Report on guarantees of origin and product declarations for electricity

Analysis of how the schemes work, effects for Norwegian players and possible changes to the schemes

OE report 2018-30, prepared for the Ministry of Petroleum and Energy

osloeconomics

About Oslo Economics

Oslo Economics offers analysis and advice for authorities and public and private companies in the power market area. Our clients include the Ministry of Petroleum and Energy, NVE, Statnett, Energy Norway and power companies.

We have consultants with broad experience from different parts of the power sector, from previous employment, research and projects. We conduct socio-economic analyses of investments and other measures within the sector and assist with analysis and advice on regulatory issues. As one of the Nordic region's leading competition economics environments, we also conduct competition economic analyses.

Socio-economic study

Oslo Economics offers economic analysis for ministries, directorates, health authorities and other organizations. We have expertise in socio-economic analysis in accordance with the Ministry of Finance's circulars and guidelines.

From socio-economic and other economic analyses, we have extensive experience in identifying and assessing the effects of various measures. We price benefits and costs, or assess impacts qualitatively if pricing is not possible.

Report on guarantees of origin and product declarations for electricity/OE report 2018-30
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Executive summary

End users in the power grid cannot choose the energy sources for their consumption

Power producers and end users are connected in a common power system through the electricity grid. This enables efficient use of our energy resources, for example by allowing power generation to take place in large hydropower plants far from the major consumption centers. At the same time, it means that end users can neither know nor choose where their electricity comes from.

End users who wish to do so can purchase guarantees of origin. Guarantees of origin are proof that the same amount of renewable energy has been produced somewhere as the end user consumes. The purchase of guarantees of origin is made in addition to the purchase of physical power and does not affect the energy sources of the physical power supply. The direct climate impact of electricity consumption with and without guarantees of origin is therefore the same. The purchase of guarantees of origin can have an indirect climate impact by incentivizing renewable energy production. However, when viewed in the context of public support schemes, such as the electricity certificate scheme, the indirect climate impact may be zero.

End users who buy guarantees of origin pay in the order of 1-3 percent more for their power contract than end users who do not buy guarantees of origin. In return, they receive documentation that they can use in various ways, for example in their climate reporting and marketing.

Guarantees of origin for electricity: How documentation on energy sources is traded

Statnett, regulated by NVE, and organizations in other European countries, have chosen to establish national registers to ensure that power producers are only issued guarantees of origin corresponding to their renewable power production and that the guarantees are not sold more than once. In addition, Statnett and other European organizations have collaborated to create common standards, as well as an international registry for trading guarantees of origin across national borders. This has made it possible for Norwegian power producers to export guarantees of origin from Norwegian power production. Partly due to low domestic demand, 80 to 90 percent of the guarantees of origin from Norwegian power production are sold to foreign customers. In 2018, we estimate that Norwegian power producers' total profit from the sale of guarantees of origin will amount to between NOK 600 and 2,000 million.

Product declarations for electricity: How power suppliers document energy sources

According to our interviewees, several foreign customers and regulators will not accept Norwegian guarantees of origin unless the Norwegian authorities ensure that power suppliers (electricity sellers) do not market electricity from the same energy sources as renewables without purchasing guarantees of origin themselves. In our opinion, the Norwegian authorities have chosen to design the rules and practices in a way that largely meets this market requirement.

According to the Regulations on electricity sales and grid services (Ministry of Petroleum and Energy, 2017), Norwegian electricity suppliers must either provide their customers with individual product declarations, based on guarantees of origin, or refer to NVE's product declaration. NVE's current practice in the design of the product declaration means that the statistics are presented under the title "National product declaration" and that "Product declaration for power purchases without guarantees of origin" mainly reflects the European energy sources for which no one buys the guarantees of origin, namely fossil thermal power and nuclear power.
The share of renewables in this is by definition low, and NVE's product declaration may give the impression that power consumption without guarantees of origin is based on 57 percent fossil

thermal power, 27 percent nuclear power and 16 percent renewable power. This gives a different impression than the statistics, which show that the physical power production in Norway is 98 percent renewable and that Norway's exchange capacity with other countries corresponds to about 20 percent of the production capacity.

Environmental reporting and marketing: How business customers document energy sources

While the power supplier's documentation of energy sources to end users is provided by regulation and NVE's practice, it is up to the market (customers and investors) to decide how companies can document their greenhouse gas emissions and energy sources to their own customers further down the value chain. In many cases, customers and investors require companies to document their GHG emissions and energy sources according to GHG reporting standards. The most widespread standard for greenhouse gas reporting, the Greenhouse Gas Protocol, allows companies to document emissions from their energy sources both by means of guarantees of origin and by referring to physical power production in the area where they are located.

The large Norwegian industrial companies we interviewed choose to disregard NVE's product declaration for power purchases without guarantees of origin when documenting the energy sources for their power consumption. Instead, they document the energy sources for their electricity consumption by showing that the production mix in Norway is 98 percent renewable, which many of their customers accept/prefer. At the same time, the guarantees of origin for some of the same power are sold, mainly to foreign companies, who use this to document that their electricity consumption is renewable. The fact that different methods are used to document the energy sources of the same electricity means that some of the same renewable energy sources are marketed twice.

