



# Analysis of the trade in Guarantees of Origin

*Economic analysis for Energy Norway*

*OE-report 2017-58*

## Oslo Economics

*Oslo Economics provides economic analysis and strategic advice to companies, governmental bodies and NGOs. Our services include cost-benefit analysis for political decision-making, competition economics in antitrust, mergers and acquisitions, economic analysis in commercial litigation and damages, evaluations of public policy and productivity, health economic analysis and strategic advice. Our economists have experience from public government, consultancies and research institutions. We provide insight and analysis based on industry experience, strong economics expertise and an extensive network of partners and business relations.*

## Energy sector expertise

*Our energy team has substantial knowledge and insight into the energy market in general and the electricity market in particular. We have knowledge about the regulation and organisation of power market, electricity trading and physical properties of the grid system. Moreover, our consultants have knowledge about policy and regulatory energy issues at a European level and how this affects the regulatory framework and organisation of the power sector in Norway. Several of our consultants have experience from the Norwegian Transmission System Operator (Statnett) and the Ministry of Petroleum and Energy.*

*Analysis of the trade in Guarantees of Origin/report 2017-58*

*© Oslo Economics, 16. januar 2018*

*Contact:*

*Jostein Skaar / Partner*

*jsk@osloeconomics.no, Tel. +47 959 33 827*

# Table of Contents

|  |           |
|--|-----------|
| <b>Executive summary</b>   | <b>4</b>  |
| <b>1. Mandate and information sources</b>                                  | <b>7</b>  |
| <b>2. Description of the trade in Guarantees of Origin</b>                 | <b>9</b>  |
| 2.1 What are Guarantees of Origin?   | 9         |
| 2.2 End-user demand for Guarantees of Origin                               | 11        |
| 2.3 The trade in Guarantees of Origin: Buyers, sellers and intermediaries  | 16        |
| 2.4 Prices and volumes in the wholesale market for Guarantees of Origin    | 18        |
| <b>3. Comparison with the trade in other renewable products</b>            | <b>22</b> |
| 3.1 Forms of trade   | 22        |
| 3.2 Comparison with other renewable products                               | 24        |
| 3.3 How other renewable products are traded                                | 26        |
| <b>4. Evaluation of the markets for and trade in Guarantees of Origin</b>  | <b>29</b> |
| 4.1 Introduction to the evaluation   | 29        |
| 4.2 Evaluation of the markets for Guarantees of Origin                     | 29        |
| 4.3 Comparison of wholesale and end-user market prices                     | 32        |
| 4.4 Wholesale trade: Evaluation of liquidity and informative prices        | 33        |
| <b>5. Developments in the trade in and market for Guarantees of Origin</b> | <b>35</b> |
| 5.1 Recent development   | 35        |
| 5.2 Possible future development  | 36        |
| 5.3 Recommended measures to improve the markets for GOs                    | 37        |
| <b>6. References</b>   | <b>40</b> |

## Executive summary

*A Guarantee of Origin (GO) is an electronic document that verifies to an electricity customer that a quantity of power, corresponding to a quantity or share of the power it consumes, has been produced from a specified (renewable) energy source. To consumers, GOs are sometimes priced explicitly, but more often they are bundled with other attributes or included “for free” in the electricity tariff or in consumer products and services. Consumers’ different preferences and perceptions of what is environmentally friendly have given rise to a wide variety of GO products. This product heterogeneity is the main reason why GOs are not exchange-traded. In the wholesale market, GOs are mainly traded through brokers, but also via trading houses and directly between producers and large businesses. We consider the wholesale trade to be well-functioning, with good liquidity, good information and transparency as well as low transaction costs for the most frequently traded GO products. However, the consumer/ end-user markets are characterised by insufficient transparency. We have identified three possible measures to increase transparency and trust in the end-user market for GOs: Harmonisation of marketing terms, price comparison tools for consumers and an annual survey analysing the market development.*

### Mandate and scope

Energy Norway, an industry organisation representing Norwegian companies involved in the production, distribution and trading of electricity, has commissioned a study into the market for and trade in Guarantees of Origin (GOs) from Oslo Economics. One of the purposes of the report is to provide Energy Norway with a basis for providing policy suggestions regarding GOs to the Norwegian Ministry of Petroleum and Energy, and to the European Commission.

In this report, we describe the trade in GOs, compare it with the trade in other “renewable products”, evaluate the market for and trade in GOs according to economic criteria, and describe the recent and possible future development in the trade in GOs.

### Description of the trade in Guarantees of Origin

The GO system was established in EU-legislation mainly aimed at giving consumers (households) a European tool to choose the (documented) origin of their power. This has enabled businesses and consumers to satisfy their demand for buying environmentally friendly products, services and investments. Consumers’ different preferences and perceptions of what is environmentally friendly have given rise to a wide variety of GO products. For instance, many consumers prefer GO products from recent and/or local power plants, which are regarded as contributors to additional renewable power production in a specific geographic area.

In the end-user markets, GOs are sold to businesses and consumers. Most GOs (around 70 per cent) are sold to businesses who want to document their renewable power claim. For example, in the RE100 initiative, over one hundred large multinationals have committed themselves to “go 100 per cent renewable”. To achieve their renewable energy targets and document their renewable claims to customers, investors and other stakeholders, these companies purchase GOs. Businesses buy different GOs depending on their renewable energy strategies and marketing goals. Some businesses simply buy the cheapest available renewable GO product, others require GO products from power plants in certain locations and with certain technologies, for instance “Dutch Wind”, while others demand customised GO products, for instance from a specific new solar power plant.

Consumers typically receive GOs included as one of many attributes of a product/electricity tariff they purchase. In other cases, the price related to the GOs in the electricity contract is bundled with the price

for other “renewable products”, for example donations to forest protection. Sometimes, the price to the consumer of the renewable attribute (GO) is presented explicitly on the electricity bill. There are examples of consumer prices of non-specific renewable GOs around 2 EUR/MWh.

In the wholesale market, GOs are usually sold from large power producers and from “portfolio companies” representing several small producers, often via brokers, to retail power suppliers. A few portfolio companies and brokerage firms also operate as “trading houses”, by keeping inventories of GOs that they package and put to the market. In addition, substantial volumes are sold bilaterally from large power producers and portfolio companies to retail power suppliers and large businesses.

Wholesale prices for GOs vary over time and between different categories of GOs. According to the GO analysis firm Greenfact, the average prices between Oct. 2016 and Oct. 2017 of common GO products span from 0,26 EUR/MWh for Large Nordic Hydro GOs to almost 3 EUR/MWh for Dutch Wind GOs in the period Oct. 2016 - Oct. 2017. These prices are equivalent to ~1 per cent and ~8 per cent of Norwegian and Dutch wholesale electricity prices respectively. The estimated market value of European GOs from Oct. 2016 – Oct. 2017 is between 240 and 400 MEUR. Of this, Norwegian GOs were worth approximately 35 MEUR. Since October 2017, GO prices have increased significantly and current 2018 prices for Large Nordic Hydro GOs are traded at around 0,5 EUR/MWh, almost twice as high as average prices between Oct. 2016 and Oct. 2017.

### Comparison with the trade in other renewable products

GOs are not easily compared to other renewable products such as electricity and el-certificates. GOs are not a physical necessity, such as electricity is to end-users, nor mandatory, such as el-certificates are to the power suppliers or emission allowances to certain industries under the EU-ETS scheme. However, GOs share many properties with voluntary carbon offsets and the market for organic food. These markets are characterised by a large product variety (heterogeneity) that can be explained by the fact that consumers have different preferences and perceptions of different instruments’ environmental value.

The heterogenous demand for renewable energy means that a standardisation of GO products to a least common denominator (i.e. renewable GO or Hydro GO) could reduce the value of the GOs to the consumers, for instance the local/national/technology specific attributes of the GO. This explains why exchange trade of GOs has been unsuccessful, as it requires relatively large trading volumes for each traded product (to be cost-effective compared to brokers and bilateral trade). We expect that brokers, trading houses and bilateral trade will continue to be the predominant wholesale market places going forward.

### Evaluation of the market for and trade in GOs according to socio-economic criteria

While there is a wholesale market for GOs, there is not one single end-user market. Instead, there are several markets, for instance the electricity, public transportation and home appliances markets, where GOs are one of many attributes. We have evaluated both the wholesale trade, as well as the wholesale market and the end-user markets for GOs.

While the market is the structure enabling supply to meet demand, trade is the activity of buyers and sellers exchanging products. To evaluate the wholesale trade, we have used the main criteria for a well-functioning trade, i.e. that that markets should be liquid, with low trading costs, and that there should be timely disclosures of financial information, resulting in market prices reflecting all available information. By these criteria, the wholesale trade in GOs can be said to be well-functioning, especially for high volume products (such as Large Nordic Hydro and EU Wind). However, for less frequently traded products, such as “Bra Miljöval<sup>1</sup> Hydro”, there is less available supply, meaning that changes in demand and supply result in larger price variations than for high-volume products.

To evaluate the end-user markets for GOs, we have used four criteria for perfectly competitive markets (absence of market power, no barriers to entry, perfect information and rational players making active choices). Based on these criteria, we consider that the competition in the end-user markets

---

<sup>1</sup> Environmental/ nature protection ecolabel.



is not perfect. There is a very large product variety, which can be explained by consumers having different preferences and perceptions of what is environmentally friendly, but which is accentuated by the bundling of GOs with other attributes and with the many different labels and marketing terms. This, in turn, affects transparency and end-users' possibility to compare products, which hinders price comparisons and thus price competition in the end-user markets. In addition, competition in the end user markets is restricted by the lack of competition in some of the underlying products markets, where GOs are included as one of many attributes (e.g. the market for railroad tickets in many European countries).

There can be relatively large differences between the wholesale and the end-user market GO prices. While producers received around 0,3 EUR per MWh between Oct. 2016 and Oct. 2017 (source Greenfact), there are examples of consumers paying around 2 EUR per MWh for similar types of GOs. Although a price difference of for instance 1,7 EUR/MWh is not large in absolute terms, it is relatively large compared to the fairly low wholesale price of 0,3 EUR/MWh. This relative price difference can be explained mainly by distribution/marketing costs; while a few employees in the biggest companies handle the wholesale trade, it takes many more employees to market and sell relatively small volumes in the end-user markets. We note that relatively large price differences between wholesale and end-user markets are common in several markets, for instance in the clothing, furniture and lighting business. The price to the private consumers is fairly low as a share of their total energy costs. 2 EUR/MWh (or 0,2 eurocent/kWh) corresponds to 1-2 per cent of the total electricity bill of an average consumer.

### **Description of recent and possible future development in the trade in GOs**

Since 2010, many new GO products for consumers and businesses have been developed, including additionality products. In the same period, the wholesale market has been professionalised. The wholesale trade, which in 2014 was described by the German Federal Environment Agency (Umweltbundesamt) as non-transparent, has seen improvements in form of a larger share of broker traded volumes, more quoted prices and a new offer of analytical services. The producers we interviewed in this study all report that they view the transparency and trust in the wholesale market as good.

In the short term, the market for GOs is mainly demand driven, as supply is largely inelastic. Therefore, a change in demand (for instance due to changes in EU-regulation) may result in large changes in GO prices. In the long term, the increasing share of renewable electricity production in Europe will affect the supply and thus price of GOs. Currently, the market is characterised by large price differences between "bulk", "premium" and "customised" GO products. Market players we have interviewed observe a trend towards increasing end-user demand for premium (national) and customised (local) GOs. The wholesale market is likely to adapt to end-user demand, perhaps leading to a smaller share of volumes being sold as "bulk" products (e.g. Large Nordic Hydro).

To improve competition in the end-user markets for GOs going forward, we have identified three possible measures, which can be implemented by industry organisations, national governments and/or the EU. The first is to harmonise across Europe the terms and definitions used to market renewable energy based products and power. For instance, there can be standards for what is meant by "renewable", and to what extent other terms, such as "green" or "environmentally friendly" can be used to market renewable power. The second is to establish retail power price comparison tools for consumers in all European countries that allows for direct comparisons of the prices of different types of renewable electricity offers (depending on technology, nationality etc.). The final measure is to commission an annual survey analysing the market development in the wholesale and end-user markets for GOs. These measures could help improve transparency and thus the market for and trade in GOs in general.

# 1. Mandate and information sources

## Mandate

This analysis of the trade in Guarantees of Origin has been commissioned from the consultancy firm Oslo Economics by the trade organisation Energy Norway. Energy Norway represents about 270 companies involved in the production, distribution and trading of electricity in Norway. The purpose of the study is to provide Energy Norway with a thorough basis for providing policy suggestions regarding GOs to the Norwegian Ministry of Petroleum and the EU commission.

## Background

Renewable Energy Guarantees of Origin appeared in the EU Directive 2001/77/E, which introduced a duty on all Member States to develop a reliable tracking scheme. GOs are defined as:

*"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"*

GOs are also regulated by the Electricity Market Directive (2009/72/EC), which regulates that a fuel mix disclosure (share of electricity supply from fossil, nuclear and renewable power plants) should be made based on the trade with GOs and not physical power production in the region or country.

Amendments to the GO scheme is currently discussed in the ongoing revision of the EU Renewable Energy Directive REDII, also known as the EU Winter Package<sup>2</sup>, and expected to be adopted in 2018 for the period 2020-2030. Among other things, these revisions include suggestions towards making GOs mandatory for power suppliers making renewable claims, and an extension of the GO system to other energy sources (gas, heating and cooling). Furthermore, GOs from generators (power plants) that receive support are to be sold on auction by the government and go towards reducing costs of other support schemes.

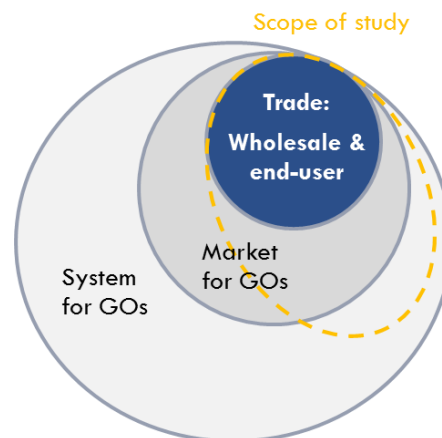
Energy Norway wants to contribute to develop the GO system further, and contribute to a well-functioning market, with a focus on the end customer. One topic of concern is whether the end consumers (households) have confidence in the price formation and relevant information on what they pay for when purchasing "renewable power" from their power supplier or products or services from companies that market themselves as renewable. Since it is voluntary to buy GOs, there is a risk that the consumers and business will abstain from buying GOs if they do not trust the price formation (Energy Norway, 2017).

## Scope of the study

A market is a structure which enables buyers and sellers to exchange goods, services and information. The main function of the market is to value any product with a price, which is influenced by supply and demand. This ensures that society's resources are distributed to those with the highest willingness to pay. While the market is the structure enabling supply to meet demand, trade is the activity of buyers and sellers exchanging products.

The main topic of this report is to describe the trade in GOs, assess evaluate it according to economic criteria and describe its recent and possible future development. To do this in meaningful way, we will also, to a certain extent, describe market for GOs in general (supply and demand) and the GO system, see Figure 1-1.

