
- Ved
- Sentralfyring
- OPEN: Annet, noter: _______
- Vet ikke

7. Er det du som betaler strømregningene i din husholdning?

- Ja
- Det er inkludert i leie/fellesutgifter
- Min ektefelle/samboer/partner
- Mine foreldre (EXIT SURVEY IF CHOSEN)

Seksjon 2 – Adferdspørsmål

8. I hvilken grad er du enig i følgende uttalelser? (1= Ikke enig i det hele tatt, 5=Helt enig)

	1	2	3	4	5
Myndighetene burde gjøre en større innsats for å redusere klimagassutslipp.					
Den økonomiske utviklingen er viktigere enn klimaendringene eller miljøspørsmål.					
Jeg er opptatt av klimaendringene.					
Jeg bruker engangsprodukter.					

9. Sorterer du eller din husholdning søppel?

- Sorterer alt
- Sorterer det meste
- Sorterer noe
- Sorterer sjelden/aldri

10. Bruker du sosiale medier? (Facebook, Snapchat, Instagram, Twitter, Reddit, Tiktok, etc...)

- Ja
- Nei (til spørsmål 13)

11. I hvilken grad deler du dine tanker, verdier og holdninger til dine venner og følgere på sosiale medier? (1= Jeg har aldri delt noe som helst, 5=Jeg deler regelmessig)

- 1
- 2
- 3
- 4
- 5

12. Følger du noen sider/grupper på sosiale medier som fokuserer på miljøet? Med dette så mener vi sider/grupper som deler informasjon om fornybar energi, bærekraft, sirkulær økonomi, klimaendringer og/eller økologiske produkter

- Ja
- Nei

Section 3 – Strømspørsmål

Fornybar strøm: Strøm produsert av fornybare ressurser for energi som vannkraft, vindkraft, solenergi, bioenergi, bølgekraft og tidevannsenergi. Denne strømmen blir også kalt «grønn strøm».

13. Sjekker du strømregningene når du mottar dem?

- Alltid
- Som regel
- Av og til
- Sjelden
- Aldri

14. Hvor mye av norsk strøm tror du er produsert fra fornybare energiressurser?

- 91% - 100%
- 81% - 90%
- 71% - 80%
- 61% - 70%
- 41% - 60%
- 21% - 40%
- Mindre enn 21%
- Vet ikke

15. Eier du eller din husholdning minst én bil?

- Ja
- Nei (til spørsmål 17)

16. Hvilken type bil/biler? (Du kan velge mer enn ett alternativ)

- Konvensjonell (bensin eller diesel)
- Elektrisk
- Hybrid

17. I hvilken grad gjør du/din husholdning en innsats for å redusere strømforbruket?

- I stor grad
- Til en viss grad
- I mindre grad
- I liten grad
- Ingenting
- Vet ikke

18. Hvor stor byrde er strømregningene for din husholdnings inntekt?

- Veldig stor byrde
- Storbyrde
- Helt OK byrde
- Liten byrde
- Ingen byrde
- Vet ikke

19. Har du hørt om opprinnelsesgarantier før?

- Ja
- Nei
- Vet ikke

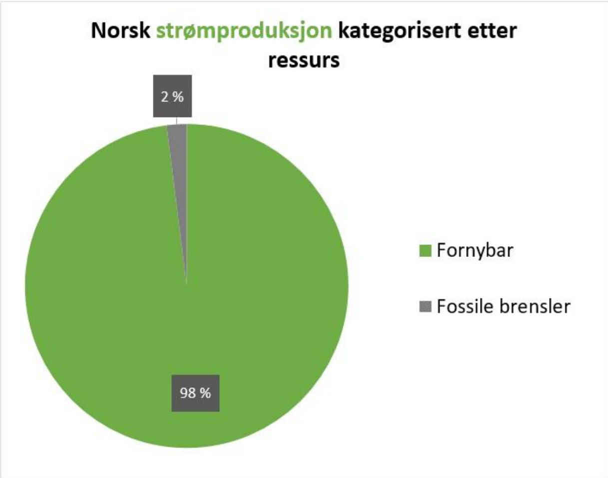
Seksjon 4 - Hva er en opprinnelsesgaranti?