Effects of guarantees of origin and declarations of origin for Norwegian players

Norway has long had a resource rent in the form of cost-effective and flexible hydropower plants. In recent years, the valuation of renewable over non-renewable power generation has added value to these energy resources. The Guarantees of Origin and Product Declarations schemes have made this value tradable on the European market.

On the one hand, trading in guarantees of origin has resulted in increased profits for Norwegian power producers. In isolation, the increase in income per unit of renewable energy produced gives producers incentives to increase their renewable production. However, seen in the context of the electricity certificate scheme, it is unlikely that guarantees of origin have so far led to a significant increase in the production of renewable energy in Norway. However, this may change when the electricity certificate scheme in Norway expires in 2021.

On the other hand, trading in guarantees of origin may have reduced the natural competitive advantage that renewable energy production gives Norwegian industry. However, the cost for Norwegian industry is limited by the fact that many of their customers accept that they document their energy sources by referring to the physical production mix, so that they do not have to buy guarantees of origin.

Product declarations can have indirect effects through the information they provide consumers and businesses about the climate impact of their electricity consumption. A CO2 emission of 531 grams per KWh has been calculated for NVE's "national product declaration", while the CO2 factor for Norwegian electricity production is 16.4 grams per kWh. At the same time, individual product declarations can give end users who buy guarantees of origin the impression that their electricity consumption does not contribute to greenhouse gas emissions.
Product declarations can thus contribute to people getting a false impression of the climate impact their electricity consumption actually causes, which can lead to irrational and unfriendly energy choices. Depending on which figures decision-makers choose to look at, the result may be that gas and diesel appear more environmentally friendly than electricity from the grid, that players choose uneconomical self-generation of electricity, or that buyers of guarantees of origin do not see the environmental benefits of energy savings. However, we do not have the impression that the extent of misunderstandings of this type is particularly large.

Overall, our assessment is that Norway as a whole has probably benefited financially from the schemes so far. The main reasons are that guarantees of origin provide increased revenue for Norwegian power production, while many customers of Norwegian industry accept/prefer to use physical production mix to document that their energy sources are renewable. However, there is a risk that more customers of Norwegian

industry in the future will require their energy sources to be documented by means of guarantees of origin. This could weaken the industry's competitiveness compared to the current situation.

Possible changes to the schemes for guarantees of origin and declarations of origin

In the course of the study, we have asked representatives of the power sector and the industry what changes they would propose for the guarantee of origin and product declaration schemes. In addition, we have assessed which changes could provide benefits from a societal perspective.

The only proposed change that has been put forward by both the power sector and the industry is to change the design of NVE's product declaration to prevent people from getting the wrong impression of the climate impact of Norwegian electricity consumption. Such a measure could include, for example, changing the name from "Nasjonal varedeklarasjon" to "Overview over kraftdokumentasjon" or similar, removing the calculation of average CO2 emissions from the residual mix (and possibly only reporting CO2 emissions from different types of power generation), and stating that information on "Varedeklarasjon for kraftkøb uten ursprungelsesgaranti" should not be used when choosing between different physical energy sources.

The other proposed amendments involve some redistribution of the value of renewable energy from one group to another. For example, Norwegian industry, in a hypothetical scenario where their customers require them to document energy sources with guarantees of origin, may have an interest in measures that make it more difficult to export the guarantees of origin and thus lower the price of the guarantees for them. However, it is uncertain whether this would be possible and whether it would actually benefit the industry and not just result in losses for the power industry and Norway as a whole, as well as prevent the development of new renewable power production.

In addition to redistribution between the power industry and Norwegian industry, a relevant measure could be to redistribute value to the community, specifically by taxing income from the sale of guarantees of origin in the same way as income from the sale of physical power.

1. About the assignment

1.1 Mandate

Following a recommendation from the Norwegian Parliament's Energy and Environment Committee (2015-2016), the Ministry of Petroleum and Energy is considering how changes can make the system of guarantees of origin and product declarations for electricity work better than it does today.

The Ministry of Petroleum and Energy has engaged Oslo Economics to prepare a report that will provide a basis for the Ministry's assessment of the further development of the guarantee of origin scheme. According to the terms of reference, the report shall contain the following main elements:

- A comprehensive description and study of the market for guarantees of origin, including pricing, value streams and the relationship to other ways of documenting the share of renewables.
- A review of the design and use of product declarations for electricity.
- A socio-economic assessment of the implications of the guarantee of origin scheme, including questions about:
  - establishment of new power generation in Norway,
  - local vs. central power generation in Norway,
  - location of industry/business in Norway vs. the rest of Europe.
- Outlines of possible changes to the guarantee of origin scheme and product declaration for electricity

1.2 Information sources

The analysis is based on a combination of written sources, available statistics, interviews with relevant stakeholders, an open meeting on the report where preliminary findings were presented, input from the Ministry and our own assessments.