Figure 1-1: Scope of study



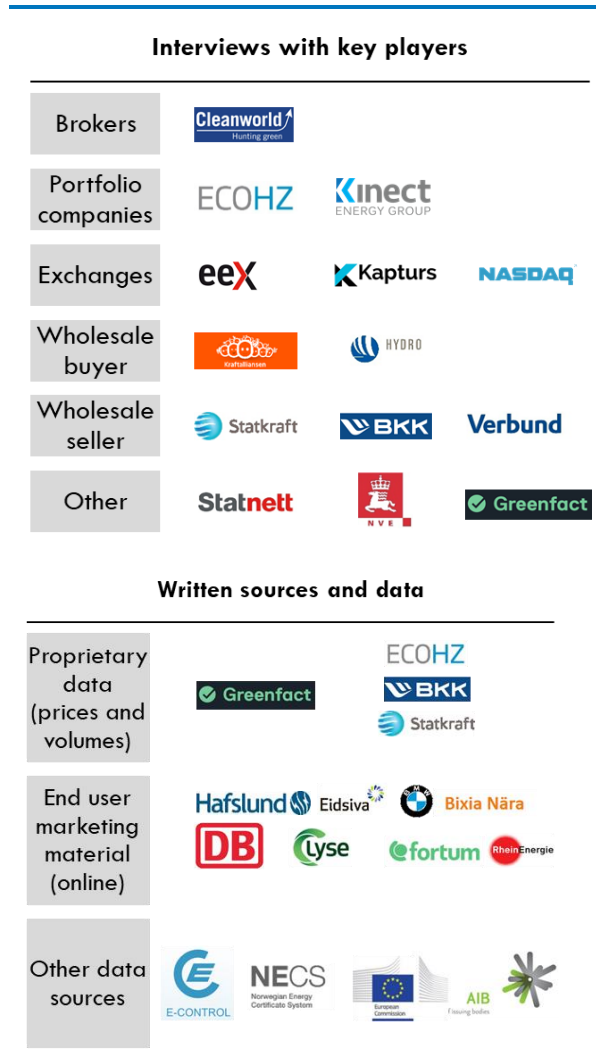
Source: Oslo Economics

<sup>2</sup> The European Commission's proposal for a revision (COM(2016)0767)

## Information sources

This study is mainly based on interviews with key market participants, written sources and publicly available and proprietary data provided by market participants, see Figure 1-2.

**Figure 1-2: Information sources**



- Claudia Grill, Verbund
- Alexandra Mara Münzer, Greenfact
- Morten Vikanes, Kapturs
- Steffen Riediger and Heine Rønningen, The European Energy Exchange (EEX)
- Nina Lillelien and Kristin Nilssen, Norsk Hydro
- Torkel Rolfseng, Trondheims kraft (Fjordkraft)

Central data for prices and volumes have been data provided Greenfact and ECOHZ, as well as publicly available data from national certificate registries and the Association of Issuing Bodies (AIB). In addition, we have received some price information from BKK and Statkraft.

We would like to thank the working group on Guarantees of Origin of Energy Norway for their contributions in the discussion of our preliminary findings. The working group consists of ECOHZ, Fjordkraft, Statkraft, SKS Kraftsalg, Agder Energi, BKK, Trønder Energi, Hafslund, Skagerak Energi, Østfold Energi and E-CO Energi.

In addition to the meeting with the working group, the preliminary findings have been presented to representatives from The Norwegian Water Resources and Energy Directorate (NVE) and the Ministry of Petroleum and Energy.

Finally, we would like to thank Energy Norway's representatives Sigrd Hjørnegård, Knut Kroepelien, Ole Haugen, Guro Wensaas and Lars Ragnar Solberg for their contribution and opportunity to conduct this survey.

The study was conducted between October 2017 and January 2018. The core team from Oslo Economics consisted of Jostein Skaar (partner/quality assurance), Svend B. Boye (project manager), Thea Sand (analyst) and Kirsten Grebstad (electricity end-user market expert).

Oslo Economics would like to thank the following interviewees for providing us insights into the market and trade in GOs:

- Mari Hegg Gundersen (Energy Systems) and Christina Stene Beisland (Energy Market Regulation) w/ colleagues, NVE
- Ivar Munch Clausen and Vibeke Midttun Borgersen, Statnett/NECS
- Thomas Fjeldheim w. colleague, Statkraft
- Tom Lindberg and Nikolai Iversen, ECOHZ
- Preben Klyve Olsen and Ann-Mari Løberg Knudsen, BKK
- Anette Gussiås, Kinect Energy
- Bjørn Syslak, Cleanworld
- Georg Aasen with colleagues, Nasdaq

The report is structured as follows. In Chapter 2, we describe the trade in GOs, and, to a certain extent, the GO system, demand drivers and prices in the end-user and wholesale market. In Chapter 3 we describe advantages and disadvantages of different forms of trade, and compare the trade in GOs to the trade in other renewable products such as emission allowances and green certificates. In Chapter 4, we evaluate the market for and trade in GOs according to economic criteria. In Chapter 5 we briefly describe the recent market development and how the market might be expected to develop in the foreseeable future. Finally, we recommend some measures to improve the trade in GOs.



## 2. Description of the trade in Guarantees of Origin

*Consumers and investors' different preferences and perceptions of which energy sources are most environmentally friendly has given rise to a wide variety of GO products. In the wholesale market, GOs are mainly traded through brokers, but also via portfolio companies/ trading houses and directly between producers and large businesses. In the end-user markets, consumers typically receive GOs as one of many attributes of a product or electricity tariff.*

### 2.1 What are Guarantees of Origin?

The GO scheme is an energy source tracking system. Each certificate verifies the energy source of the electricity produced at a specific power generation plant and issued to the power producer. One GO corresponds to 1 MWh of electricity produced, and includes detailed information on the origin of the power; the energy source (technology) and other attributes such as the age of the power plant, whether it has received support and the plant size.

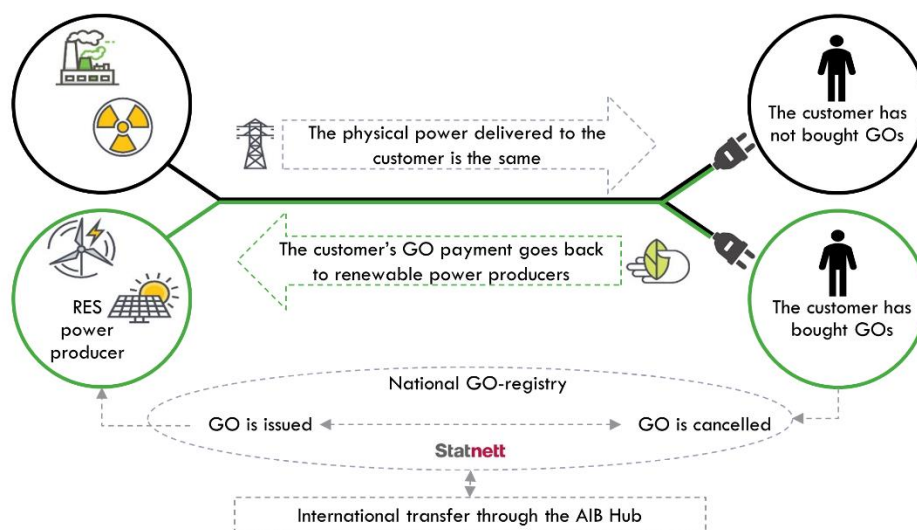
GOs are traded at a voluntary basis. The producer can sell its GOs to a power supplier or to a business that wants to make a renewable claim. The GO electronic document verifies to the electricity customer that a corresponding quantity of the power it consumes is somewhere produced with the specified energy source attributes.

Every producer of renewable electricity in countries within the GO system is entitled to receive GOs corresponding to the quantity of renewable electricity produced at the power

plant, from an Issuing Body, usually the national registry that keeps track of all the commercial transactions. The power supplier may only disclose renewable electricity on the electricity bills and for advertisement if they have cancelled GOs for the delivered amount of energy in the register. The registry system makes it possible to track ownership, verify claims and prevents electricity suppliers from double selling renewable energy.

Due to the physical properties of electricity flows, it is impossible to accurately track the energy source of the electricity delivered to a specific power outlet. Rather, the GO certificate market is designed to track energy production information, or the "attributes" of the generated electricity. Hence, GO is a non-tangible commodity that is, by design, separate from the actual, physical power distribution delivery. Figure 2-1 illustrates how the physical power delivered to different households is "the same" because the energy source cannot be traced physically through the electricity grid, and how the payment of customers that pay for GOs goes back to the renewable energy producers. Once the GO is used for disclosure purposes to the final consumer, the electronic document is cancelled in the national registry. The usage of GOs in Europe is harmonised in the European Electricity Certificate System (EECS), which functions as a common tracking system for national Issuing Bodies and registries. This enables the technical transfer of traded certificates across country borders. Hence, while the commercial trade in GOs is executed between market participants, cancellations and statistical transfers are made technically under the EECS, through a common IT communication hub, operated by the Association of Issuing Bodies (AIB), an association of the national registries/ issuing bodies in 20 European countries.

Figure 2-1: The GO system



Source: Oslo Economics

The system for GOs was established through EU-legislation mainly aimed at giving consumers the right to know and choose the (documented) origin of their power. GOs<sup>3</sup> are the official way to provide consumers and businesses with information on the source of energy that they procure. Today, GOs is mainly used to prove to end-users that a corresponding volume of power is generated from renewable energy sources to the volume they consume.

Renewable Energy Guarantees of Origin appeared in the EU Directive 2001/77/E, which introduced a duty on all Member States to develop a reliable tracking scheme. The Renewable Energy Directive clarified that the purpose of GOs is to serve as evidence of the origin of electricity generated from renewable energy sources, and specified the minimum information which each GO should contain. The current Renewable Energy Directive 2009/28/EC defines GOs (Article 2(i)) as:

*"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"*

The Renewable Energy Directive 2009/28/EC established a common framework for the promotion of renewable energy sources in the European Union. The Directive makes it clear that the purpose of the GO system is inherently different from renewable energy support schemes such as Feed-in-Tariffs or Swedish-Norwegian tradable el-certificates. The sole goal of GOs is documentation, to prove that the energy was produced from renewable energy sources, by facilitating the accurate and reliable disclosure information on the attributes of the electricity sold.

The consumers' right to be informed about the sources of the electricity they consume and the environmental impact<sup>4</sup> associated with the electricity generation for their tariff, is established in the Electricity Market Directive (2009/72/EC). The Electricity Market Directive regulates that a fuel mix disclosure (share of electricity supply from fossil, nuclear and renewable power plants) should be made based on the trade with GOs and not physical power production in the region or country (physical consumption not being technically possible to estimate). At least once a year, power suppliers must disclose the energy mix of the electricity generation on the electricity bill. Fuel mix disclosure aims to allow customers to differentiate

<sup>3</sup> And similar certificates in other regions, such as RECs in America.

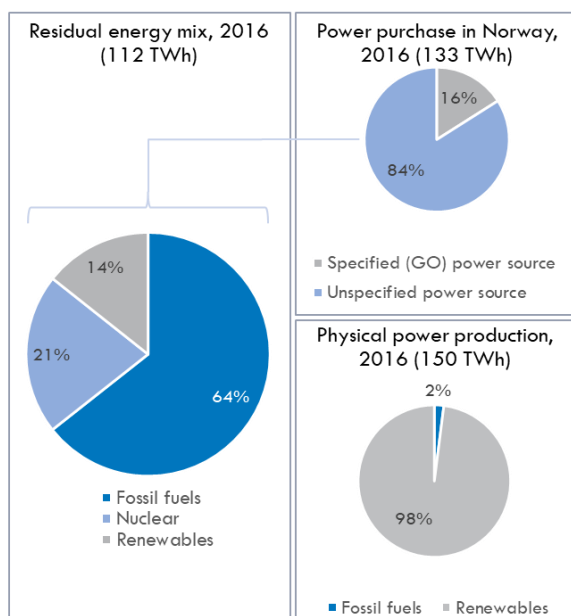
<sup>4</sup> Greenhouse gas emissions and nuclear waste

between power suppliers based on the source of energy.

The fuel mix disclosure required by the Electricity Market Directive is based on national and imported GOs, which are treated equally for disclosure purposes.

In Norway in 2016, 21 TWh (16%) of the total electricity consumption of 133 TWh, was backed by GOs. The fuel mix disclosure valid for Norwegian power consumers who did not buy GO backed electricity, i.e. the Norwegian residual energy mix, included 64 per cent thermal power (fossil energy sources), 21 per cent nuclear power, and 14 per cent renewable energy power. By comparison, 98 per cent of the physical power production in Norway was renewable, see Figure 2-2:

**Figure 2-2: Fuel mix disclosure Norway 2016**



Source: NVE, reproduced by Oslo Economics

The system implies, that consumers and businesses who do not buy GOs, officially owe their electricity supply to a mix of mainly fossil sources,

regardless of the physical location of the consumer or business.

The GO system strengthens the EUs focus on the role of consumers in changing energy behaviour, by giving the consumers an option to express their environmental awareness; households wishing to contribute to a better environment or companies wishing to improve their carbon footprint, can purchase GOs for their electricity supply, and products which have been made with GO-backed production. Thus, the GO system allows for informed consumer choice, not based on electricity prices alone, and to signal their preference for renewables to the market. GOs gives renewable producers a possible, voluntary additional income source in their competition with other energy sources (fossil, nuclear etc.)

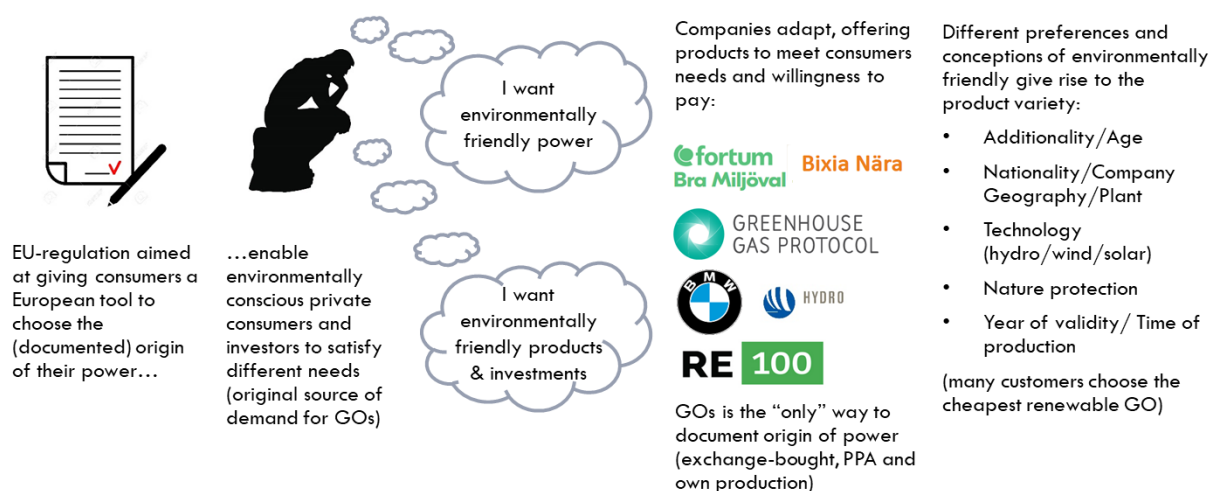
Similar systems for electricity source disclosure are implemented in other regions. For example, both the US and Australia have national Renewable Energy Certificates (RECS) (NREL, 2017) (Australian Government Clean Energy Regulator, 2017). The International REC Standard, I-REC, is a global tracking system that allows consumers to cover their power consumption with renewable energy irrespective of where they are located, and to let them choose where their renewable energy is produced (The International REC Standard, 2017).

## 2.2 End-user demand for Guarantees of Origin

### 2.2.1 The sources of demand for Guarantees of Origin

As described in the previous chapter, the basis for GOs in Europe is the EU regulation aimed at giving consumers a European tool to choose the documented origin of their power. This has enabled consumers and investors to satisfy their demand for buying environmentally friendly products, services and investments.

**Figure 2-3: GOs enable consumers and investors to choose and pay for electricity origin according to their preferences**



Source: Oslo Economics

However, for consumers, as well as investors, GOs are not solely about documenting the energy source origin of their power. The demand for GOs stems from a wish to be environmentally friendly. This demand for environmentally friendly options include a demand for renewable power, products and investments. Hence, the GO system has enabled environmentally conscious consumers and investors to satisfy their demand for buying renewable products and services and investing in renewable companies. Companies adapt to the demand by matching their customers' needs and willingness to pay. This has resulted in the development and marketing of renewable, "green" and "environmentally friendly" offers.