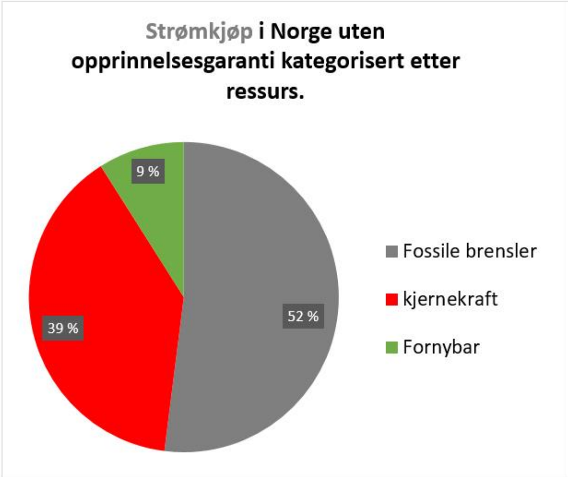
Vennligst les følgende tekst og svar på spørsmålene basert på informasjonen gitt under.

(Statistiske tall er hentet fra Norges vassdrags- og energidirektorat 2019)

Norge **produserer** 98 % av strømmen fra fornybare energiressurser (vannkraft og vind). Om du ikke bevisst kjøper et miljøvennlig strømabonnement vil 91 % av strømmen du kjøper være ikke-fornybar. For å være sikret kjøp fra fornybare kilder må du kjøpe strøm som har «*opprinnelsesgaranti*». Opprinnelsesgarantier vil bli forklart under i denne teksten.

Bildet under viser komponentene for norsk **strømproduksjon** og **strømkjøp uten opprinnelsesgaranti** for 2019.



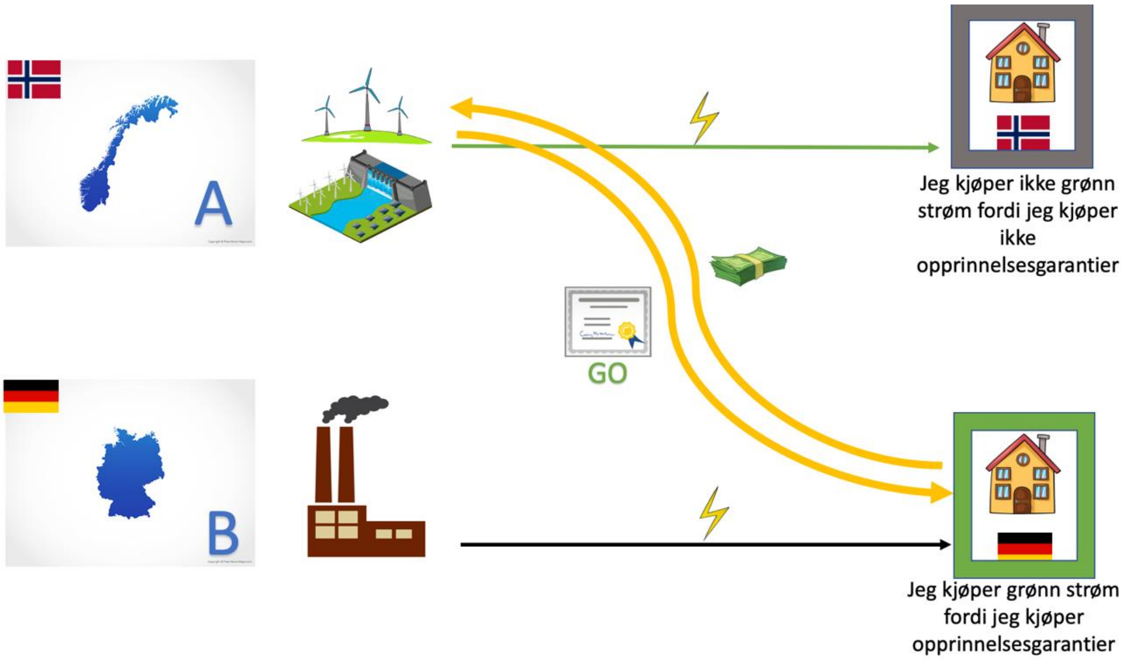


En opprinnelsesgaranti er et sertifikat utstedt for hver enhet av grønn strøm produsert. *For å kunne hevde at strømkjøpet ditt er grønt må du kjøpe opprinnelsesgarantier*. *Dette systemet startet som en løsning for konsumenter som kun ønsket å bruke grønn strøm.*

All strøm produsert i Europa er blandet på strømnettet. Det finnes ikke et eget nettverk for strøm produsert fra fornybar energi. Det krever store infrastrukturinvesteringer og energitap å installere et eget fysisk nettverk for grønn strøm. Med opprinnelsesgarantier trenger man det heller ikke.