1.2.1 Written sources

The following documents have been central to the study:

- EU Renewable Energy Directive - on Guarantees of Origin (EU, 2009)
- EU Electricity Market Directive - on electricity product declarations (EU, 2009)
- NVE's regulation on metering and settlement (2017)
- NVE's descriptions of the national product declaration for electricity in 2017 (NVE, 2018)
- Oslo Economics analysis of trade in guarantees of origin (2017)

- Meld. St. 25 Power for change - Energy policy towards 2030 (Ministry of Petroleum and Energy, 2015-2016)
- Innst. 401 S. Recommendation from the Energy and Environment Committee on Power for Change - Energy policy towards 2030 (2015-2016)

For sources on the volume of traded guarantees of origin, we have used figures from the Norwegian Energy Certificate System (NECS) and from the European Association of Issuing Bodies (AIB). For price data, we refer to price statistics up to the fall of 2017 from the analysis company Greenfact (published in Oslo Economics' analysis from 2017 on the trade in guarantees of origin). Updated figures on price developments up to August 16, 2018 have been obtained from the broker/trading house ECOHZ and power producers such as Agder Energi.

For a complete overview of written sources, please refer to the list of references in chapter 8.

1.2.2 Interviews

We have conducted interviews with representatives from a total of 15 organizations. The interviewees from the power sector and industry were selected in collaboration with representatives from Energy Norway and the Federation of Norwegian Industries.

See the full list of interviewees below:

- Regulator:
  - NVE: Stian Skaalbones, Senior Consultant, End User Market Section (Norwegian Electricity Market Authority)
- The energy industry
  - Energy Norway Department for market and customers: Knut Kroepelien, director and Lars Ragnar Solberg, advisor
  - Statkraft: Einar Hoffart, Head of Business Development with colleague
  - BKK: Preben Klyve Olsen, sales manager production and market
  - Agder Energi: Jan Atle Liodden, Portfolio Manager Renewables Trading
  - Fjordkraft: Arnstein Flaskerud, Strategy Director
  - Småkraftforeningen: Knut Olav Tveit, general manager
- Industry players
  - Norwegian industry: Ole Løfsnes, Head of Environment and Climate

  - Hydro: Nina Lillelien, Energy Strategy and Policy Analyst
  - Alcoa: Toini Løvseth, Nordic Energy Director
  - Borregaard: Jostein Røynesdal, Energy Director
- Other industry players
  - Green Mountain: sales representative
  - ASKO (Norgesgruppen): Knut Aaland, Director Quality/Environment/Safety, Ronny Johnsrød, General Manager ASKO Renewable
- Market players
  - ECOHZ (trading house/broker): Tom Lindberg, general manager
  - Becour (trading space): Hans Petter Kildal, CEO

In addition to the interviews, we have received written input from Landssamanslutninga av Vasskraftkommunar, represented by Torfinn Opheim (chairman) and Kraftfylka, represented by Niklas K. Tessem (general manager).

1.2.3 Open meeting on preliminary findings

Preliminary findings from the study were presented at an open meeting on June 12, 2018, hosted by the Ministry of Petroleum and Energy. The 52 meeting participants were given the opportunity to ask questions, provide input and make comments.

1.2.4 Input from the Ministry of Petroleum and Energy

The Section for Energy Use and Electricity Certificates at the Ministry of Petroleum and Energy set the framework for the assignment and provided input and comments on the report from the start-up meeting in April 2018 until the final report was submitted in September 2018.

1.2.5 Own assessments

The information we have received through the interviews, the open meeting and from the Ministry is included as background information in the report.

All conclusions and assessments in the analysis are our own. We would like to thank the interviewees, the representatives of the Ministry of Petroleum and Energy and other stakeholders for their contributions to the report.

1.3 Delimitations

In our overview of possible measures, we have only included measures that, in our understanding as economists, may be feasible within the current regulatory framework. However, we have not conducted a legal assessment of which measures will actually be possible to implement within Norwegian legislation, the EEA Agreement and other relevant legal sources.

1.4 Content of the report

In Chapter 2, we describe the Guarantees of Origin scheme for electricity, including the origin of the scheme, how the scheme works and the market for Guarantees of Origin.

In Chapter 3, we describe the system of product declarations for electricity and how power suppliers and authorities document energy sources to power consumers, including the connection between the value of guarantees of origin and the design of NVE's product declaration.

In Chapter 4, we describe how Norwegian industrial companies and other commercial players document the energy sources of their electricity consumption to their customers, and to what extent this is done on the basis of guarantees of origin and other methods.

In Chapter 5, we analyze how the trade in guarantees of origin and the use of product declarations have so far affected various Norwegian actors - power producers, industrial companies and other businesses.

In Chapter 6, we analyze the most important uncertainty factors that may affect the supply of and demand for Norwegian guarantees of origin, and thus the effects for various Norwegian players.

Finally, in chapter 7, we outline possible changes to the schemes for guarantees of origin and declarations of origin and how they will affect various Norwegian players.