As shown in Figure 2-3, the demand for renewable consumer power stems from environmentally conscious consumers that want to make renewable claims, and choose to buy their electricity from a power supplier that offers electricity backed with GOs. The energy suppliers buy GOs to market the power they sell to their customer as "renewable power".

Consumers' and investors' demand for renewable products and investments is met by businesses who adapt to the demand. To make renewable claims and fulfil other environmental targets, companies purchase GOs. For some businesses, this involves purchasing GOs to fulfil criteria for environmental standards or labels, such as the Greenhouse Gas Protocol or RE100, a

collaborative, global initiative of influential businesses committed to 100% renewable electricity, working to increase demand for and delivery of renewable energy. The compliance with recognized standards can be a powerful tool in the marketing of their products or to attract investors.

For some companies, any renewable GO will suffice to meet their environmental goals. Other businesses may have more specific requirements to the origin of their power. For instance, they want national GOs, Wind-GOs and/or GOs which contribute explicitly to additional power production.

Consumers different preferences and perceptions of what is environmentally friendly has given rise to a wide variety of GO products. For instance, many consumers prefer GO products from recent and/or local power plants<sup>5</sup>, which are regarded as contributors to additional renewable power production. Although it is not an expressed intent of the GO system in the EU, additionality seems to be an important motivation for opting for renewable energy products backed by GOs.

## 2.2.2 Consumer demand for GOs

In the end-user markets, consumers typically receive GOs included as one of many other attributes of a product or electricity tariff, which means that the GO is not priced explicitly. In other cases, the price for GOs in the electricity tariff is bundled with other environmental values,

<sup>5</sup> Some consumers/ green labels even require that the power plants are subsidy-free, in order to assure additionality. Source: BKK, Ok Power label (Reichmuth, et al., 2014)

for instance rain forest protection. In some cases, the GOs are priced explicitly.

**Figure 2-4: End-user markets – How the renewable attribute of GO-backed products is priced in consumer products and services**



Source: Oslo Economics, Company web sites

Through the purchase of power backed by renewable energy GOs, consumers can signal to the market that they prefer renewable energy or products made with renewable energy. As Figure 2-4 shows, the GO part of the electricity tariff or product price, is either explicit, bundled with other products/services/environmental values or included in the electricity tariff or product price.

Our impression is that very few power suppliers state the price of the “renewable” attribute (GO) of the power they sell explicitly to their customer. However, there are examples. Rhein Energie offers power backed by GOs for a premium of 2 EUR/MWh<sup>6</sup>, while Bixia Nära offers power backed by GOs from local power plants for a premium of around 2,2 EUR/MWh<sup>7</sup>.

In many cases, power is sold to the consumer with a specific label, in which GOs is a part of the label criteria. For example, the Swedish ecolabel Bra Miljöval, are GOs issued to renewable energy producers that have met strict requirements for environmental protection of their power plant operations. For example, Fortum

offers “Bra Miljöval” electricity tariffs where the “Bra Miljöval” premium is 15 SEK per month to private households.<sup>8</sup> With an average electricity consumption in Sweden of around 16 000 kWh, this corresponds to a premium around 1,1 EUR/MWh. This power price premium, however, includes a contribution to environmental funds (Fortums miljöfond), and the GO price is therefore not explicit to the customer. Similarly, Hafslund’s “Grønt Valg”<sup>9</sup> option to electricity tariffs costs 1,5 NOK per day<sup>10</sup>. Included in this price is a 100% renewable energy source guarantee, a yearly donation of NOK 100 to the Rainforest Foundation Norway and professional power consumption advice (Hafslund, 2017). Excluding the donation to rainforest protection the price premium is approximately 1,8 EUR/MWh<sup>11</sup>.

There are also many examples of power suppliers that market their power as renewable through the purchase of renewable GOs, but in their communication to their customers state that the “renewable” part of the power they sell is sold without additional costs to the customer.<sup>12</sup> This is also true for a product and service

<sup>6</sup> [https://www.rheinenergie.com/de/privatkundenportal/tarif/e/strom\\_2/strom\\_fairregio\\_plus/oekostrom\\_option\\_fair/ind ex.php](https://www.rheinenergie.com/de/privatkundenportal/tarif/e/strom_2/strom_fairregio_plus/oekostrom_option_fair/ind ex.php)

<sup>7</sup> 29 SEK/Month. Price per MWh calculated assuming an average household power consumption of around 16 000 kWh in Sweden. <https://www.bixia.se/elpriser/bixia-nara#>

<sup>8</sup> <https://www.fortum.com/countries/se/privat/el/miljoval/br amiljoval/pages/default.aspx>

<sup>9</sup> “Green Choice”

<sup>10</sup> [https://www.hafslundstrom.no/strom/privat/gront\\_valg/10 183](https://www.hafslundstrom.no/strom/privat/gront_valg/10 183)

<sup>11</sup> Incl. power consumption advice

<sup>12</sup> <https://www.eidsivastrom.no/stromavtaler/innlandsspot/>, <https://www.lyse.no/stroem/innkjoepris/>, [https://www.goteborgenergi.se/Privat/Produkter\\_och\\_priser /Elhandel/Vara\\_avtal](https://www.goteborgenergi.se/Privat/Produkter_och_priser /Elhandel/Vara_avtal)



purchased from a company that market it is as “renewable” through the purchase of GOs. For example, while BMW purchases GOs to increase their share of renewable energy in their production and value creation<sup>13</sup>, the customers of BMW are not confronted with an explicit price premium linked to the car manufacturer’s renewable claim.

Due to the different levels of transparency, the end-user does not necessarily have a complete overview of what the actual price of the “renewable” attribute is and what it includes. It largely depends on how active the consumer is in terms of choosing between different renewable power tariffs and how information on these is communicated from the power supplier.

Moreover, consumers have different preferences and conceptions of what is meant by terms such as “renewable”, “green” or “environmentally friendly”. What exactly is the ‘green’ in a ‘green electricity’ offer? To some consumers, it simply means renewable energy source as opposed to non-renewables such as coal- or gas-fired power plants. To others it means other environmental goals such as wildlife protection. To some, GOs need to contribute to new renewable energy production to deserve the term “renewable”. Others want GOs from a power plant geographically close to themselves because it is perceived as more credible. Although contribution to new renewable energy production, so called “additionality”, is not the defined purpose of the GO system<sup>14</sup>, this is one of the main motivations for many consumers buying GOs.

Some consumers are willing to pay more for renewable energy offers, especially if some of their money is spent on funding investment in new renewable energy capacity (BEUC, 2016). Additionality is the most important criteria for consumers and perceived in Germany as “credibility” (Reichmuth, et al., 2014). For this reason, there is a higher willingness to pay for GOs from more recent and/or local power plants.

Furthermore, consumers have different conceptions of what it means to “go green”, for example in terms of which energy source/ technology they perceive as more renewable or more environmental friendly. While wind power is regarded as a renewable energy source, some consumers may not like the environmental impact of the installations. Some may prefer smaller hydro power plants or run-of-river technologies to large hydropower plants.

### 2.2.3 Business demand for GOs

Many companies are expected to report according to international standards for reporting on carbon footprint and sustainability. In addition, a growing number of businesses, for example Ikea, Google and BMW have a strategy to become zero-carbon emitters.

For these companies, GOs is the main way of documenting the origin of their power supply. The GOs system complies with the Greenhouse Gas Protocol Scope II Accounting Guidance, which is the most widely used international accounting framework to understand, quantify, and manage greenhouse gas emissions.

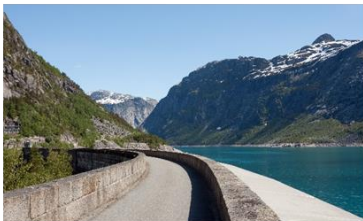


The Carbon Disclosure Project is a global organisation that supports companies in disclosure of their environmental impact. More than 9 out of 10 Fortune 500 companies report to CDP using GHG Protocol. Other relevant environmental standards include The Global Reporting Initiative (GRI) and RE100, as well as the ISO14000 Standard for Environmental Management.

A voluntary renewable energy strategy to establish an environmentally-friendly image is a high priority for many businesses. Some of these companies do not only want to buy renewable GOs equivalent to their power demand, they may require GOs from specific power sources, if they believe this is valued by the customers, as shown in Figure 2-5.

<sup>13</sup> BMW Sustainable Value Report 2016

<sup>14</sup> National support schemes such as feed-in tariffs and el-certificates, are designed to incentivise investments in new renewable electricity generation.

**Figure 2-5: End-user markets – Business demand for Bulk, Premium and Tailored products**

| Bulk – cheapest product  | Premium – ready products   | Tailored – custom products   |
|--|--|--|
|   |    |   |
| <ul style="list-style-type: none"> <li>Nordic Hydro is usually the cheapest renewable GO</li> <li>Unspecified EU Wind also trades at low prices</li> </ul> | <ul style="list-style-type: none"> <li>Standard geographical and technology requirements, e.g. Dutch wind</li> <li>Standard age classes and subsidy (free) requirements, e.g. younger than 5 years</li> <li>Known labels, e.g. Bra Miljöval</li> </ul> | <ul style="list-style-type: none"> <li>Tailored additionality products, inc. top financing and synchronized GOs</li> <li>Plant specific (close to customer)</li> <li>Reporting and marketing services (also for bulk and premium GOs)</li> </ul> |
| <b>Price Oct. 16-17: ~0,26 EUR/MWh</b><br>Forward price 2018: ~0,5 EUR/MWh   | <b>Prices Oct. 16-17: ~0,5-4 EUR/MWh</b>   | <b>Prices Oct. 16-17: ~2-8 EUR/MWh</b>   |

Source: Price data from Greenfact and EcoHz, Oslo Economics

Most businesses buy the cheapest, basic renewable GO volumes to give them the right to make a renewable claim. These “Bulk GOs” are made up of unspecified renewable GOs, Nordic Hydro or European Wind, and are not further differentiated in terms of country of origin or type of power plant. Bulk GO products are typically traded at relatively low prices due to large supply and low local demand.

Some businesses pay an additional premium for certain attributes that match their preferences and the preferences of their customers. We have termed these types of GO products as “premium GO”. Increasingly, market participants are experiencing a demand for local GOs, i.e. GOs issued to power producers that are geographically close to the GO buyers. According to ECOHZ, the national railway company in the Netherlands conducted a survey among its customers which revealed that they preferred Dutch Wind as an energy source. To meet its customers’ demands, the national railway company bought Dutch Wind GOs equivalent to its electricity demand to market itself as powered by Dutch Wind. This led to very high prices for Dutch GOs (see section 2.4). Other businesses pay premiums for GO ecolabels and standards which are valued by their customers, such as Bra Miljöval (“Good Environmental Choice) or the German ecolabel TÜV SÜD<sup>15</sup>. All ecolabels provide a set of predefined criteria to certify

that renewable product is climate- and environmentally friendly.

Some businesses want tailored GO products that meet some very specific preferences. Some recently developed GO products are designed to contribute directly to the financing of new renewable generation capacity. These products address one of the main critiques of the GO system, that it has not directly contributed to increased renewable energy production (Reichmuth, et al., 2014).

This is done by linking the consumers’ contribution through the purchase of GOs to the top financing of (specific) new renewable energy generation projects. This implies that the buyers of these GO products, in addition to their documented renewables claim from buying GOs, contribute to realise a new renewable power plant.

ECOHZ has implemented such additionality GOs in their product range, called GO<sup>2</sup>. Their customers can either buy the co-operative product GO<sup>2</sup> United, in which their contribution is pooled with that of others through the ECOHZ Renewable Energy Foundation, or the exclusive GO<sup>2</sup> Signature product where their engagement contributes to the financing of a specific named new power plant.

Kinect Energy’s Track my Electricity GO product for companies has a similar additionality feature. For every MWh of the renewable energy

<sup>15</sup> Other ecolabels include EKOenergy, OK-Power, Centopercenoverde, Naturemade, Green-E Energy, BREEAM, LEED, Naturemade, The Milieukeur, Umweltzeichen

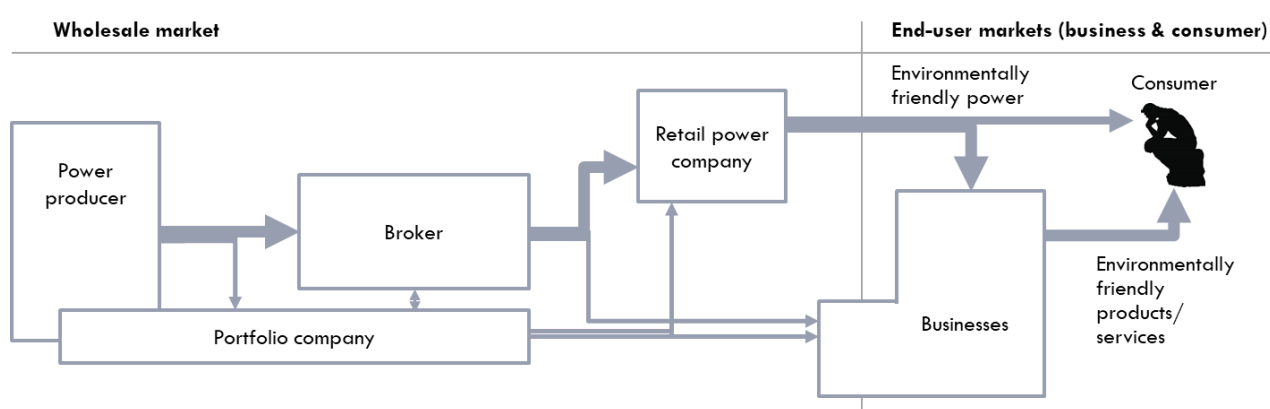
sourced from the power plant that the company has chosen, EUR 0,10 goes toward funding renewable energy projects.<sup>16</sup>

The most recent development in the “customised GO segment” are requests for GOs that are broken down into shorter time intervals to better “imitate” the end-user’s consumption profile.

## 2.3 The trade in Guarantees of Origin: Buyers, sellers and intermediaries

In the wholesale market, GOs are mainly traded through brokered transactions between power producers and a power suppliers, but also via trading houses and directly between producers and retail power companies. Most end-users (consumers and businesses) buy GOs from their retail power supplier, while some large businesses purchase GOs directly in the wholesale market (Figure 2-6).

**Figure 2-6: How GOs are traded: Buyers, sellers and intermediaries**



Source: Oslo Economics

The GO system is a market-based instrument. GOs are traded at a voluntary basis between those who generate physical renewable electricity and those who want to pay for the right to classify their power consumption as renewable.

Trade in GOs is exercised on an open market where certificates are traded freely across the countries’ border. The prices of different GOs, differentiated by origin attributes, is determined by supply and demand.

### GO trade in the wholesale market

In the wholesale market, the buyers are generally power suppliers or large businesses. The sellers of GOs are power producers that are issued the certificate. Power producers can sell their GOs themselves (via brokers or directly) or let a

portfolio management company, or a large power producer, handle its GO trade.

In the wholesale market, there are several so-called portfolio management companies that manage substantial volumes of GOs on behalf of small and medium sized power producers. These companies are counterparty to both seller and buyer. Through their commercialisation activities, they aim to create value for the producers, by at the same time optimising their client’s renewable energy strategies by providing them access to a wide portfolio of GOs. To meet their client’s needs, they work on the entire value chain of the end-user; they take care of the entire process from helping customers choose, implement and document renewable energy consumption in line with a solution that matches their needs. This involves packaging of GOs together with diplomas, certifications, labels and marketing and PR material that their buyers can use in their

<sup>16</sup> These projects are in remote, off-grid areas – aim to eliminate energy poverty and to build sustainable communities. <http://www.trackmyelectricity.com/>

marketing and branding communication to their customers. Examples of such companies are ECOHZ, Kinect Energy and Danske commodities. In the Norwegian GO-registry, NECS, there are a total of 1,182 generating units that receive GOs. Three market participants<sup>17</sup> act as registrants for two thirds of the GOs of these generating units.