En opprinnelsesgaranti representerer forbruket av en enhet av grønn strøm, og kan dermed kun forbrukes en gang. AIB (Association of Issuing Bodies) har ansvar for oppsyn i Europa. Norge er den største eksportøren av disse sertifikatene i Europa, og Tyskland er den største kjøperen.

En forenklet illustrasjon av hvordan opprinnelsesgarantier fungerer er vist i bildet under:



For å bedre forstå konseptet, har vi laget følgende eksempel:

Land A og land B produserer hver 10 enheter strøm. Land A produserer kun grønn strøm og mottar dermed 10 opprinnelsesgarantier som det kan selge videre. Land B produserer ikke grønn strøm og mottar dermed 0 opprinnelsesgarantier. Hvis land A selger 8 stk opprinnelsesgarantier til land B, vil:

- Strømkjøpet til land B nå bestå av 80 % grønt og 20 % ikke-grønt (husk at land B ikke produserer fornybar strøm). Dette er lignende det som skjer i Tyskland.
- Strømkjøpet til land A nå bestå av 20 % grønt og 80 % ikke-grønt (husk at land A produserer kun fornybar strøm). Dette er lignende det som skjer i Norge.

20. Hvor mye betaler din husholdning gjennomsnittlig i strøm per måned?

➡NB! Strømprisene varierer mye (de har vært spesielt høye de siste tre månedene). Merk at dette estimatet skal være et noenlunde gjennomsnitt for hele året.

- Mindre enn 500 NOK
- 501 - 700 NOK
- 701 - 900 NOK
- 901 - 1200 NOK
- 1201 - 1500 NOK
- 1501 - 2000 NOK

- 2001 – 2500 NOK
- 2501 – 3000 NOK
- OPEN: Mer enn 3000 NOK. Ca. hvor mye? _____ NOK

21. Basert på informasjonen over og til en fornuftig pris (for deg), hadde du vært villig til å kjøpe strøm med opprinnelsesgaranti?

- Ja (Gå til spørsmål 22)
- Nei (Gå til spørsmål 25)

22. Hvis du skulle abonnert på opprinnelsesgarantier, hvilken av de følgende fornybare energiressurser ville du valgt? (FILTER: ONLY IF Q21:JA)

- Det er ikke så farlig så lenge det er fornybar energi.
- Solenergi
- Vindkraft
- Vannkraft
- Bioenergi
- Brenselcelle
- Annet: _____________

23. I prosent, hvor mye ekstra ville du vært villig til å betale for å sikre deg et 100% «grønt» strømkjøp via opprinnelsesgarantier? Opprinnelsesgarantiene kan bli kjøpt gjennom din strømleverandør og du vil betale en månedspris.

→ Husk at denne kostnaden vil gå ut over ditt budsjett. Du vil dermed ha mindre til rådighet for andre produkter og tjenester.

- Vennligst velg din maksimale betalingsvillighet per måned for kjøp av opprinnelsesgarantier mellom alternativene under:

  - 2%
  - 4%
  - 6%
  - 8%
  - 10%
  - 12.5%

- 15%
- 17.5%
- 20%
- 22.5%
- 25%
- Mer enn 25%, hvor mye ? ______%

24. Hvor fornøyd er du med din strømleverandør på en skala fra 1 til 5 (1=Veldig misfornøyd, og 5=Veldig fornøyd)

- 1
- 2
- 3
- 4
- 5

25. Hva er den viktigste årsaken til at du ikke ville vært villig til å kjøpe strøm med opprinnelsesgaranti? (FILTER: ONLY IF Q21:NEI)

- Jeg tror ikke at klimaendringene er et reelt fenomen.
- Jeg tror klimaendringene er et ekte fenomen, men jeg tror ikke slike ordninger er effektive.
- Jeg tror klimaendringene er et ekte fenomen, og jeg tror også at slike ordninger er effektive, men jeg vil ikke betale for dem.
- Annet (vennligst spesifiser: ____)