2. Guarantees of origin for electricity: How documentation on energy sources is traded

2.1 End users in the power grid cannot choose the energy sources for their consumption

Power producers (renewable and non-renewable) and end users (businesses and households) are connected in a common power system through the electricity grid, see Figure 2-1. The Norwegian power system is further integrated with the Nordic and continental European power system through transmission links.

Figure 2-1: The power system unites all power producers and power users in one grid

Source: Illustration taken from iStock

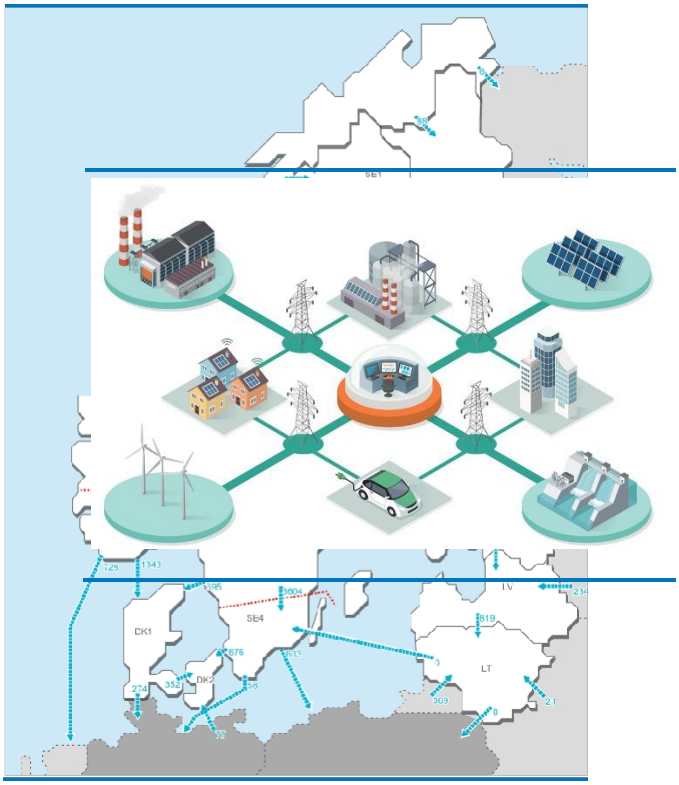
The power fed into the grid follows the laws of physics and flows in a path of least resistance. It is therefore not possible to separate different power deliveries from each other. A consumer customer cannot know who has actually produced the physical power he uses and which energy sources this production is based on, and therefore cannot choose which energy sources their electricity comes from.

The types of energy sources that contribute most to pushing electrons back and forth in the power grid depend on the local generation mix and the transmission capacity between areas. An additional uncertainty is the marginal effect, i.e. which type of power generation will increase when a consumer in a given area uses more electricity at a given time.

Hydropower accounts for 98 percent of Norwegian power production (NVE, 2018) and Norway's exchange capacity with other countries corresponds to around 20 percent of Norway's installed production capacity (Ministry of Petroleum and Energy, 2017).

For example, Figure 2-2 shows the Nordic power flow for the last 24 hours up to approximately 8:40 a.m. on August 17, 2018. At that time, power was exported from most grid areas in Norway, indicating that Norwegian physical consumption at that time was mainly based on hydropower.

Figure 2-2: Nordic power flow, 17.8.2018 at approx. 8:40 am (last 24 hours)



Source Statnett. The blue figures indicate the size of trade between areas (MWh). The arrows indicate the direction of export.

2.2 Demand for environmentally friendly power and guarantees of origin

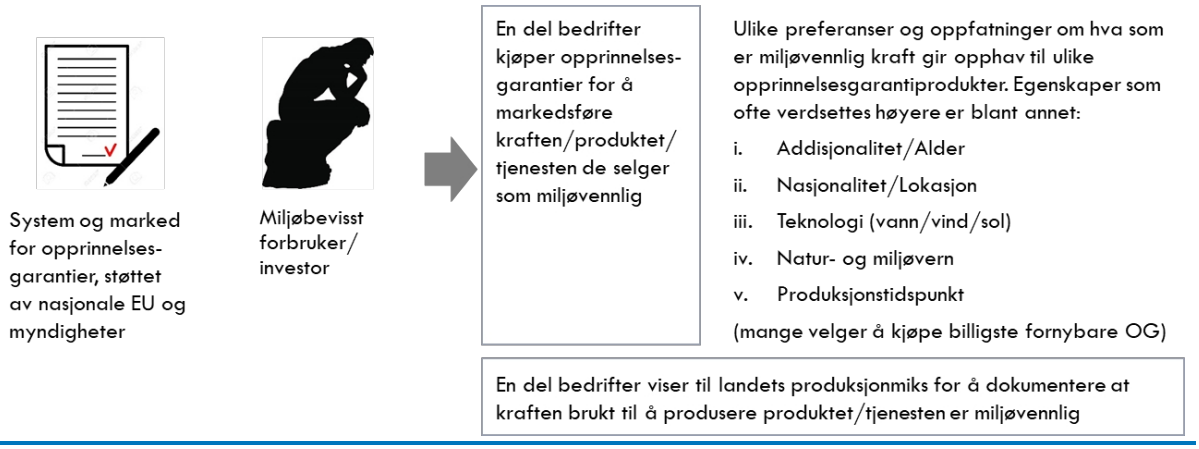
Electricity customers (businesses and consumers) can to some extent influence their physical power sources when choosing where to locate. Once the location decision has been made, electricity customers can only influence their physical power supply by fully or partially disconnecting from the grid and producing their own energy. In most cases, this would be inappropriate, and almost all households and businesses get their power from the grid. Customers connected to the grid cannot choose which actual energy sources (renewable or non-renewable) their electricity comes from.