Trade in the wholesale market is done “over-the-counter”. Based on information from our information sources (interviews), we consider that the largest volumes go through brokers, but that there are also very significant volumes that are traded bilaterally and via “portfolio companies”. The Norwegian state-owned power producer Statkraft estimate that 60-70 per cent of their volumes are traded through brokers, but this is not necessarily representative for the entire wholesale market. Examples of brokerages that act as intermediary negotiating parties between the buyer and seller are ICAP, Cleanworld, Commerç, STX, GSM and SKM (Svensk Kraftmäkling).

There are some reported cases of brokerage firms that sometimes act as traders (buying GOs to hold on their own account). Also, portfolio companies do act as traders in the sense that they often hold GOs on their balance sheets before they can pass them on. However, the market players we interviewed are under the impression that speculation is rare, and that most portfolio companies and brokers sell their GOs as quickly as possible to minimise risk.

Bilateral trade, carried out directly between two parties is quite common. Power producers can typically sell their GOs directly to power suppliers, large businesses or public organisations that want to make renewable claims. This means that GOs can be purchased separately or together with power purchase. Some businesses commit to purchase all electricity generation from a power plant for several years, through a long-term power purchase agreement (PPA), often together with the corresponding amount of GOs.

Some large businesses and public organisations purchase GOs through a public tender/ auction for delivery of a specific volume of GOs. The tender/auction winner results in the choice of a supplier of GOs and a bilateral contract between the two parties. For example, Bane NOR, the state-owned company responsible for the national railway infrastructure, issued a public tender for the delivery of GOs corresponding to

Bane NOR and the Norwegian train companies' physical power consumption.

In addition to the broker, “portfolio company” and bilateral Over-The-Counter (OTC) trade there have been attempts to establish exchange trade (bourse) for GOs. Examples of exchange operators are the EEX Power Exchange and Gestore Mercati Energetici (GME). However, these attempts have been unsuccessful, in part due to higher transaction costs and/or lower prices. While brokers charge around 0,25 eurocent/MWh in brokerage fee, trading costs at EEX are around 0,6 eurocent/MWh for continuous trading and/or trade registration (EEX, 2017) and a clearing fee of 0,25 eurocent/MWh (ECC, 2017). According to EEX, there had been no exchange trades of GOs from the start of 2016 until the end of 2017, when we spoke with them.

The most recent development in the wholesale trade is the establishment of a new type of electronic network trading platform, Kapturs. The technical solution is still being tested, and traded volumes are very limited. See Chapter 3.1 for more information.

### GO trade in the end-user markets

While there is a wholesale market for GOs, there is not one single end-user market. Instead, there are several markets, for instance the electricity, public transportation and home appliances markets, where GOs are one of many attributes.

In the end-user markets, consumers buy electricity backed by GOs from their power supplier and products and services from businesses that document renewable claims through the purchase of GOs. Most businesses making renewable claims also buy electricity backed by GOs from their retail power company in the end-user market for electricity. However, some large businesses buy GOs directly in the wholesale market, independently from their power purchase.

Most GOs are sold to businesses. In Germany 72 per cent of GO-backed electricity in 2014 was sold to businesses (including public services), while 28 per cent was sold to consumers (Reichmuth, et al., 2014).

---

<sup>17</sup> Statkraft, ECOHZ, Kinect Energy

## 2.4 Prices and volumes in the wholesale market for Guarantees of Origin

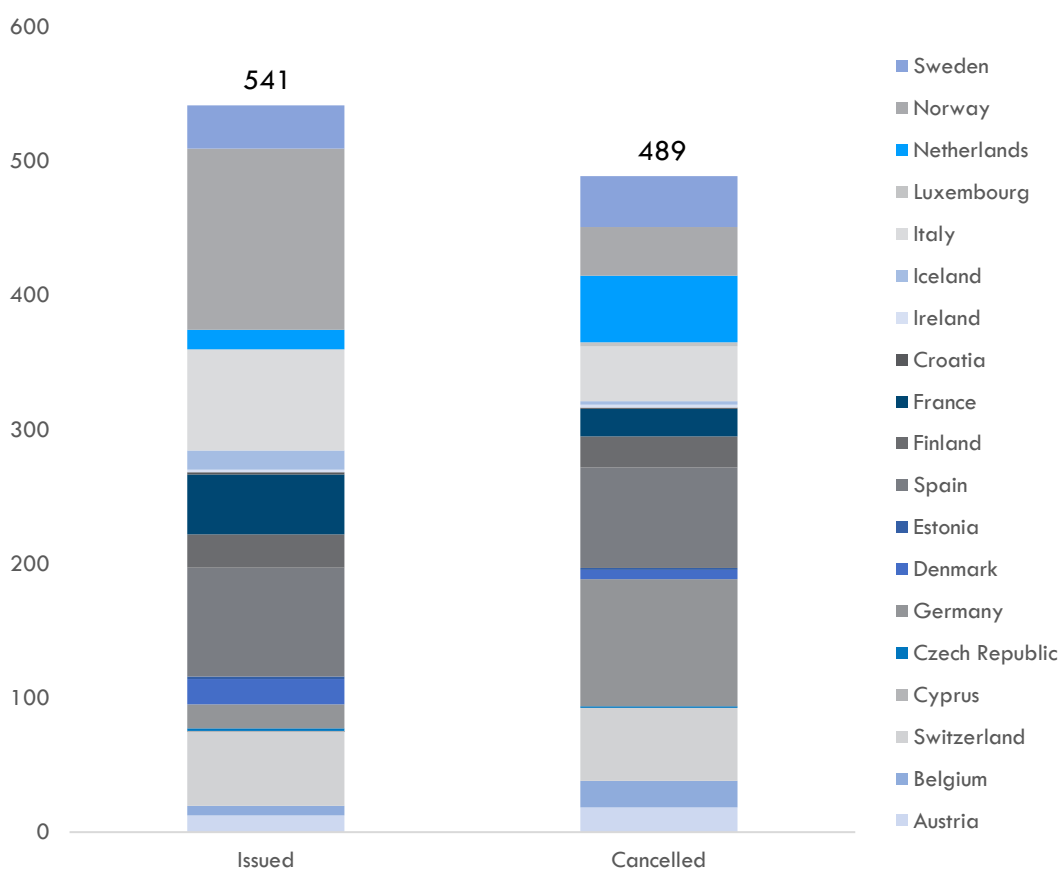
### 2.4.1 Volumes of Guarantees of Origin

Prices in the market for Guarantees of Origin are determined by supply and demand for different GO products. The supply of one MWh of energy gives the right to issue one GO. The demand and purchase of a GO results in the cancellation of a

GO in the registry. Hence, transaction volumes of issued and cancelled GOs define the total supply and demand for GOs.

In Figure 2-7, we present statistics from the AIB, which includes all GOs following the European Energy Certificate System (EECS). AIB statistics (2016) show that Germany, Switzerland, Netherlands and Italy are the largest national markets for Guarantees of Origin in Europe in terms of cancelled (purchased) GOs.

**Figure 2-7: Issued (supplied) and cancelled (purchased) GOs (transaction volumes), per country, Oct. 2016 – Oct. 2017, million GOs (TWh)**



Source: Official AIB statistics (AIB, 2017).

From the figure, we observe that there is not a perfectly balanced relationship between supply and demand. The main reason is that the demand for GOs does not imply higher supply: Higher supply depends on the legal framework in the different countries and the actual renewable energy production. New renewable generation capacity is mainly determined by support-schemes such as feed-in-tariffs.

### 2.4.2 Prices of Guarantees of Origin

Since GOs is not a homogenous product, and different GOs are valued differently, the aggregate supply and demand cannot explain prices alone. As explained in Chapter 2.2, there is a different demand for different types of GOs, dependent on attributes such as the location or technology of the generation unit, creating sub-markets/niche markets with surplus demand and higher prices.



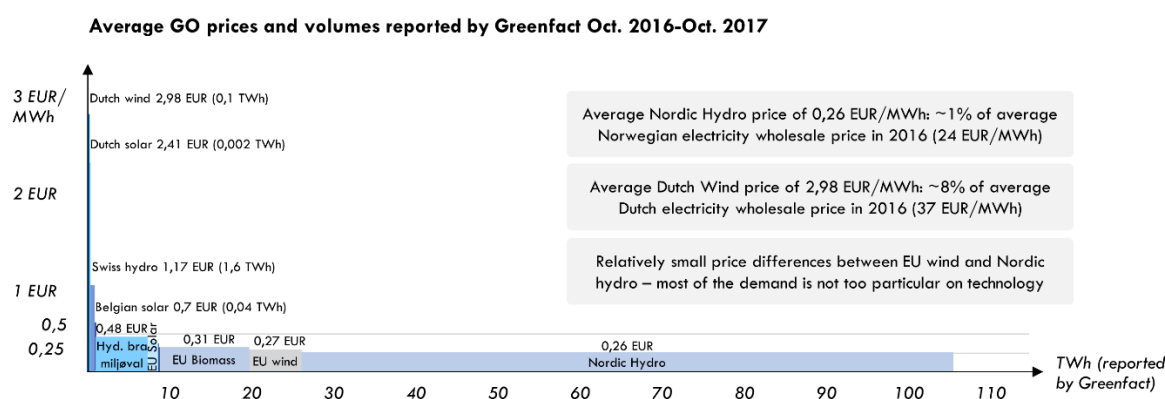
GOs are mainly traded via two types of contracts: spot price contracts and forward contracts. For both types of contract, the price of GO is set on the date of the agreement. The main difference between the contract types is the date of transfer of, and payment for the GO.

Since most GOs are not traded on an exchange, price-information is not very transparent for market outsiders. Market participants on the other hand, typically have access to prices quoted by brokers or other platforms, such as Montel Online<sup>18</sup>. The most reliable source for price and volume data for GOs we have identified is the analysis company Greenfact. Greenfact gathers trading data for a large

volume of GOs. We have had access to Greenfact's price data, and they have provided data on traded volumes and prices for the main GO products. Moreover, some of the market participants that we have been in contact with, including ECOHZ, BKK and Fjordkraft, have provided us with price observations.

In Figure 2-8, we present a graph showing average wholesale prices and volumes for GO products reported by Greenfact for the period October 2016 to October 2017.

**Figure 2-8: Average prices and volumes on GO products reported by Greenfact Oct. 16-Oct. 17**



Source: Oslo Economics, Greenfact. 2018 Large Nordic Hydro prices in Dec. 17 were ~0,5 EUR/MWh ~100% above prices in nov.16-17.

Average prices Oct. 2016- Oct. 2017 reported to Greenfact varied from 0,26 EUR/MWh (Large Nordic Hydro) to almost 3 EUR/MWh (Dutch Wind). These prices are equivalent to ~1 per cent and ~8 per cent of the Norwegian (24 EUR/MWh<sup>19</sup>) and Dutch (37 EUR /MWh) wholesale electricity prices respectively (TenneT, 2017). Since then, the average price for Large Nordic Hydro GOs have doubled to around 0,5 EUR/MWh, making up around 2 per cent of the Norwegian wholesale price.

As the graph shows, large volumes of GOs that we have termed “bulk GOs”, are traded at relatively low wholesale prices. These include Nordic Hydro, EU Wind, Biomass and Solar, although the latter technologies are typically traded at a small premium to Nordic Hydro. The

“Bra Miljöval” labelled GOs are traded at a premium to these “Bulk products”, while small volumes of Swiss and Dutch renewable energy GOs are traded at much higher prices.

Although the total volumes reported by Greenfact does not cover the entire traded volumes of GOs, the impression of the market divided in large volumes of low-price products and smaller volumes of high-price products, fits well with the prices reported by market participants that we interviewed.

#### 2.4.3 Estimated market value of European GOs

The total volume reported by Greenfact represents over one fifth of the EECS-GO demand in the same period (GOs cancelled Oct. 2016-Oct. 2017<sup>20</sup>). To complete this information,

<sup>18</sup> [http://archive.montel.no/Montel/2011/New\\_features/guarantees%20of%20origin.asp](http://archive.montel.no/Montel/2011/New_features/guarantees%20of%20origin.asp)

<sup>19</sup> Average electricity wholesale price 2016 of 0,2407 NOK/kWh. SSB Table 09363

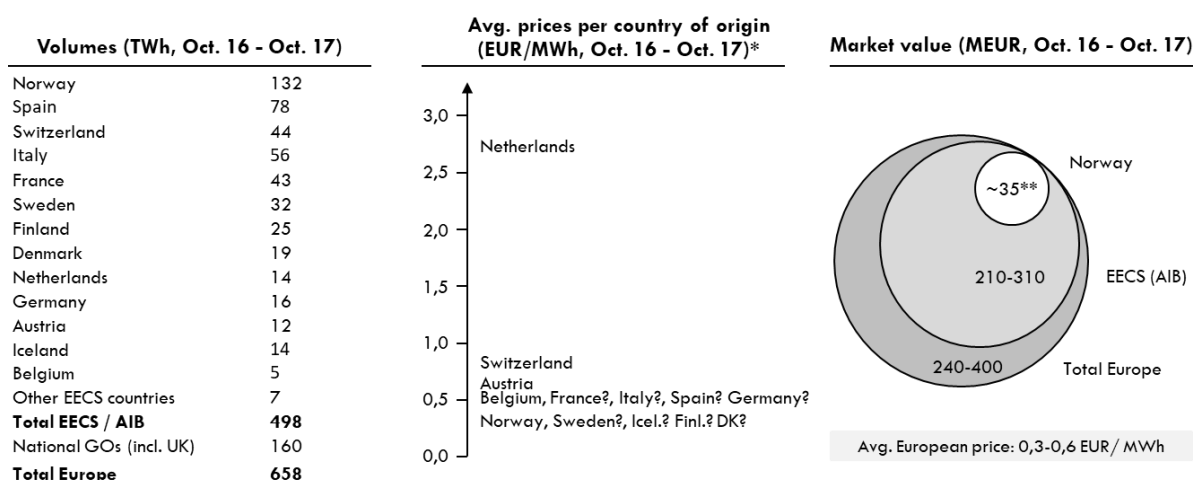
<sup>20</sup> GOs cancelled Oct. 2016-Oct. 2017 = 488.9 TWh (AIB)

we have gathered price observations from available public sources of information (Austria<sup>21</sup> and Switzerland<sup>22</sup>)

Because we lack price information from many countries, we have had to make assumptions based on price information from neighbouring countries.

In Figure 2-9, we show the assumptions we have used to estimate the market value for European GOs between Oct. 2016 and Oct. 2017. We note that the estimate is very uncertain, and should be viewed as indicative of the actual value of European GOs.

**Figure 2-9: Estimated wholesale market value of European GOs (Oct. 2016 - Oct. 2017)**



Source: Oslo Economics

Source EECS GO volumes: AIB. Issued minus expired (transactions), in million GOs (TWh).

Source National GO volumes: ECOHZ. These are estimated cancelled volumes in 2017 of 160 TWh.<sup>23</sup>

The market value estimates of GOs for different regions and countries are based on the total volumes issued to power producers minus expired GOs in the period Oct. 2016 – Oct. 2017. These volumes are multiplied with the estimated prices per country of origin to estimate the market value for each producing country.

Using the volumes and price estimates in Figure 2-9, we find that the market value of European GOs, including GOs from countries with national GO systems<sup>24</sup>, is MEUR 240-400. The EECS (AIB) market volume is valued to between MEUR 210-310.

Norway is the largest producer and exporter of GOs in Europe, accounting for 28% (138,5 TWh)

of total issued EECS-GOs in 2016. In 2016, the net export was 84.2 TWh (NECS, 2017), accounting for 46% of the exported GOs (AIB, 2017). More than 98% of GOs issued in Norway in 2016 were hydro GOs (NECS, 2017). A conservative estimate of the market value of GOs issued to Norwegian power producers is therefore the average Nordic Hydro price of 0,26 EUR/MWh in the period Oct. 2016 – Oct. 2017 multiplied by the volume of issued (minus expired) GOs in the same period. This gives an estimated market value of around 35 MEUR.