Seksjon 5 – Demografiske spørsmål

26. Hva er ditt utdanningsnivå (inkludert programmet du er påmeldt nå om du er student)?

- Ungdomsskole eller lavere
- Videregående vitnemål
- Fagbrev
- Bachelorgrad

- Mastergrad elller høyere

27. Arbeidsstatus

- Yrkesaktiv (fulltid)
- Arbeidsledig
- Permittert
- Hjemmeværende
- Pensjonist
- Trygdet
- Student/Deltidsjobb

28. Hva er din husholdnings årlige gjennomsnittsinntekt før skatt?

- Mindre enn 100 000 NOK
- 100 000 - 300 000 NOK
- 300 001 – 500 000 NOK
- 500 001 – 800 000 NOK
- 800 001 – 1 200 000 NOK
- 1 200 001 – 2 000 000 NOK
- Mer enn 2 000 000 NOK

Appendix 5. Translation of Survey

Section 1 – General questions

1. Age

- Less than 18
- 18 - 27
- 28 - 37
- 38 - 47
- 48 - 57
- 58 – 67
- 68 or more

2. Gender

- Male
- Female

3. What region do you live? (e.g, Hordaland, Rogaland, Nord-Trøndelag, etc.)

- Agder
- Innlandet
- Møre og Romsdal
- Nordland
- Oslo
- Rogaland
- Troms og Finnmark
- Trøndelag
- Vestfold og Telemark
- Vestland
- Viken

4. What type of residence do you currently live in?

- Apartment
- House

- Farm
- Row Housing
- Semi-housing (dormitory, multi-living facility)
- Others, note (………)

5. How many are living in your households (including you)?

- I live alone
- 2
- 3
- 4
- 5
- More than 5

6. What is your heating source?

- Electricity
- Heat pump
- Wood
- Central heating
- Others, note: …….
- I don't know

7. Are you the person paying the electricity bill?

- Yes
- My spouse/boyfriend/partner pays
- It's included in the rent/common expensess
- My parents pay (Finish the survey)

Section 2 – Behavioral Questions

8. To what extent do you agree with the following statements? (1= completely disagree, 5=completely agree)

Statement	1	2	3	4	5

The government should make active efforts to reduce greenhouse gas emissions.					
The economic development is more important than climate change or environmental issues.					
I am so much concerned about climate change.					
I use disposables					

9. Do you or your household sort the waste?

- Everything
- Most of the things
- Some of the things
- I do not sort

10. Are you a user of social any media (Facebook, Snapchat, Instagram, Twitter, Reddit, Tiktok etc...)

- Yes
- No (go to quest. 13)

11. To what extent do you care about sharing your thoughts, values, and behavior to your friends and followers on social media? (1= I have never share anything, 5=I share content regularly)

- 1
- 2
- 3
- 4
- 5

12. Do you follow any page/group on social media that is focused on environment? By this we mean pages/groups that share information about renewable energy, sustainability, circular economy, climate change and/or organic products.

- Yes
- No

Section 3 – Electricity questions

<u>Renewable Electricity</u>: Electricity produced from renewable energy resources like hydro, wind, solar, geothermal or biomass also known as green or clean electricity.

13. Do you to check your electricity bill when you get them?

- Always
- Mostly
- Occasionally
- Hardly
- never

14. In your opinion, how much of the electricity produced in Norway is from renewable energy resources?

- 91% - 100%
- 81% - 90%
- 71% - 80%
- 61% - 70%
- 41% - 60%
- 21% - 40%
- Less than 21%
- I don´t know

15. Do you or your household owns a car?

- Yes
- No (Go to question 17)

16. Which type of the followings? (you can choose more than one option)

- Conventional (Diesel/Gasoline)
- Hybrid
- Electric

17. Is your household making an effort to reduce electricity consumption?

- We are/I am actively trying
- To some extent yes
- To a normal extent
- Very little
- Not at all
- I don’t know

18. How much of a burden are the electric bills relative to your family´s income?

- very burdensome
- Somewhat burdened
- Appropriate
- Little
- No burden at all
- I don’t know