End users who wish to do so can purchase guarantees of origin. Guarantees of origin are proof that the same amount of renewable energy has been produced somewhere as the end user consumes. The purchase of guarantees of origin is made in addition to the purchase of physical power and does not affect the energy sources of the physical power supply. The direct climate impact of electricity consumption with and without guarantees of origin is therefore the same.[1] The purchase of guarantees of origin can have an indirect climate impact by incentivizing renewable energy production. However, when viewed in the context of public support schemes, such as the electricity certificate scheme, the indirect climate impact may be zero.

End users who buy guarantees of origin pay in the order of 1-3 percent more for their power contract than end users who do not buy guarantees of origin. In return, they receive documentation that they can use in various ways, for example in their climate reporting and marketing.

Because there are many different perceptions among consumers and investors about which power sources are climate and environmentally friendly, there are many different types of guarantee of origin products (e.g. Nordic hydropower and Dutch wind power) with different prices, see Figure 2-3.[2]

Figure 2-3: Demand for guarantees of origin



Source: Oslo Economics

2.3 Value flows when buying guarantees of origin

For an electricity customer who buys electricity with guarantees of origin, in most cases only a small part of the total electricity price they pay to their electricity supplier accrues to the producer who has been issued the guarantee of origin and who owns the power plant in question.

The main part of the electricity price paid by the electricity customer is used by the electricity supplier (the electricity sales company) to pay for the physical electricity they buy for their customers at a certain time in a certain area. In most cases, this power is purchased on an exchange, where both renewable and non-renewable producers trade their power generation. In addition, the power suppliers charge a margin to cover

[1] For example, the direct climate benefit of saving electricity will be the same for a household that buys Guarantees of Origin as for a neighboring household that does not.

payment for electricity certificates and for the services they provide.

The proportion of the price the customer pays that actually goes to the seller of guarantees of origin will vary over time, between power suppliers and how they implement the purchase of physical electricity. In many cases, guarantees of origin are not priced explicitly to the customer, but may be included as one of many features, for example in a power contract with "100% renewable power", fixed price and set payment terms. For illustration purposes, we can describe the power purchase in this imaginary example:

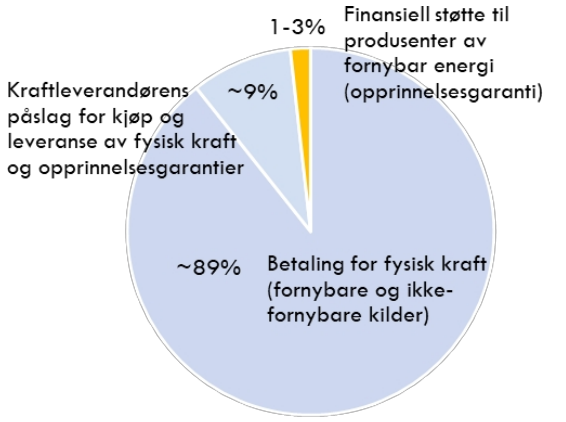
Total electricity price for end users with a power contract with guarantees of origin: 56 øre per kWh:

- Price of physical power: 50 øre ex VAT (Nord Pool Spot July 2018)
- Surcharge for physical power: 4.5-5.5 cents

[2] See section 2.7 for more information on why different guarantees of origin are valued differently.

- Price of guarantees of origin paid by the electricity supplier to the producer of renewable electricity: approx. 0.5-1.5 øre/kWh[3]

Figure 2-4: Share of price of power contract with guarantees of origin that goes to renewable producer that has been issued OG



Example based on prices in July 2018. Source: Oslo Economics

Of a total price paid by the power customer of around 56 øre/kWh (hypothetical example July 2018[4]), approximately 0.5 to 1.5 øre/kWh (1-3 percent) goes to the renewable power producer that has sold its guarantees of origin. The rest goes to payment for physical electricity (from renewable and non-renewable sources), as well as to cover the power supplier's costs and margin[5].

2.4 Guarantees of origin as a documentation tool

In addition to customers who purchase guarantees of origin from power producers on the open market, several companies use guarantees of origin to document their own power production. This includes companies that produce their own power at and outside their own production facilities (e.g. ASKO, Norgesgruppen) and some companies that enter into long-term power agreements and receive guarantees of origin as part of these to document their energy sources (e.g. Facebook, Google).

[3] Price of guarantees of origin for end users: 2 øre/kWh ~ approx. 2 EUR/MWh, of which a significant part goes to cover the electricity supplier's costs and margin. See Oslo Economics' report on trading in guarantees of origin for an overview of examples of retail prices for guarantees of origin (Oslo Economics, 2017).