Since October 2017, average prices for Norwegian and Nordic Hydro GOs have almost doubled, from 0,26 EUR/MWh to 0,5 EUR/MWh. If prices remain at this level throughout 2018, the

<sup>21</sup> <https://www.e-control.at/documents/20903/388512/e-control-stromkennzeichnungsbericht-2017.pdf/3a19191c-4c85-8d28-e36c-c0993eaab9e8>

<sup>22</sup>

<https://www.news.admin.ch/news/message/attachments/42531.pdf>

<sup>23</sup> \*Indicative average price ranges. Source Netherlands (2,4-3 EUR/MWh), Belgium (0,4-0,7 EUR/MWh), Norway (0,26 EUR/MWh): Greenfact. Source Austria 2017: Greenfact (supported GOs are traded at 0,93, while unsupported are traded at 0,39 EUR/MWh). Source Switzerland (0,6-1,3 EUR/MWh): Schweizerische

Eidgenossenschaft. For other countries (marked with ?) we lack data on average prices. To estimate market value we have used price ranges corresponding to neighboring countries for which we have price data.

\*\*2018 Large Nordic Hydro prices in Dec. 17 were ~0,5 EUR/MWh ~100% above prices in Oct.16-17 (Greenfact).

<sup>24</sup> According to ECOHZ, EECS-GOs account for over 60 per cent of the total market demand in Europe in 2016, including national GOs<sup>24</sup>, and is expected to account for 75 per cent of the total market demand in 2017 (ECOHZ, 2017). A reason for this increase is that Spain entered the market in 2016, and that more countries may follow suit.

annual value of Norwegian GOs will be around 66 MEUR. This estimate illustrates the value of Norwegian GOs to customers in the wholesale market and the income to Norwegian renewable energy power producers.

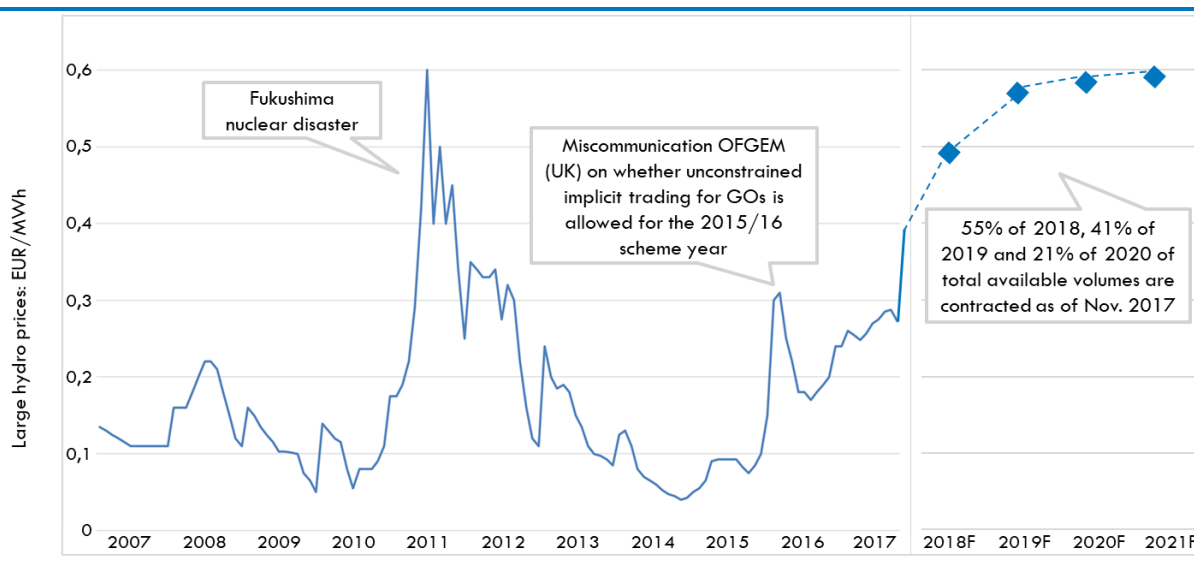
#### 2.4.4 Price fluctuations

Because of price fluctuations, the estimated market value is highly sensitive to the time period

considered, and may therefore be substantially different in the future.

Figure 2-10 illustrates that spot prices on Large Nordic Hydro have varied between 0,05 and 0,6 EUR/MWh over the past ten years.

**Figure 2-10: Prices on Large Nordic Hydro GOs 2007-2017 and future prices for 2018-2021**



Source: ECOHZ (2007-2017), Greenfact (forward prices), Oslo Economics

The GO prices respond to changes in demand for renewable energy. For example, there was a GO price hike in 2011, after the Fukushima nuclear power plant disaster caused many German consumers and businesses to demand nuclear free power contracts (with renewable GOs)

GO prices are also sensitive to regulatory changes. For example, the end of 2015 saw a price surge due to a miscommunication of OFGEM, the power sector regulator in the UK, regarding new regulation that allowed for unconstrained implicit trading of GOs for the 2016/17 scheme year onwards. This would allow British businesses and consumers to buy foreign GOs, thus increasing the demand for EECS-GOs. At the time of the announcement, it was not clear

whether the same decision would apply for the 2015/16 scheme year (Ofgem, 2016). When the misconception that implicit trading was allowed was corrected early 2016, prices went down again to reflect this information.

The market expects GO prices to rise in the next year. This is reflected in the futures prices. Forward prices of Large Nordic Hydro GOs in 2018 are almost 100% above prices in Oct. 2016-17 (0,50 Euro vs. 0,26 Euro). At the same time, a substantial part of futures volumes is already contracted. As of November 2017, 55% of 2018, 41% of 2019 and 21% of 2020 of total available volumes have already been sold.

### 3. Comparison with the trade in other renewable products






*GO products are not easily compared to other products such as electricity and el-certificates. GOs are not a necessity, such as electricity, nor mandatory, such as el-certificates or EU ETS emission allowances. Like voluntary carbon offsets, a GO is a voluntary product with an environmental and renewable value. The heterogenous demand for GOs implies that standardisation can lead to lower prices. This, and the limited market value of GOs, explain why GOs are not exchange traded.*

#### 3.1 Forms of trade

There are two basic ways to organize market places for trade in financial products: exchange (bourse) and over-the-counter (OTC). Exchanges are open to all market participants equally, whereas OTC markets are generally less transparent and regulated by fewer rules. In addition to OTC and exchange-trade, digitalisation has permitted the emergence of electronic market facilities that challenge the traditional distinction.

Figure 3-1 summarises the main advantages and disadvantages of different forms of trade, and central requirements for the type of trade to take place.

**Figure 3-1: Advantages and disadvantages of different forms of trade**

|   | Description   | Main advantages  | Main disadvantages                                       | Requirements  |
|---|---|--|--|---|
|  | <b>Bilateral trade between producer and end-user</b>                            | No fees paid to third parties  | Information cost (knowledge about prices, volumes), risk | No requirements   |
|  | <b>Traders buying volumes from producers and selling to buyers/users</b>        | Increased liquidity, lower searching costs, lower counterparty risk                | Lower price transparency than brokers, costs of trading  | Capital of trading house(s), relationships with producers and users/buyers                |
|  | <b>Brokers mediating between sellers and buyers</b>                             | Increased liquidity, and transparency, lower search costs and risk (vs. bilateral) | Broker fee, time consuming (no clearing as in exchanges) | Relationships with sellers and buyers   |
|  | <b>Electronic trade – buyers and sellers bid and ask online, bilateral deal</b> | Potentially efficient, low transaction costs and high liquidity (if popular)       | Counterparty risk and counterparty information cost      | A large base of ready buyers and sellers  |
|  | <b>Exchanges, regulated, organized market place, gathering all players</b>      | High trust and transparency, clearing, potentially high liquidity                  | Costs of operation and regulatory demands                | Standardization of products and contracts and relatively high trading volumes per product |

Source: Oslo Economics

#### Bilateral trade

Trade directly between two parties implies that buyers build direct relationships with sellers. There is no standard way to carry out a direct trade; each trade is based on a bilateral market contract between the two parties.

Advantages of trading bilateral trade is that no transaction costs are paid to third parties. However, the internalised transaction costs, including search costs, the times it takes to gain knowledge on players, prices and volumes, can be substantial.

Moreover, buyers and sellers are reluctant to trade with parties they do not know to be creditworthy and trustworthy. There is the risk that their counterparty does not acknowledge their trade, refuse to or is financially unable to settle their trades. This counterparty risk can limit trading to a few trusted counterparties, which is fragile and makes it difficult for the parties to know whether they get a fair price. The result is often poor liquidity.

### Traders (inc. portfolio management companies)

Portfolio management companies in the wholesale GO market act as traders, buying volumes from producers that they sell to buyers, acting as a counterparty to both seller and buyer. This implies that they keep inventories. The producer/seller has an agreement with the portfolio management company that gives the company the fully or restricted mandate to manage their volumes. To make money, the company must manage the portfolio (pool) on behalf of producers in a good way.

Portfolio management companies trade in the wholesale market, though their main activities are concerned with the end-user markets where they serve their clients.

The portfolio management companies earn trading profits by supplying liquidity. Producers typically pay a fixed fee to cover the portfolio management company's administrative costs related to transactions and a "finder's fee" (in percent) related to finding an appropriate buyer.

These companies serve an important role in terms of product and market development. They have significant market knowledge and expertise. Their business model is to create additional value for their customers.

With a wide portfolio, they can largely meet the demand from buyers for a range of different attributes, and if they do not have a match in their portfolio, they work with their network to get it. They help their customers choose specific power plants with distinct characteristics, including choice of technology, location, age, size, and owner profile.

Similar to brokerages, these portfolio management companies provide increased liquidity and lower searching costs and lower risk than bilateral agreements. However, price transparency to the end-user is low because the GO price is only part of a product package that may involve other services in addition to the core product. In addition, these firms must be paid for their services and risk taking.

### Brokerage trading

A broker is not a part in a trade, but acts as an intermediary connecting buyers and sellers and negotiating between them. Brokers identify and introduce counterparties who have indicated their willingness to trade. The broker matches their clients' order with the order of the counterparty on the other side of the transaction. Thus, the

broker facilitates the price discovery and the transaction.

Buyers and sellers typically use brokers to arrange their trades because brokers typically have market and product knowledge and information, as well as a large network of potential sellers and buyers. Also, using a broker reduces the buyers' and sellers' search and transaction costs (relative to bilateral trade) since every buyer and seller no longer has to check prices and volumes with every potential seller and buyer. In addition, brokers can give information on the creditworthiness of new buyers and sellers, although they do not offer clearing services, i.e. guarantee payments.

Brokerage firms earn commissions for arranging the trades for their clients. Fee models vary, in some cases brokers charge fixed fees, in other cases they charge percentage fee of the value of traded products, or charge the difference between the bid and ask prices (floating fee).

Compared to bilateral trade, broker-trade leads to increased liquidity and lower search and transaction costs. Buyers and sellers will typically call up to 4-5 brokers before making a trade, rather than a high number of individual sellers and buyers.

A downside to brokered transactions is that prices are normally not public, as they are in exchange (bourse) trade. Some brokers do, however, publish post-trade prices and volumes. Moreover, brokers do not solve the problem of credit risk and can be time consuming to use than fully functioning exchanges.

### Multi-dealer electronic trading platform

In some OTC markets, digitalisation has encouraged the development of electronic trading platforms. Such platforms can serve as a meeting place for market participants, allowing for an efficient matching of commercial interests. Kapturs is developing such an electronic platform in the market for GOs.

To trade on this electronic platform, access to the network is necessary. Network access enables sharing of commercial interests, such as GOs. The system allows the user to trade by selecting its preferences (buy/sell and what attributes are relevant). By doing this, the party only receives information that is relevant. The user thus gets a complete overview of its own position as well as the relevant market price.



As soon as a match of interests is confirmed between two network users, the electronic platform gives the parties concluding the transaction a recapitulation document (contract draft) containing a description of the product, the agreed price and volume, and time of exchange and settlement.

Multi-dealer electronic trading platform is typically termed all-to-all trading because all market participants submit quotes and execute trade directly through the electronic system. Still, this type of trade differs from exchange (bourse) transactions where trades are matched up and guaranteed by the exchange. The two parties are solely responsible for the clearing and settlement of the transaction that they have agreed on via the electronic platform.

Since there is no intermediary guaranteeing the counterparty, parties are exposed to a counterparty risk similar to the risk in bilateral trade. The main advantage of electronic trading platforms is the potential low cost of operation. Furthermore, network trading on an electric platform can potentially contribute to a liquid, transparent market place if enough market players use it.

Another advantage of this type of network trading is that everyone gets the same information at the same time, therefore high degree of transparency. Like exchange trade, this gives equal opportunity to trade and low cost per transaction. This can allow smaller businesses to do their own trades. Still, an account is needed to be part of the network and see other trades.

### Exchange

An exchange is a marketplace that is regulated to ensure fair and orderly trading, as well as efficient information flows. An exchange centralizes the communication of bid and ask prices to all market participants, who in turn can respond by selling or buying at a quote or by replying with a different quote. When two parties reach an agreement, the closing price is effectively communicated throughout the market. This ensures a level playing field.

The main advantage of exchanges, compared to OTC trading, are the settlement and clearing services, which can greatly reduce counterparty credit risk. In case that an exchange participant defaults, the exchange is obliged to fulfil the open obligations. To offer this service, the exchange needs to make sure that all participants provide guarantees of liquidity and

solidity for their trades and follow the rules of trade.

Once a trade takes place it is immediately recorded publicly so everyone can see the latest trade and price at which it was transacted. The centralization of all buying and selling orders in one place and allowing all parties to trade at the best available price, contributes to high degree of trust and transparency. Prices on published on an exchange can also serve as a reference price in other types of trade.

Exchange trade requires standardisation of the underlying product as well as the contract between the two parties. In order to justify the investment and cost of regulated exchange trade, the volume for each standardised product and contract need to be relatively high.

## 3.2 Comparison with other renewable products

To describe the trade in GOs, we will consider it in light of how other renewable products are traded. We have chosen to compare the trade in GOs with the trade in five other renewable products, with which GOs share some properties:

- The wholesale electricity market (physical power)
- The Swedish-Norwegian el-certificate market
- The mandatory market for carbon offsets:
- The voluntary market for carbon offsets
- The market for organic food

### The wholesale electricity market (physical power):

Due to the physical properties of electricity, the physical power delivery must be produced and consumed instantly, as it cannot be easily stored. This implies that demand and supply must be constantly balanced in real time. In competitive power markets, a market operator facilitates an implicit auction where bids to buy and offers to sell meet to form a time specific equilibrium price, taking into account physical constraints such as transmission capacity. The balancing market makes sure that physical electricity production match consumption.

### The Swedish-Norwegian el-certificate market is

a market-based support scheme to encourage new renewable generation capacity. Renewable power producers included in the scheme receive one certificate per MWh power produced for 15 years, that they can sell. Retail power suppliers and large consumers are obliged by law to purchase certificates corresponding to a given

share (quota) of their power supply or consumption. This obligation creates a demand, and pricing is market-based.

**The mandatory market for carbon offsets:** A carbon offset is a reduction in greenhouse gas emissions made to compensate for or to offset an emission made elsewhere. In the mandatory market for carbon offsets, companies or governments buy carbon offsets to comply with government-mandated emission caps that are set for the total amount of greenhouse gases that can be emitted by installations covered by the system. Within the cap, the entities receive or buy emission allowances, and must surrender enough allowances to cover all its emissions each year. Companies trade allowances with each other, and the trade shall ensure that emissions are cut where the costs to do so are the least. Such compliance schemes exist for Annex 1 Parties under the Kyoto Protocol, and for liable entities under the EU Emission Trading Scheme.

**The voluntary market for carbon offsets:** In the much smaller, voluntary market for carbon offsets, consumers or businesses purchase carbon offsets

to balance greenhouse gas emissions caused by their consumption, e.g. vacation flights or electricity use. Various private organisations and social enterprises offer different carbon offset labels that certify that a company has, for example, reduced its emissions or contributed to the financing of emission reduction projects elsewhere.