19. Have you ever heard about Guarantees of Origin before?

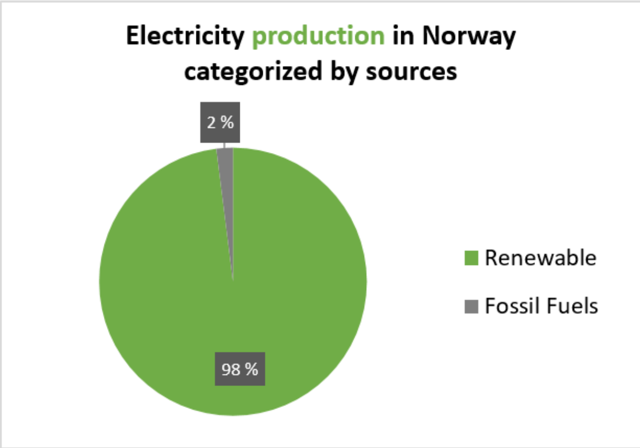
- Yes
- No

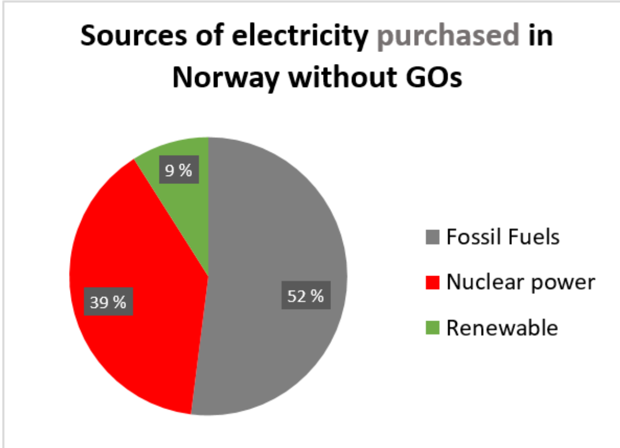
Section 4 – GO

(Statistical numbers are retrieved from NVE 2019)

Norway **produces** 98% of its electricity from renewable energy (hydro and wind). However, if you don’t buy an explicit green electricity plan, 91% of your electricity purchase **cannot** be considered as renewable electricity. The reason behind this difference is “*guarantees of origin*” also called GOs. GOs will be explained further in this text.

The charts below shows the components of Norwegian **production** and **electricity purchase without GOs** for 2019.



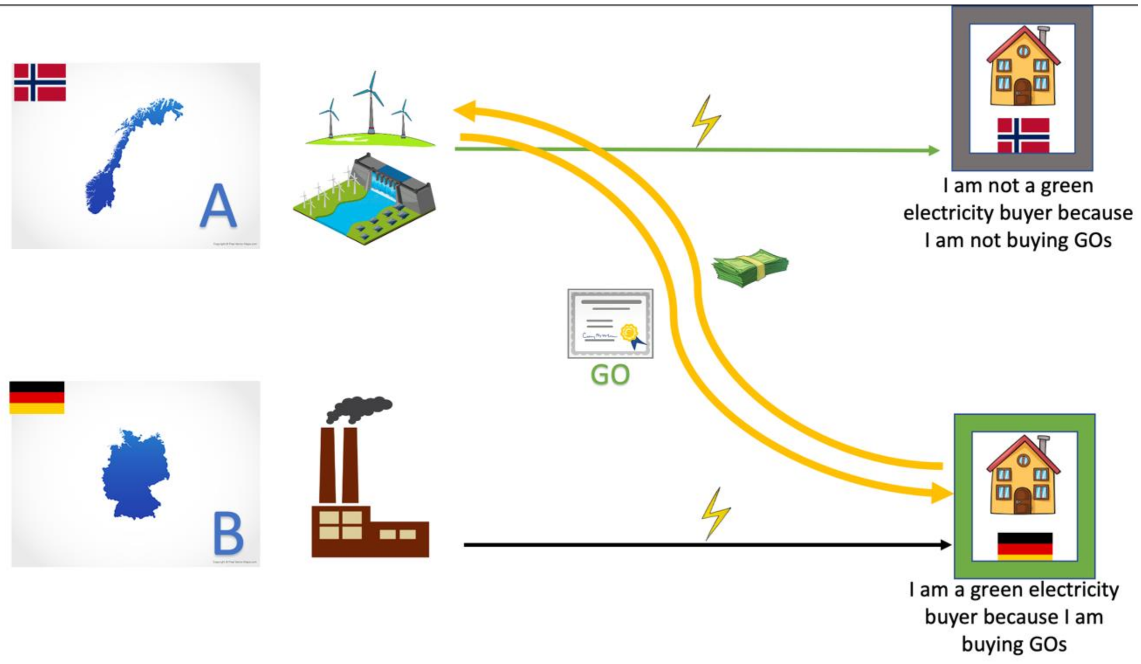


A GO is a certificate (paper) issued for every unit of green electricity produced. The only way for you to have the right to claim that you acquire one unit of green electricity is by purchasing one GO. The GO system started as a solution for making electricity trade smoother.