[4] In addition, the customer pays taxes and grid rent.

2.5 Developments in the Guarantees of Origin scheme

2.5.1 First guarantees of origin and registers

According to our interviewees, guarantees of origin were first used by some power plants as a means of financing renewable production. In its original and unregulated form, a power producer could obtain a document showing that a certain amount of power was produced in a certain way and sell the certificate to power consumers who wanted to support renewable production and/or document their renewable energy sources to their customers.

As more and more power plants began issuing guarantees of origin, challenges arose in relation to double counting, i.e. power plants selling their guarantees of origin more than once. Partly to overcome this problem, which had a negative impact on the demand for guarantees of origin, registers were established to track the guarantees of origin and prevent double selling/double counting.

2.5.2 EU regulation

In the EU's first Renewable Energy Directive (2001), a requirement was introduced for all member states to establish a reliable system for tracing the origin of a quantity of electricity produced from renewable energy sources. Norway joined the scheme in 2006 as part of the common energy market under the EEA Agreement.

The scheme was continued in the EU's second renewable energy directive (2009). Here too, member states were required to facilitate the use of guarantees of origin. The second Renewable Energy Directive leaves a high degree of freedom of choice to the member states regarding the detailed regulation of guarantees of origin. Most governments have chosen to harmonize the design of and trade in guarantees of origin with other countries, while some others, such as the UK, Portugal and the Czech Republic, do not follow the same system and therefore have very little trade with other countries. Some countries have chosen to limit the trade in guarantees of origin from power plants that have received support. In Germany, no guarantees of origin are issued at all for power production that has received renewable energy support from public support schemes, and Austria does not allow the export of publicly supported renewable energy.

5 The electricity supplier's margins vary widely between suppliers and over time. The mark-up referred to here (4 øre/kWh) is not intended to be representative of the industry, but only an imaginary example.

power generation (Communicating Sustainability, 2017).

2.5.3 Norwegian regulation and international agreements

In Norway, all power producers can be issued guarantees of origin corresponding to their power production.[6] Statnett is the registrar in Norway and is responsible for operating and maintaining the certificate register NECS[7] where transactions and transfers of guarantees of origin are registered.

One guarantee of origin corresponds to a guarantee from Statnett that 1 MWh of generated electricity comes from a specified energy source. In the register, the Guarantees of Origin are marked with information that characterizes the production and that affects their value. For example, they are marked with which power plant they originate from, how old it is, and the technology involved (e.g. hydro, wind, solar).

To promote cross-border trading of guarantees of origin, common standards for guarantees of origin and their trading have been developed, as well as a hub for the sale and cancellation of guarantees of origin across borders in the EU/EEA.

This development is driven by the Association of European Registrars, AIB[8], of which Statnett is a member. In 2007, AIB started working towards a common standard for guarantees of origin, EECS (European Energy Certificate System), and in 2011 AIB started implementing a hub that enables transactions of guarantees of origin approved in accordance with the EECS standard between all certificate registries connected to the AIB Hub. By contributing to AIB, Statnett ensures Norwegian players full market access to the European market for guarantees of origin (Statnett, 2014).

Since its creation, more and more countries have joined the Hub, and as of today, member registries from 19 countries are connected[9]. The AIB-Hub ensures that a record of transactions is kept and has enabled a common European marketplace for guarantees of origin.

[6] Producers who wish to receive guarantees of origin for their production of renewable electricity must have the plant approved by NVE. Three types of guarantees of origin are issued: guarantees of origin for i) electricity from renewable energy sources, ii) electricity from high-efficiency cogeneration and iii) other types of electricity production.
[7] Norwegian Electricity Certificate System, necs.statnett.no
[8] Association of Issuing Bodies (of which Statnett is a member).

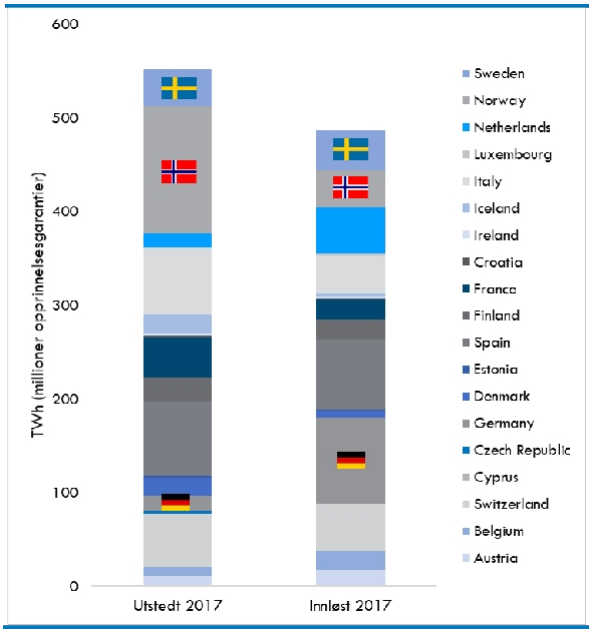
2.6 Trading in guarantees of origin

2.6.1 Trading volumes

Statistics from AIB show that the market for guarantees of origin with the EECS standard has grown significantly. From 2012 to 2017, the number of guarantees of origin issued has doubled to over 500 TWh (5 million certificates). The total European market for guarantees of origin is even larger, as national guarantees of origin from countries that are not members of AIB are not included in the statistics. In 2017, the trading house ECOHZ estimated that the total market was in the order of 650 TWh/million guarantees of origin.