**The market for organic food:** Organic food is produced by methods that comply with the standards of organic farming set by regional organisations, national governments and international organisations. In many countries, producers are required to obtain special certification to market food as organic. Organic food is traded on a global market with a market size of tens of billions of euros.<sup>25</sup>

Figure 3-2 summarize the main supply and demand drivers in these different markets, the assumed size of the markets and the degree of product standardization. These are central determinant of how trade in the underlying asset is carried out.

**Figure 3-2: Comparison of Guarantees of Origin with other “renewable products”**

|                     | Electricity (physical)                         | El-certificates                               | Mandatory carbon offsets  | Voluntary carbon offsets            | GOs  | Organic food                       |
|---------------------|--|---|---------------------------|-------------------------------------|--|------------------------------------|
| Main demand drivers | Necessity                                      | Mandatory quota obligation                    | Mandatory                 | Voluntary                           | Voluntary  | Voluntary                          |
| Main supply drivers | Electricity demand, public subsidies           | New renewable electricity production          | System regulation         | Climate projects                    | Electricity supply (largely decoupled from GO demand itself) | Demand                             |
| Market size         | Several billion euros (Scandinavia)            | 390 million euros per year (16-17, SWE & NOR) | Tens of billions of euros | Much smaller than compliance market | 240-400 MEUR (Europe)  | Tens of billions of euros (Europe) |
| Standardisation     | One single quality for a given time and volume | One single quality for a given time           | One single quality        | Many customized products/projects   | 6-12 main products, 100 - 10 000 smaller products            | Many thousand different products   |

Source: Oslo Economics

Of these markets, we consider GOs to have the most in common with voluntary carbon offsets and organic foods. Like voluntary carbon offsets and organic foods, GOs are purchased at a voluntary basis. Demand for organic food is primarily driven by concerns for personal health and for the environment, the latter of which is also a key demand driver for GOs and voluntary of carbon

offsets. This creates a very different demand than for the mandatory carbon offsets like emission allowances under the EU-ETS and el-certificates, in which retail power supplier are subject to a quota regulation that obliges them to buy el-certificates corresponding to a given share of their electricity delivery, and thus could be

<sup>25</sup> [https://www.forbes.com/sites/niallmccarthy/2015/07/27/t](https://www.forbes.com/sites/niallmccarthy/2015/07/27/the-worlds-largest-markets-for-organic-products-infographic/#3bc08ef7146f)

[he-worlds-largest-markets-for-organic-products-infographic/#3bc08ef7146f](https://www.forbes.com/sites/niallmccarthy/2015/07/27/the-worlds-largest-markets-for-organic-products-infographic/#3bc08ef7146f)

considered a fee. Physical power is not mandatory, but is essentially a necessity.

GO supply is determined by the renewable energy production, which is determined by natural conditions, historical development and support schemes such as feed-in-tariffs. By design, the supply of GOs is largely decoupled from demand, as opposed to the delivery of physical power which must match the demand for electricity at all times. Similarly, the supply of organic food is driven by a demand for organic produce. The el-certificate market is designed to encourage higher supply (of new renewable energy generation) by creating a demand through mandatory obligation to redeem certificates.

The sizes of these markets vary substantially. While the Nordic power market, the European market for organic foods and the mandatory market for emission allowances probably amounts to be several billion Euros each, the European market for GOs is estimated to around 240-400 million Euros (Chapter 2.4). This is about half of the market for El-certificates, which are only traded in Sweden and Norway.<sup>26</sup>

Although the largest share of traded GO volumes are probably the more standard types of GO products, there is, theoretically, up to thousands of different GOs, differentiated along the information they carry on their attributes such as

technology, age, subsidy-eligibility etc. GOs are therefore heterogenous products, like organic foods which are recognized by a wide range of attributes and labels. Electricity is a standardized product with a normalized frequency of alternating current, voltage, and some other indices. There are however different prices for different types of demand and supply reliability, areas, times of consumption etc. el-certificates are standardised (one quality) for a given time. While mandatory carbon offset schemes include standardised units within the different systems, voluntary carbon offsets are characterized by differentiated products offered by a range of private organisations.<sup>27</sup>






### 3.3 How other renewable products are traded

In the previous section, we found that the market for GOs shares some properties with voluntary carbon offsets and organic food. These properties can explain why the products are traded as they are. For example, the relatively small volumes for standardised products in the GO wholesale market, and likewise for voluntary carbon offsets and organic food, implies that exchange trading is less interesting (as it requires standardisation and relatively high volumes). In Figure 3-3 we show how the different renewable products are traded. In the next sections, we will describe the trade in these markets.

<sup>26</sup> Based on transaction prices and volumes cancelled, retrieved from the certificate registry (NECS, 2017).

<sup>27</sup> E.g. TerraPass, The Carbon Neutral Company, Climatecare, ClimateKind, MyClimate

**Figure 3-3: How GOs and other “renewable products” are traded**

|   | Electricity (physical) | El-certificates | Mandatory carbon offsets | Voluntary carbon offsets | GOs                     | Organic food |
|---|------------------------|-----------------|--------------------------|--------------------------|-------------------------|--------------|
|  | ✓                      | ✓               | ✓                        | ✓                        | ✓                       | ✓            |
|  | ✓                      | ✓               | ✓                        | ✓                        | ✓                       | ✓            |
|  | ✓                      | ✓               | ✓                        | ✓                        | ✓                       | ✓            |
|  |                        |                 |                          |                          | Under establishment*    |              |
|  | ✓                      | ✓               | ✓                        |                          | EEX exchange w/o trades |              |

\* Electronic trading platforms are in use in bond trading

Source: Oslo Economics

### Trade in physical electricity

Power producers, suppliers, industry and other large consumers buy and sell power in competition with other market participants in the electricity wholesale market. Trading can take place bilaterally or on exchanges, and contracts for electricity can be struck over timescales ranging from several years ahead to on-the-day trading markets.

A uniform system clearing price in the day-ahead market is determined through an implicit auction where bid offers from generators are matched to bids from consumers at each node to develop a classic supply and demand equilibrium price. The system price (in Norway) is calculated for every hour for the following day, and for each bidding zone in which physical constraints of cross-zonal capacity is taken into account. Closer to the production hour, electricity is traded in an intraday market that make it possible to adjust imbalances and a balancing market that ensure that electricity supply and demand match on a second-by-second basis. This can be done by accepting offers of electricity (generation increases and demand reductions) and bids for electricity (generation reductions and demand increases) at very short notice. The technical complexity of the systems means that the market players need to have some basic knowledge in order to trade.

This system price is used as reference for price setting in the financial market where electricity derivatives such as electricity futures and options are actively traded, as well as for bilateral contracts and retail contracts in the market.

### Trade in el-certificates

El-certificate volumes are traded in forward contracts on the Nasdaq OMX exchange. Trade in el-certificates also occurs through bilateral agreements between energy producers and market participants with quota obligations, as well as via brokers, such as CleanWorld, ICAP and SKM. There are also some traders in the market, who aim to buy electricity certificates and sell them later at a profit.<sup>28</sup> El-certificates are traded in spot price and forward contracts.

El-certificate prices are market-based and vary over time with the quota obligation, electricity consumption and supply of new renewable electricity generation. Wholesale prices for el-certificates are published by private market facilitators such as Greenfact, ICAP and SKM. Since March 2017, average weekly spot prices at traded through SKM have varied between almost 80 and just over 40 SEK/MWh, corresponding to roughly 4-8 EUR/MWh. In October-November 2016, el-certificates were traded at prices up to 150 SEK/MWh.<sup>29</sup> Average transaction prices for the last year (Nov. 2016-Nov. 2017) published by the Norwegian

<sup>28</sup> [https://www.nve.no/Media/4750/elcertifikat-2015-en\\_web.pdf](https://www.nve.no/Media/4750/elcertifikat-2015-en_web.pdf)

<sup>29</sup> <http://www.skm.se/priceinfo/history/>

certificate register NECS were 12,7 EUR/MWh (NECS, 2017).

Retail power suppliers with quota obligation pass on their costs related to their el-certificate purchases to their customers. In 2016, the price to the end-user of the el-certificates amounted to around 3.1 øre/kWh<sup>30</sup> (~3 EUR/MWh) in 2016 (NVE, 2017). By design, the el-certificate quota obligation, and thus the cost to end-users in Norway<sup>31</sup>, will increase towards 2020 (after which new RES-E generation is not eligible for certificates) before it is gradually reduced toward 2035, when the last producer to be included in the scheme has received el-certificates for 15 years.

#### Trade in mandatory carbon offsets

In principle, anyone can trade in the compliance carbon market as long as they have an account in a registry that keeps track of the relevant unit. The ultimate buyers of compliance credits are individual companies that expect emissions from their activities to exceed their allowances needed to offset their emissions. The main categories of market players are energy companies and industrial installations that are required to cancel quotas corresponding to their emissions, and financial intermediaries such as banks which also act on behalf of smaller companies and emitters (European Commission, 2017). Typically, they purchase emission allowances directly from another party with excess allowances, from a broker/intermediary, or on a climate exchange, such as the EEX. EU-ETS emission allowances are currently traded at around 7 EUR/tCO<sub>2</sub><sup>32</sup>.

#### Trade in voluntary carbon offsets

Trade in voluntary carbon offsets differs from trade in emission allowances under the compliance schemes. Businesses and individuals who want to voluntarily offset their carbon emissions typically purchase them from private organisations. These organisations offer standards or certificates awarded to businesses that reduce their emissions – typically through combination of internal emissions reductions and the purchase of environmental instruments

including renewable energy certificates and carbon credits. These carbon credits results can come from emission reductions made elsewhere, typically achieved through financial support of emission reducing projects, such as a renewable energy projects in the third world. For example, Scandinavian Airlines (SAS) purchase carbon offsets from The CarbonNeutral Company on behalf of their customers who want to compensate for their emissions related to air travel. In return for the compensation collected, they receive a certificate from The CarbonNeutral Company<sup>33</sup>.

#### Trade in organic food

Organic produce is typically bought by a supplier/primary producer, who sells it to a packer/manufacturer who processes the produce into products that are sold in the by distributor/retailers/wholesalers to private and institutional consumers. Organic produce is largely sold through bilateral contracts throughout the supply chain. The standards and ecolabels verify traceability and product liability to the end-consumer.

According to several studies, price premiums for organic niche products can be significant<sup>34</sup>, but may fall if production increases significantly, for example due to regulations that supports organic farming. The price is however largely demand driven, and demand varies for different products in different regions.

#### Note on electronic trading platforms

We do not know of electronic trading platforms as described in Chapter 3.1 for any of the markets studied. In the bond market, in which most bonds do not trade on exchanges, there has been a push for increased transparency that has increased the interest in electronic trading platforms (The Economist, 2017). This provides investors access to more information about prices. To our knowledge, one market facilitator in the GO market, Kapturs, is under establishment, and time will show whether trade is attracted to this network platform.

<sup>30</sup> incl. VAT

<sup>31</sup> Sweden has extended the el-certificate scheme.

<sup>32</sup> Retrieved from: <https://www.eex.com/en/market-data/environmental-markets/spot-market/european-emission-allowances#!2017/12/15>

<sup>33</sup> <https://www.flysas.com/en/is/SAS-for-business/Conventions/Carbon-offset/>

<sup>34</sup> See for example (Roheim, et al., 2011)



## 4. Evaluation of the markets for and trade in Guarantees of Origin

*While competition in the wholesale market for GOs is strong, competition in the end-user markets is far from perfect. There is a very large product variety, which can be explained by consumers having different preferences and perceptions of what is environmentally friendly, but which is accentuated by the bundling of GOs with other attributes and with the many different labels and marketing terms. This, in turn, affects transparency and end-users' possibility to compare products, which hinders price comparisons and thus price competition in the end-user markets. There can be relatively large differences between wholesale and end-user market GO prices.*

### 4.1 Introduction to the evaluation

A market is the structure that enables buyers and sellers to exchange goods, services and information. The main function of the market is to value any product with a price, which is influenced by supply and demand. This ensures that society's resources are distributed to those with the highest willingness to pay. While the market is the structure that enables supply to meet demand, trade is the activity of buyers and sellers exchanging products.

In this chapter, we first evaluate the markets for GOs (wholesale and end-user) in Section 4.2. In 4.3, we consider the link between the wholesale and retail prices. Finally, in Section 4.4, we evaluate the wholesale trade in more detail, with emphasis on liquidity and informative prices.

### 4.2 Evaluation of the markets for Guarantees of Origin

#### 4.2.1 Criteria for perfectly competitive markets

An efficient market structure is crucial to maximize the benefits to the parties that use the markets and to the economy as a whole.

To evaluate the markets for GOs, we have used four criteria for a perfectly competitive market. In

the general equilibrium theory, a perfect market is defined by several theoretically ideal conditions that lead to perfect competition. If the conditions of perfect competition hold, it can be demonstrated in theoretical models that a market will reach an equilibrium in which the quantity supplied for every product or service, including labour, is equal to the quantity demanded at the market price. This equilibrium is a Pareto optimum, meaning that nobody can be made better off by exchange without making someone else worse off.

A perfect competition market ultimately leads to efficient economic activity, where production and allocation decisions ensure that resources are used where they are most valuable. This is ensured because no single market participant has the power to set the price, so that neither producers nor buyers can affect the price through, for example, by limiting supply or demand. Instead, the producers accept the prevailing market prices and compete to reduce their costs in order to maximize their profits, and supernormal profits cannot be achieved.

To ensure perfect competition, the following conditions, among others, should be met:

**Many buyers and sellers:** In a well-functioning competitive market, no firm has power to dominate the market. The existence of significant monopoly power in a market restricts the participation opportunities of smaller competitors and potential new market entrants. If there are very few buyers and sellers, the market pressure for competitive efficiency and innovation is reduced and consumer choice and price protection are weakened.

**No barriers to entry:** Free entry and exit makes markets function efficiently. Barriers to entry, for example restrictive licenses, large investment requirements or high transaction costs, reduce possibilities for participation in the market, thereby limiting the extent of competition, and thereby market efficiency.

**Perfect information:** All parties in the market, including firms and consumers, must be well-informed in order to make effective decisions. Perfect information requires the widespread availability of timely and relevant information, which is ensured through sufficient transparency.

Barriers to information, such as high product heterogeneity and bundling, weaken the ability of markets to function efficiently. Moreover, if two parties entering into a transaction do not have the same level of information (information asymmetries), one is placed one at an advantage over the other, hurting the price formation and market efficiency.









**Rational market participants making active choices:** In economic theory, the market participants are purely rational. This implies that they make optimal decisions based on a careful weighing of costs and benefits.


#### 4.2.2 Evaluation of the markets according to criteria for perfectly competitive markets

Even though most markets do not perfectly fulfill all criteria for perfectly competitive markets, these criteria are still useful in evaluating to what extent the competition in a market can be said to be perfect.

In Figure 4-1, we summarize our overall assessment of the wholesale and end-user markets.

**Figure 4-1: Evaluation of the wholesale and end-user markets according to criteria for perfect competition**

| Criteria for perfect competition                  | Wholesale market   | End-user markets   |
|---|--|--|
| Many buyers and sellers (absence of market power) |  No producers/buyers with substantial pricing power     |  Many buyers and sellers in most segments<br>Players with market power in some segments |
| No barriers to entry                              |  Not very relevant as supply is not dependent on demand |  Low barriers to entry in some segments<br>High barriers to entry in others             |
| Perfect information (transparency)                |  Good transparency for market players                 |  Very low transparency, mainly due to heterogeneity and bundling                      |
| Rational players making active choices            |  Mostly rational players, but some inactive producers |  Private consumers and businesses buying GOs more active than most customers          |

 Four shaded boxes indicate that criterion for perfect competition is fully satisfied

Source: Oslo Economics

#### 4.2.3 Evaluation of the wholesale market for GOs

The wholesale market is found to fulfil most of the criteria perfect competition.

##### Criteria 1: Many buyers and sellers (wholesale)

There are many producers and many buyers in the wholesale market. According to the interview objects, there is not one player who alone wields significant market and pricing power.