In Europe, all electricity produced is blended on the grid. Physical export/import of only green electricity needs a huge investment in infrastructure, and also lots of energy will waste during the transfer. However, by trading GOs there is no need for physical transfer of electricity.

Every unit of GO can only be used once. AIB (Association of Issuing Bodies) is responsible for supervision in Europe. Norway is the largest exporter of these certificates in Europe, and Germany is the largest customer.

In the picture below, you can see a simplified illustration of how GOs work:



To understand the concept of GO better, consider the following simplified case:

Country A & B both produce and consume 10 units of electricity each. Country A produced only green electricity which gives them 10 GOs to sell, and country B produces only non-renewable electricity which results in 0 GOs. If country A sells 8 GOs to country B, then:

- Country A's electricity *purchase* becomes 20% green electricity and 80% non-renewable electricity (Country A produces 100% renewable energy). *Country A is similar to what happens in Norway.*

- Country B's electricity *purchase* becomes 80% green and 20% non-renewable (Country B produces 0% renewable energy). *Country B is similar to what happens in Germany.*

20. How much does your household pay the average **monthly** electricity bill?

➞ *Please Note that electricity charges vary by season (especially during last three months it was so high), but please choose the average amount.*

- Less than 500 NOK
- Between 501 - 700 NOK
- Between 701 - 900 NOK
- Between 901 - 1200 NOK
- Between 1201 - 1500 NOK
- Between 1501 - 2000 NOK
- Between 2001 – 2500 NOK
- Between 2051 – 3000 NOK
- Higher than 3000 please indicate: ………….

21. Based on the information given above, are you willing to buy GOs for a reasonable price (reasonable for you)?

- Yes (Go to question 22)
- No (Go to question 24)

22. If you subscribe to GOs, which of the following energy source would you pick?

- It doesn't matter as long as it is from renewable source.
- Solar
- Wind power
- Hydro
- Bio Energy
- Fuel cell
- Others (please specify …………….)

23. In percentage, how much is the maximum additional money per month you are willing to pay to ensure buying 100% green electricity through buying GOs? The GOs can be purchased through electricity providers, and you will be charged monthly on your bill. ➞ *Please note that it means you will have less amount of money to spend on other goods and services.*

- Your maximum willingness to pay for GOs per month is:
- 2%
- 4%
- 6%
- 8%

- 10%
- 12.5%
- 15%
- 17.5%
- 20%
- 22.5%
- 25%
- More than 25%, how much? ______%

24. How much satisfied are you with your electricity provider on a scale from 1 to 5 (1= completely dissatisfied, 5= completely satisfied)?

- 1
- 2
- 3
- 4
- 5

25. What is the main reason you would not be willing to buy electricity with a guarantee of origin?

- I don´t believe climate change is a real phenomenon
- I believe climate change is a real phenomenon, but I don´t think such programs are effective.
- I believe climate change is a real phenomenon, I also think such programs are effective, but I don´t want to pay.
- Others (please specify:-------------------)

Section 5 – Demographics

26. What is your highest level of education (including the education you are studying if you are student)

- Middle School diploma or less
- High school diploma
- Fagbrev (a Norwegian diploma)
- Bachelor

- Master or higher

27. Employment status

- Working full-time
- Unemployed
- Temporarily laid off because of COVID-19
- On Parental leave
- Retired
- living on unemployment benefits
- Student/working part time

28. Could you indicate your households' average yearly income before tax?

- Less than 100 000 NOK
- 100 001 - 300 000 NOK
- 300 001 – 500 000 NOK
- 500 001 – 800 000 NOK
- 800 001 – 1 200 000 NOK
- 1 200 001 – 2 000 000 NOK
- More than 2000 000 NOK