The statistics for transactions through AIB by country (Figure 2-5) clearly show that the Nordic countries, and Norway in particular, are major producers of guarantees of origin, while a larger share of the use takes place on the continent.

Figure 2-5: Issued and redeemed guarantees of origin, by country, 2017



Source: Statistics from AIB as of 2018Q2

In 2017, 141 million guarantees of origin were issued to Norwegian power producers[10], i.e. guarantees of origin for 141 TWh of renewable power production, corresponding to approximately 94 percent of total Norwegian power production in the same period (149.3

[9] https://www.aib-net.org/facts/eecs_registries/registries
[10] Figures for issuance based on production date in 2017. Issued Guarantees of Origin in the same period based on transaction date in 2017 was 136 million OGs (TWh).

TWh11.). Norway has been by far the largest exporter of guarantees of origin within the scheme. However, Norway's share of the trade is declining, as there is strong growth in renewable energy production in Europe (Association of Issuing Bodies, 2018).

Export figures from AIB show that about one third of the guarantees of origin issued in Norway in 2017 were exported to Germany. Other important import countries for Norwegian guarantees of origin were Sweden, Austria, the Netherlands, Belgium and Italy (NECS, 2018).

2.6.2 Wholesale and retail market for guarantees of origin

In Figure 2-6, we have illustrated the trade flows with guarantees of origin from power producers to consumers.

Wholesale market

Most guarantees of origin are sold from power producers to power suppliers in the wholesale market. Most of the trade goes through brokers, such as ICAP and Cleanworld, but some are sold directly to power suppliers.

Most companies that want guarantees of origin buy these together with the power they buy from their power supplier. Some guarantees of origin are also traded bilaterally between power producers and large companies. This can be done directly in the form of an agreement on the purchase of guarantees of origin or in connection with entering into long-term power purchase agreements (PPA12). In the latter case, a PPA for power deliveries and a separate agreement for the purchase of a corresponding amount of Guarantees of Origin are often entered into.

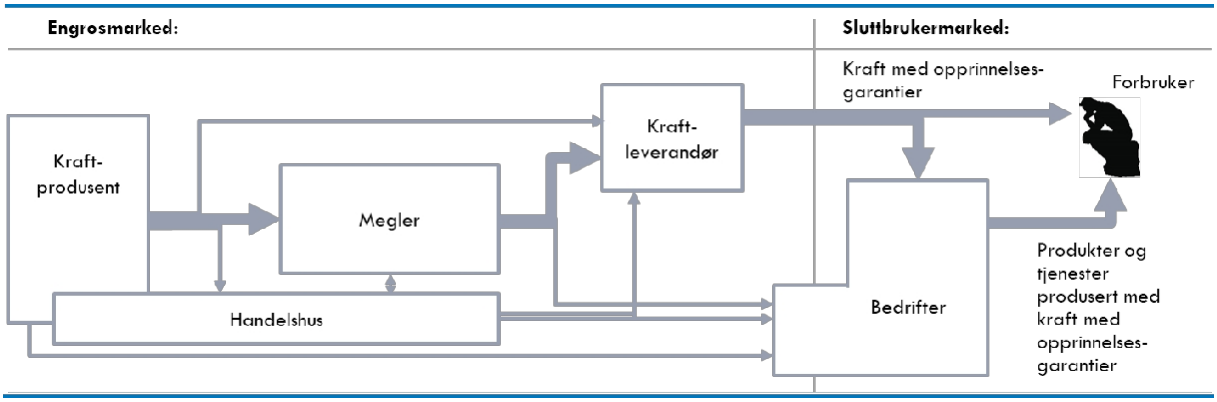
In addition to brokerage and bilateral trading, there are some trading houses that combine guarantees of origin from specific power plants for different products to meet the needs of different companies. Examples of such players are ECOHZ and Kinect Energy.

The retail market

In the retail market, guarantees of origin are sold to companies and consumers. Most guarantees of origin (around 70 percent) are sold to companies that want to document their energy sources and that use guarantees of origin to reduce their accounting emissions in their greenhouse gas accounts (Oslo Economics, 2017).

Consumers obtain guarantees of origin indirectly by purchasing electricity contracts from power suppliers who have purchased guarantees of origin on behalf of their power customers and by purchasing products from companies that have purchased guarantees of origin corresponding to their power consumption and who use it to achieve ecolabeling, greenhouse gas reporting or market the guarantees of origin directly (pictures of power plants they are buying from, etc.). The marketed renewable value the guarantee of origin represents of the electricity contract or product is usually one of many features and not priced explicitly.