##### Criteria 2: No barriers to entry (wholesale)

We have not identified significant barriers to entry. Our impression is that the issuance of GOs is in different countries is effective. Thus, new generators can supply the market with new GOs. Furthermore, supply side barriers are not very relevant as the supply of GOs, is dependent on

the demand for renewable energy, and to a much less extent dependent on the demand for GOs.

##### Criteria 3: Perfect information (wholesale)

Although there is no regulated exchange that ensures that every player is guaranteed all relevant information at the same time, market participants in the wholesale market describe the market as sufficiently transparent. For liquid GO products, quoted prices and historical prices can be retrieved from platforms that quote traded volumes, such as Commerg and Montel. These market facilitators help provide reference prices<sup>35</sup> to market participants who have access to their platforms (usually require a payable account). For less liquid GO products, the price transparency is low. Hence, more specialized

<sup>35</sup> Reference prices reflect a product's real market value based on underlying economic conditions.

GOs typically entail higher search and information costs and it is more difficult to know what is a fair price because of the lack of a reference price.

#### **Criteria 4: Rational players making active choices (wholesale market)**

Market participants in the wholesale market can be characterized as rational players, mostly making active choices. The GO system is voluntary, and large businesses and power suppliers buying GOs in the wholesale market are well-informed in terms of what renewable attribute that is relevant for their business model. On the producer side, however, some producers are described as relatively inactive. There are cases of producers not professionally engaged in in GO trade who hurriedly sell off their volumes right upon expiry, without actively looking into what prices they may achieve for their GOs.

#### **4.2.4 Evaluation of the end-user markets for GOs**

There is not one end-user market for GOs. Instead, there are several markets, for instance the electricity, public transportation and home appliances markets, where the renewable feature (the GOs) is one of many attributes.

Many of the end-user markets for GOs do not satisfy the characteristics of a perfectly competitive market. This can be partly explained by the heterogeneous demand for GOs (and the resulting imperfect information), as well as the lack of competition in several underlying product/service markets.

#### **Criteria 1: Many buyers and sellers (end-user markets)**

In the end-user markets, GOs are usually not sold separately, but as one of many attributes of an electricity tariff or a product. The number of buyers and sellers vary from segment to segment.

In many consumer segments, such as electricity in Norway, there are many buyers and sellers. Thus, no seller can be said to have significant market power in the marketing of GOs as an attribute to their products/services. In other segments, however, for instance railway tickets in Germany, there is mainly one company (Deutsche Bahn) which can market GOs to railroad passengers.

#### **Criteria 2: No barriers to entry (end-user markets)**

In most countries, consumer oriented companies can easily start purchasing and marketing GOs. To do so, they need an account in a certificate

registry. Some use intermediaries to take care of the administrative transactions (in some countries, only power suppliers have the right to cancel GOs). However, the main barriers to entry in selling GOs to consumers are not associated with the trade in GOs in itself, but with market barriers in the underlying product segment (e.g. train services in many European countries).

#### **Criteria 3: Perfect information (end-user markets)**

In the end-user markets, the consumer buys an electricity tariff, a car or railroad ticket, not a GO directly. To the private consumer, the GO is usually one of many attributes of the service or product he buys. Packaging and bundling of GOs with other attributes gives rise to a wide variety of products and services that are sold as “renewable”. This heterogeneity makes it difficult for end-users to compare prices and product properties.

Low transparency, imperfect knowledge and a substantial range of different products and pricing makes it difficult for consumers to make informative choices. Imperfect information implies that the average consumer does not know the precise differences between the various products, or what a fair price for them is. This increases the consumer’s information gathering and information processing costs. Product differentiation on quality and other attributes can make it difficult for consumers to know exactly what they pay for and whether the price they pay is fair.

#### **Criteria 4: Rational players making active choices (end-user markets)**

In the end-user market for electricity, the average household is relatively inactive in terms of switching between power suppliers. In many countries, switching is quite difficult. The main motivation to switch power supplier is usually price, while renewable offers are relevant for some customers, but not necessarily crucial (BEUC, 2016). Inactive customers may give the power supplier some pricing power.

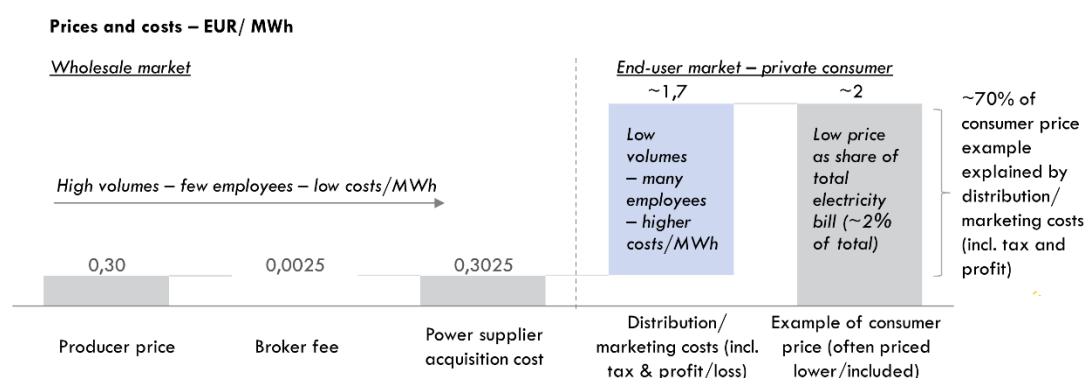
This characteristic may, however, not be directly applicable for the market for GO-backed power. Customers that want renewable energy, have usually made an active choice, and are likely to be more active than other customers. Such customers are likely to gather necessary information to make a choice between alternative electricity offers. A challenge for these customers is the relatively poor transparency for GO prices in most end-user markets. Therefore, the active customer incurs information and search cost.

Moreover, low transparency exposes the customer to misleading offers that pretend to be “environmentally friendly” but do not deliver additional environmental benefits. When German consumers were asked in a VZBV<sup>36</sup> survey why they hesitated to switch to a ‘green’ tariff, the uncertainty about the credibility of the offer was cited as the most important barrier by more than 40 per cent of the consumers surveyed (Forsa, December 2011).

## 4.3 Comparison of wholesale and end-user market prices

In this section, we consider the link between the wholesale and end-user market prices. In Figure 4-2, we illustrate how the GO attribute is valued in the wholesale market and in the end-user market for electricity. We note that this is an illustration of price differences in one type of trade

**Figure 4-2: Price differences between wholesale and end-user markets (producer and consumer prices)**



**Note:** One example of trade (producer via. broker to power supplier to consumer with explicit prices) – Not representative for margins in all types of trade (GOs are often included in product/electricity prices). Source: Oslo Economics.

We note that there are relatively large differences between producer (wholesale) and consumer (end-user) market prices. In the price example in Figure 4-2, the price to the producer of a GO traded in the wholesale market is 0,30 EUR/MWh. A power supplier buys the GO through a broker, at a small margin to this price (broker fee of 0,0025 EUR/MWh). To sell renewable power to its customers, the retail power supplier spends resources on marketing the renewable attribute. Also, they have some administrative costs, taxes and profits related to the sale of GO-backed electricity. As described in section 2.2.2, the GO price is usually not presented explicitly to the customer, and the actual price premium and profit margins of the power supplier is therefore unknown. There are however, examples of explicit pricing of the renewable attribute to the private consumer at 2 EUR/MWh. In this case, 70 per cent of the price paid by the consumer cover the

marketing/distribution cost of the retail power supplier (including administration, tax and profit).

This relative price difference can be explained mainly by distribution/marketing costs; while a few employees in the largest companies handle the wholesale trade, it takes many more employees to market and sell relatively small volumes in the end-user markets. We note that relatively large price differences between wholesale and end-user markets are common in several markets, for instance, they are much present in the clothing, for instance in the clothing, furniture and lighting business. Furthermore, the price to the private consumer of is fairly low as share of his total energy costs. 2 EUR/MWh (or 0,2 eurocent/kWh) corresponds to 1-2 per cent of the total electricity bill of an average consumer.

<sup>36</sup> Verbraucherzentrale Bundesverband - VZBV (The Federation of German Consumer Organisations) is a non-

governmental organisation acting as an umbrella for 41 German consumer associations.

## 4.4 Wholesale trade: Evaluation of liquidity and informative prices

In the previous sections, we have evaluated the wholesale and end-user markets for GOs. In this section, we will complement this analysis with an evaluation of wholesale trade in GOs, i.e. the activity of buyers and sellers exchanging products.

### 4.4.1 Criteria for well-functioning trade

The market microstructure literature, a branch of financial economics, is concerned with the trading mechanisms. This field of study is concerned with the role of information in the price discovery process, the liquidity and transaction costs, and the implication for efficiency and welfare.

In terms of trade, markets have, according to O'Hara (2003), two principal functions: They provide liquidity and facilitate price formation and price discovery.

**Liquidity** refers to the matching of ready and willing buyers and sellers. More precisely, it is a measure of the ability to buy or sell a product without causing a major change in its price and without incurring significant transaction costs. Price continuity, meaning that prices do not change substantially from one transaction to another unless significant news arises, requires numerous buyers and sellers that gives depth to the market. An important feature of a liquid market is therefore the presence of a large number of buyers and sellers that are willing to transact at all times. Intermediaries can provide liquidity

when buyers are ready to buy and but cannot find a seller or, conversely, when sellers are ready to sell but cannot find a buyer. The middle man is compensated for providing an immediate execution of orders by the spread that emerges between the buying and selling price. This spread is a transaction cost for the principal parties involved. If transaction costs are too high and liquidity low, it can be a barrier to entry to the market and thus hinder economic development.

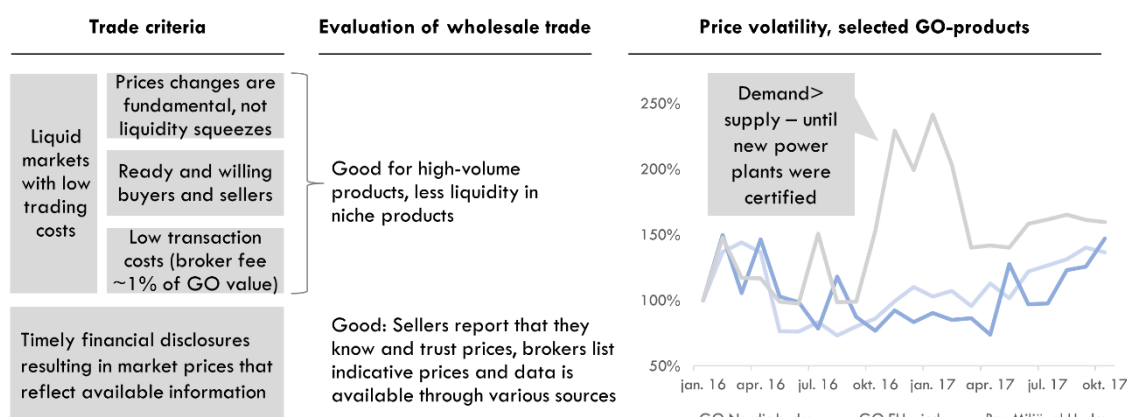
Secondly, markets should ensure **informative prices** that reflect available information. To ensure efficient price formation, new information must be brought to the market in a timely and accurate way. Efficient information dissemination and disclosure is closely linked to transparency. (Madhavan, 2000) defines market transparency as the ability of market participants to observe information about the trading process. Information in this context refers to knowledge about prices, quotes, volumes, sources of order flow, and the identities of market participants.

People use the information in prices to make good production and allocation decisions. Hence, liquid markets that produce informative prices ensure public benefits because resources are well allocated (efficient economic activity), in turn making market economics wealthy.

### 4.4.2 Evaluation of the wholesale trade according to criteria

According to these criteria, we consider that the trade in GOs is well-functioning, particularly for the high-volume, bulk products, see Figure 4-3.

**Figure 4-3: Evaluation of wholesale trade in Guarantees of Origin**



Source: Price data from Greenfact. Oslo Economics.



The market participants we have interviewed find it quite easy to buy and sell GOs. This implies that the market for GOs is sufficiently liquid. There are numerous buyers and sellers, giving some depth to the market. This is particularly true for the bulk GO products, such as Nordic Hydro GOs that are traded in large volumes. Liquidity may result in greater price transparency. Market participants report that they know what prices they can expect to buy or sell these GOs at, and that the traded volumes are generally sufficiently large to quote the prices on available platforms. Greater price transparency in these GO products may in turn provide opportunities for increased competition across the market.

The fees that brokers require to facilitate trades are reportedly between 0,25 and 0,50 eurocent/MWh, most often at 0,25 eurocents. This is roughly one per cent of the value of a GO, which is viewed as a reasonable fee by the market participants we interviewed. The market participants report that a large share of the volumes is traded through brokers, and that the competition has improved with increasing numbers of brokerage firms entering the market for GOs.

GO sellers (i.e. power producers) report that they know what prices they can receive for their volumes, and that they have confidence in the price discovery. Some brokers list indicative prices that serve as a reference, and by calling a

few brokers, the seller will have a good overview of where the market is at. GO sellers report that there is generally a high degree of agreement between the price offers and that their price expectations are usually met by the brokers.

More narrow GO categories are typically less liquid, in the sense that they are traded in low volumes, by fewer buyers and sellers and less frequently. For example, prices for GOs with the ecolabel “Bra Miljöval” more than doubled for a short period of time in the autumn of 2016, as shown in Figure 4-3. According to players we interviewed, this price change can be explained by the fact that the supply of “Bra Miljöval” GOs is limited by the time it takes time to certify a power plant. If several businesses or power suppliers have committed to deliver Bra Miljöval products to their customers, a scarcity in the supply can appear in periods of low power production (i.e. precipitation to hydro power plants) or an increase in demand, causing price rises.

For niche products, prices are less transparent and liquidity lower. Trade in these GOs are typically driven by demand for specific power source attributes, and the market participants will negotiate the price in each case. For example, ECOHZ trade GOs at over 400 different price points, in which most are not particularly robust.

## 5. Developments in the trade in and market for Guarantees of Origin

Since 2010, the relatively free end-user markets for GOs have resulted in many new products for consumers and businesses, including additionality products. In the same period, the wholesale market has been professionalized. We suggest some recommendations for the future development of the market for Guarantees of Origin: Harmonisation of marketing

terms, price comparison tools for consumers and an annual survey analysing the market development

### 5.1 Recent development

Several trends and developments have influenced the market for GOs over the past years. In Figure 5-1, we illustrate some recent developments in the end-user and wholesale market:

**Figure 5-1: Recent development in the end-user and wholesale markets for GOs**



Source: Oslo Economics

#### Recent development in the end-user markets

In the recent years, the end-user market for renewable electricity has largely been driven by a growing demand for documented renewable energy from businesses that have a strategy to build an environmentally friendly image. For example, the RE100 group of influential businesses that are committed to using 100% renewable energy, has seen a steady increase in number of members.

Market participants seek to meet the demand for different renewable attributes through product

innovation. For example, ECOHZ and Kinect Energy offer GO products that contributes to additionality because this is what many consumers demand.

In some end-user markets, there have been measures to increase transparency in the prices for GO-backed products. Recently, the Norwegian price comparison website [strompris.no](http://strompris.no)<sup>37</sup> was updated to include a sorting criteria, so that the consumer can compare the prices of renewable electricity from different sources (hydro, wind, etc.). Some other countries

<sup>37</sup> "powerprice.no"

have similar price comparison tools. This contributes to increased transparency and information to the consumers.

### Recent development in the wholesale market

According to market participants, the wholesale market has been professionalised over the recent years. The market has been allowed to develop quite freely, and is becoming increasingly more mature.

In 2014, the wholesale market was described as non-transparent by the German Umweltbundesamt. In 2017, the market players have interviewed report that transparency has improved and that there is little doubt about current market prices.