Appendix 6. Correlation matrix

	Age	Town Size	Education	Household number	Male paying bill	More investment on CC	Economic growth vs. fighting CC	Caring about environment	Using disposables	Sorting trash	Using social media	Sharing content on social media	Following environmental related pages	Checking electricity bills	Knowledge about Norway's GE production	Having a diesel car	Having an electric car	Reducing electricity consumption	Electricity bill being a burden
Age	1.00																		
Town size	-0.09	1.00																	
Education	0.02	0.14	1.00																
Family size	-0.20	-0.10	0.05	1.00															
Male paying bill	0.24	-0.02	0.05	0.08	1.00														
More investment on reducing GHG emissions	-0.13	0.08	0.14	0.05	-0.12	1.00													
Economic growth vs. fighting climate change (CC)	-0.01	-0.06	-0.10	0.05	0.11	-0.36	1.00												
Caring about CC	-0.14	0.11	0.14	0.10	-0.14	0.63	-0.41	1.00											
Using disposables	-0.22	0.05	-0.01	0.14	0.03	0.01	0.19	-0.06	1.00										
Sorting trash	-0.14	0.02	-0.06	-0.01	-0.06	-0.14	0.08	-0.16	0.18	1.00									
Using social media	-0.25	-0.01	-0.04	0.07	-0.18	0.06	0.00	0.05	0.13	0.02	1.00								
Sharing content on social media	-0.20	0.04	-0.02	0.13	-0.06	0.09	0.08	0.09	0.14	-0.04	0.38	1.00							
Following environmental-related pages	-0.31	0.06	0.03	0.12	-0.15	0.20	-0.09	0.25	0.03	-0.06	0.65	0.46	1.00						
Checking electricity bills	0.24	-0.08	0.08	0.00	0.25	-0.03	0.09	0.01	-0.08	-0.11	-0.05	0.03	-0.05	1.00					
Knowledge of Norway's GE production	0.11	0.01	0.11	0.05	0.23	0.06	-0.02	0.01	0.02	-0.09	-0.07	-0.02	-0.04	0.07	1.00				
Having a diesel car	0.17	-0.34	-0.03	0.17	0.12	-0.16	0.13	-0.13	-0.04	-0.06	-0.06	-0.07	-0.10	0.08	0.05	1.00			
Having an electric car	0.09	0.02	0.04	-0.09	-0.04	-0.03	-0.06	-0.03	-0.02	-0.01	-0.04	0.01	0.00	0.07	-0.09	-0.02	1.00		
Reducing electricity consumption	0.01	0.05	-0.03	0.01	-0.03	-0.15	0.06	-0.21	0.19	0.30	0.06	-0.13	-0.08	-0.28	-0.03	-0.01	0.02	1.00	
Electricity bill being a burden	-0.03	0.15	0.02	-0.13	-0.01	0.10	-0.07	-0.01	0.00	0.06	-0.02	-0.13	-0.09	-0.26	0.08	-0.13	-0.08	0.21	1.00

Electricity bill being a burden

Prior knowledge about GOs	0.07	0.03	0.16	0.10	0.26	0.09	0.04	0.01	0.01	-0.15	0.01	0.11	0.15	0.13	0.27	-0.02	0.05	-0.09	0.02	1.00	**Prior knowledge about GOs**				
Electricity bill range	0.23	-0.29	0.03	0.32	0.16	-0.12	0.05	-0.01	-0.05	-0.06	-0.03	-0.07	-0.08	0.24	0.05	0.27	-0.01	-0.01	-0.36	0.02	1.00	**WTB**			
WTB	-0.14	0.03	0.05	0.07	-0.19	0.21	-0.20	0.27	-0.03	-0.08	0.05	0.13	0.19	-0.03	-0.12	0.02	0.00	-0.17	-0.11	-0.07	-0.03	1.00	**WTP**		
WTP	-0.16	0.11	0.12	0.10	-0.12	0.28	-0.18	0.33	0.03	-0.14	0.02	0.23	0.28	-0.04	-0.02	-0.03	0.00	-0.11	0.00	0.05	-0.06	0.62	1.00	**Satisfaction provider**	
Satisfaction with provider	0.06	0.05	0.02	-0.01	-0.02	0.00	0.08	0.01	0.01	-0.05	0.03	0.04	0.05	0.00	0.07	-0.01	0.00	0.03	0.21	0.14	-0.15	0.02	0.08	1.00	**Income**
Income	0.17	-0.09	0.26	0.32	0.19	-0.02	0.04	-0.01	-0.03	-0.07	-0.04	-0.10	-0.12	0.13	0.13	0.19	-0.07	0.02	0.12	0.08	0.29	-0.02	-0.01	0.04	1.00