*«Everyone» in the market knows the current prices of frequently traded GOs.*

*BKK (Norwegian power producer)*

Several brokerage firms now quote indicative prices, and access to platforms with price data are available from several market facilitators, such as Commerc and Montel. Moreover, since more brokers have entered the GO market, competition and availability of brokerage services have improved. Also, Greenfact, who quote GO prices for traded volumes, also

provide relevant news, market analysis and insights into the GO market.

Recently, effort has been made to harmonise the market for GOs. The AIB has been key to promote a harmonised, reliable and transparent European market for energy certificates. The main task of the AIB has been to develop, use and promote the standardised European Energy Certificate System (EECS), which today is the dominant GO standard in Europe. The EECS has been fundamental to facilitate the international exchange of EECS certificates. The harmonised EECS rules, launched in 2011, ensures that EECS energy certificate systems are reliable, secure and inter-operable as each EECS certifies that one MWh of energy is produced from a certain source, with a certain quality and with a certain method of production.<sup>38</sup>

Moreover, to further facilitate the international exchange of energy certificates, the AIB operates an inter-registry telecommunications Hub. Local electronic registries, connected through the AIB Hub registry, have made the transfer procedure easier and the system more trustworthy.

## 5.2 Possible future development

Several market drivers on both the demand and supply side may considerably influence the market for and trade in Guarantees of Origin. In this section, we describe how market drivers and some observed trends may affect the market for GOs in the future (see Figure 5-2).

**Figure 5-2: Possible future development in the market for and trade in Guarantees of Origin**

| Market drivers  | Customisation vs. Standardisation   |
|---|---|
| <ul style="list-style-type: none"> <li>In the short term, the market for GOs is mainly demand driven, as supply is largely inelastic. Therefore, a change in demand may result in large changes in GO-prices</li> <li>Depending on the result of the EU "Winter package", power suppliers who make renewable claims must back these claims by GOs. In addition, there is a suggestion that GOs from generators (power plants) that receive support may be sold on government auctions</li> <li>In the long term, the increasing share of renewable electricity production in Europe will affect the supply and thus price of GOs</li> </ul> | <ul style="list-style-type: none"> <li>Current market characterized by large price differences between "bulk", "premium" and "tailored" products</li> <li>Market players we have interviewed observe a trend - an increase in the demand for local and customized GOs</li> <li>The wholesale market is likely to adapt to end-user demand, perhaps leading to a smaller share of volumes being sold as "bulk" products (e.g. Large Nordic Hydro)</li> </ul> |

Source: Oslo Economics

<sup>38</sup> <https://www.aib-net.org/eeecs>

## Market drivers

In the short term, the market for GOs is mainly demand driven, as supply is largely inelastic. Therefore, a change in demand, for example due to regulation, may result in large changes in GO prices.

The so-called EU Winter Package include some proposed modifications to the Guarantees of Origin system<sup>39</sup> (European Commission, 2016). Some provisions imply that an increased demand for GOs. One of these modifications is to make the use of GOs mandatory for RES-E and renewable gas disclosure:

*“Where energy suppliers market energy from renewable energy sources [...] to customers with a reference to environmental or other benefits of energy from renewable sources [...], Member States shall require those energy suppliers to use guarantees of origin to disclose the amount or share of energy from renewable sources.”<sup>40</sup>*

In addition, there is a suggestion that GOs from generators (power plants) that receive support should be sold on government auctions. The final provisions will be agreed in 2018/2019.

In the long term, the increasing share of renewable electricity production in Europe will affect the supply of renewable energy GOs in the market. In the current EU 2020 Energy Strategy, EU's energy priorities between 2010 and 2020 aims to increase the share of renewable energy in the EU's energy mix to at least 20% of consumption. EU countries have agreed that a target of at least a 27% share of renewable energy consumption should be met by 2030. A 35% share has been proposed by the European Parliament. In the EU 2050 Energy Strategy, the EU has set itself a long-term goal of reducing greenhouse gas emissions by 80-95%, when compared to 1990 levels. To achieve these goals, significant investments in renewable energy source electricity production are needed, as well as other low-carbon technologies, energy efficiency, and grid infrastructure (The European Commission, 2017). If a very high share of

renewable power in Europe is achieved, demand for some GO-products (for instance bulk products like EU Wind) may fall, while others (such as plant-specific, local products) may remain popular, depending on consumer preferences and perceptions.

## Customisation vs. Standardisation of GO products

Currently, the market is characterised by relatively large price differences between “bulk”, “premium” and “tailored” GO products. While standardised products are likely to remain, market players that were interviewed observe a trend for more customised GO products. According to the interview objects there is an increased end-user demand for GOs from specific countries, regions, districts and even power plants. There are also observed orders for GOs broken down in smaller time-units to better imitate the customers actual electricity consumption. The wholesale market is likely to adapt to end-user demand, perhaps leading to a smaller share of volumes being sold as “bulk” products (e.g. Large Nordic Hydro).

## 5.3 Recommended measures to improve the markets for GOs

Our evaluation of the markets for and trade in Guarantees of Origin concluded that while competition is good in the wholesale market, competition in many end-user markets is not perfect, mainly due to insufficient transparency. There is a very large product variety, in part due to bundling of GOs with other attributes and with the many different labels and marketing terms. This affects transparency and end-users' possibility to compare products, which hinders price comparisons and thus price competition in the end-user markets.

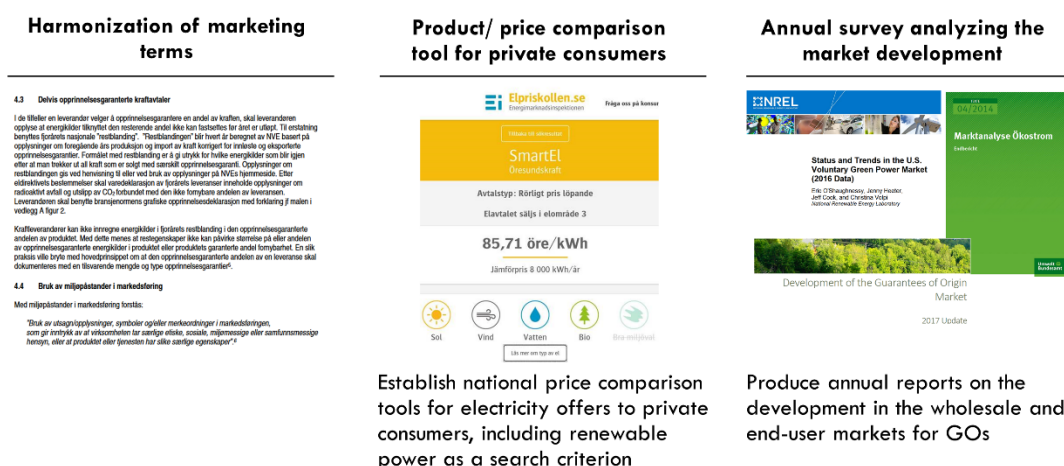
Low transparency and competition in the end-user markets can be a problem for several reasons. In addition to the disadvantages to consumers, it risks reducing the value of GOs for power producers in the long term, as the value of GOs largely depends on consumers viewing the renewable product as credible.

Competition in the end-user markets for GOs depends to a large extent on competition for the underlying products, for instance electricity for households, or railway tickets. There are, however, some measures which could be made to promote better transparency for the GO-

<sup>39</sup> Directive 2009/28/EC Article 19

<sup>40</sup> Amendment Article 19 (14)

We have identified three possible measures to improve competition in the end-user markets going forward. These can be implemented by industry organisations, national governments and/or the EU. The first is to harmonise across Europe the terms and definitions used to market renewable energy based products or power. The





comparable manner. In many end-user markets for electricity offers across Europe, it is not always easy to compare different offers.

Besides the general consumer rights guaranteed in the EU legislation, and the EUs defined set of rights that all EU citizens shall enjoy as energy consumers, the European Commission is working on expanding these basic rights to allow consumers to actively participate in the energy market. One of the objectives of the Commission is that in the future, energy consumers in the EU should be able to have access to at least one certified price comparison tool meeting minimum standards (European Commission, 2017). The tool should enable the consumer to compare easy-to-understand offers from different suppliers.

To improve transparency and competition in the GO-attribute, we suggest that such price comparison tools include price comparisons for the renewable attribute (GO), depending on technology, nationality etc.

In Norway, the Norwegian Consumer Council, in cooperation with the NVE, has established the web site *strømpris.no*<sup>41</sup>, which provides a transparent overview of prices and makes it easier for retail electricity customers to choose and switch between suppliers. Recently, a new sorting criteria was introduced to give consumers the opportunity to choose renewable power tariffs, where the price of the renewable attribute is included through the cancellation of GOs. It is also possible to customise the search to only include some certain renewable energy sources, for instance wind (Forbrukerrådet, 2017). The Swedish *elpriskollen.se*<sup>42</sup> has similar features and many other European countries already have price comparison websites.<sup>43</sup>

## Annual survey analysing the market development

To remedy the lack of transparency in the market for and trade in GOs, and to increase the general knowledge about the GO system, it could be beneficial that more information is made widely available to those interested.

This could be accommodated in the form of an annual report or fact sheet on the main market development, both in the wholesale and end-user markets for GOs.

In the US, the National Renewable Energy Laboratory publish a market report yearly called *Status and Trends in the U.S. Voluntary Green Power Market* (NREL, 2017). The report includes a description of utility green pricing and renewable contracts, and status and trends of competitive green power suppliers, unbundled RECs and power purchase agreements.

For the European GO system, Grexel, provider of a central certificate registry platform, has published a market report based on certificate registry data, and Greenfact market analysis and insights are available for those with an account there.

We recommend that a market report that is relevant and available to a broad audience, including market participants, regulators, NGOs and other interested parties, is produced for the European GO market. Preferably, a neutral party such as the AIB could commission such a report, but it could also be produced by an NGO or external party. With the help of an annual public report, consumers, businesses and politicians can follow the development in product, prices and competition the wholesale- and end-user markets.

---

<sup>41</sup> "[www.powerprice.no](http://www.powerprice.no)"

<sup>42</sup> "[www.powerpricewatch.se](http://www.powerpricewatch.se)"

<sup>43</sup>

[https://ec.europa.eu/energy/sites/ener/files/documents/Pri ce\\_Comparison\\_Website.pdf](https://ec.europa.eu/energy/sites/ener/files/documents/Pri ce_Comparison_Website.pdf)

## 6. References

- AIB, 2017. *Annual statistics - 2017Q3*. [Online]  
Available at: [https://www.aib-net.org/aib\\_activity\\_statistics](https://www.aib-net.org/aib_activity_statistics)  
[Accessed 8 December 2017].
- Australian Government Clean Energy Regulator, 2017. *Welcome to the REC Registry*. [Online]  
Available at: <https://www.rec-registry.gov.au/rec-registry/app/home>  
[Accessed 5 December 2017].
- BEUC, 2016. *BEUC Mapping report Current practices in consumer-driven renewable electricity markets*, Brussels: BEUC - The European Consumer Organisation.
- ECC, 2017. *ECC Price List*. [Online]  
Available at:  
<http://www.ecc.de/blob/12114/7a3965813f84a863b8bee91b88dadcc3/price-list-ecc-en-data.pdf>  
[Accessed 04 12 2017].
- ECOHZ, 2017. *Labels and standards*. [Online]  
Available at:  
<https://www.ecohz.com/renewable-energy-solutions/eco-labels/>  
[Accessed 10 November 2017].
- ECOHZ, 2017. *Presentation: Market demand data*. s.l.:s.n.
- EEX, 2017. *Price lists EEX Group*. [Online]  
Available at:  
<https://www.eex.com/blob/76218/c7ffdcf97d7fee57968c3324f1cacd10/20171117-pricelist-eex-group-0060a-e-final-data.pdf>  
[Accessed 04 12 2017].
- Energy Norway, 2017. *Innspill til forbedring av opprinnelsesgarantiordningen*. Oslo: Brev til Olje- og energidepartementet 08.05.2017.
- European Commission, 2016. *COM (2016) 767 Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the promotion of the use of energy from renewable sources*, Brussels: European Commission.
- European Commission, 2017. *Consumer rights and protection*. [Online]  
Available at:  
<https://ec.europa.eu/energy/en/topics/markets-and-consumers/consumer-rights-and-protection>  
[Accessed 13 December 2017].
- European Commission, 2017. *The EU Emissions Trading System (EU ETS)*. [Online]  
Available at:  
[https://ec.europa.eu/clima/policies/ets\\_en](https://ec.europa.eu/clima/policies/ets_en)  
[Accessed 12 December 2017].
- European Securities and Market Authority, 2017. *MiFID II*. [Online]  
Available at:  
<https://www.esma.europa.eu/policy-rules/mifid-ii-and-mifir>  
[Accessed 7 December 2017].
- Forbrukerrådet, 2017. *Sjekk strømprisene*. [Online]  
Available at: <https://www.strompris.no/>  
[Accessed 12 December 2017].
- Forsa, December 2011. *Erwartungen der Verbraucher an Ökostrom und Konsequenzen für Ökostrom-Labelkriterien*, s.l.: p. 9.
- Hafslund, 2017. *Grønt valg - For deg som er opptatt av miljøet*. [Online]  
Available at:  
[https://www.hafslundstrom.no/strom/privat/gront\\_valg/10183](https://www.hafslundstrom.no/strom/privat/gront_valg/10183)  
[Accessed 5 December 2017].
- Madhavan, A., 2000. Market microstructure: a survey.. *J Financ Markets* 3(3), pp. 205-258.
- NECS, 2017. *Statistics Elcertificates*. [Online]  
Available at:  
<http://necs.statnett.no/WebPartPages/AveragePricePage.aspx>  
[Accessed 12 December 2017].
- NECS, 2017. *Statistics GO*. [Online]  
Available at:  
<http://necs.statnett.no/Lists/PublicPages/Statistics.aspx>  
[Accessed 28 November 2017].
- NREL, 2017. *Status and Trends in the U.S. Voluntary Green Power Market (2016 Data)*, Colorado: National Renewable Energy Laboratory .
- NVE, 2017. *Elsertifikater - Statistikk og publikasjoner*. [Online]  
Available at:  
<https://www.nve.no/energiforsyning-og-konsesjon/elsertifikater/statistikk-og-publikasjoner/>  
[Accessed 12 December 2017].

Ofgem, 2016. *Further clarification on 2015/16 Guarantees of Origin and implicit trading*. [Online] Available at: <https://www.ofgem.gov.uk/publications-and-updates/further-clarification-201516-guarantees-origin-and-implicit-trading> [Accessed 22 November 2017].

O'Hara, M., 2003. Presidential address: liquidity and price discovery.. *Finance* 58(4), p. 1335–1354.

Point Carbon AS, 2007. *Norsk bransjenorm for opprinnelsesgaranterte*, Oslo: Markedsførings- og verifikasjonsnorm.

Reichmuth, M. et al., 2014. *Marktanalyse Ökostrom*, s.l.: Umweltbundesamt.

Roheim, C. A., Asche, F. & Santos, J. I., 2011. The Elusive Price Premium for Ecolabelled Products: Evidence from Seafood in the UK Market. *Journal of Agricultural Economics*, 23 May, pp. 655-668.

TenneT, 2017. *Market Review 2016 Electricity market insights*, s.l.: s.n.

The Economist, 2017. *Digitisation shakes up business-bond markets*. [Online] Available at: <https://www.economist.com/news/finance-and-economics/21721208-greater-automation-promises-more-liquidity-investors-digitisation-shakes-up> [Accessed 20 November 2017].

The European Commission, 2017. *Energy Strategy and Energy Union*. [Online] Available at: <https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union> [Accessed 13 December 2017].

The International REC Standard, 2017. *We give consumers a choice*. [Online] Available at: <http://www.internationalrec.org/> [Accessed 5 December 2017].

osloeconomics

*www.osloeconomics.no*

post@osloeconomics.no  
Tel: +47 21 99 28 00  
Fax: +47 96 63 00 90

Besøksadresse:  
Kronprinsesse Märthas plass 1  
0160 Oslo

Postadresse:  
Postboks 1562  
Vika  
0118 Oslo