Figure 2-6: Trading in guarantees of origin



Source: Oslo Economics

[11] Production figures taken from SSB Table 08583: Electricity balance (MWh) 2010M01 - 2018M06

[12] Power Purchase Agreement

2.7 Guaranteed of origin products and prices

2.7.1 Guaranteed of origin products

The value of guarantees of origin comes from consumers and investors who:

1. Want renewable power and products/investments that use renewable power, and
2. Who consider that buying Guarantees of Origin gives them that.

Because there are many different perceptions of what is environmentally friendly, a number of different guarantee of origin products have also been developed. The various guarantees of origin products combine guarantees of origin from power plants with similar characteristics and are marketed to customers who want that product.

For some customers, it is important that the premium they pay for a renewable product or service contributes to the development of new renewable production capacity.
This is often referred to as additionality. Some customers try to achieve additionality effects by buying guarantees of origin from newer power plants, and perhaps also power plants that have not received support from a renewable energy support scheme, such as the electricity certificate scheme. Other customers want to buy guarantees of origin from power production located geographically close to their own consumption or from their home country, which is perceived by many as more credible than guarantees of origin from remote areas with no physical connection (e.g. Iceland). Some are concerned about how environmental and nature conservation considerations are taken into account at the power plant to which the guarantees of origin are issued, such as salmon traps for hydropower. To meet this need, certification schemes have been established that award ecolabels to power plants that meet certain requirements, such as the Swedish ecolabel "Bra Miljöval". Furthermore, there are generally different opinions about which production technologies are the most environmentally friendly (some prefer solar, for example).

A recent trend has been towards tailor-made guarantees of origin products from individual power plants. Demand comes both from customers who want guarantees of origin from local power plants, such as Hammeren power plant in Oslo, and customers who want to help trigger investment in a specific power plant, such as Sandvik power plant in Rogaland.[13]

[13] https://www.medvind24.no/bygg-og-industri/bygde- power-plants-with-aid-from-european-power-investors
[14] Nordic system price, as calculated by Nord Pool Group.

2.7.2 Price differences on guarantee of origin products

Different preferences mean that some types of guarantees of origin or guarantee of origin products are valued differently. Properties that are often valued more highly include:

1. Additionality/Age
2. Nationality/Localization
3. Production technology (water/wind/solar)
4. Environmental protection at the power plant (eco-label)
5. Time of production

For example, guarantees of origin from Dutch wind power production and Swiss hydropower production are priced several times higher than guarantees of origin from wind power plants elsewhere in Europe and from Norwegian hydropower plants. Norwegian hydropower plants that have been environmentally certified can sell guarantees of origin with environmental labels, such as Bra Miljöval, at a slightly higher price (in the order of 5 to 15 percent). At the opposite end of the scale, prices for Icelandic guarantees of origin are very low. One of the main reasons is that they are perceived by many customers as unreliable, as there are no power cables between Iceland and the continent.

2.7.3 Price development

Since October 2016, prices for Norwegian guarantees of origin of the "Large Nordic Hydro" type have increased significantly and as of August 2018 stand at around 1.65 EUR/MWh, an increase of more than 600 percent from the average price of 0.26 EUR/MWh in the period from October 2016 to October 2017. According to the interviewees, the price differences between Norwegian and continental guarantees of origin have decreased during the period. Since 2006, the price has varied significantly and is now at a historical peak, see Figure 2-7. As a share of the electricity price as of August 17, 2018 (47.52 EUR/MWh)[14], the guarantee of origin price in August 2018 amounts to 3.5 percent.[15]

[15] https://www.nordpoolgroup.com/

Figure 2-7: Price development (EUR/MWh) for guarantees of origin from Nordic hydropower

Sources: ECOHZ, interviews, Oslo Economics. Empty August 2018.[16]

The price development of guarantees of origin from Nordic hydropower is driven by supply (power production) and demand for these. Demand for Nordic guarantees of origin can in turn be affected by the prices/supply/demand for other guarantees of origin. For example, the price increase around 2011 can be partly explained by increased continental, especially German, demand for guarantees of origin for renewable energy after the Fukushima accident. Subsequent price falls may have complex causes, including increased supply as a result of more countries joining the joint European trade in guarantees of origin (AIB-Huben), as well as falling demand in times of widespread criticism of the guarantee of origin scheme. The very strong price growth so far in 2018 can partly be explained by reduced supply of guarantees of origin from hydropower (as a result of low precipitation), and possibly also speculation about changes in the new Renewable Energy Directive that may increase demand for guarantees of origin in general. This will be described in more detail in the uncertainty analysis in Chapter 6.

[16] In the beginning of September 2018, we have received observations of forward prices for 2019 for Nordic

hydropower above 2 EUR/MWh.

3. Product declarations for electricity: How power suppliers document energy sources

3.1 Background: Product declarations in general and in the electricity market

Product declarations are prepared by manufacturers in many markets to provide information about a product's quality and properties, including its origin. For example, the label on a wine bottle states where the grapes were grown, food products are labeled with the ingredients they contain, and sometimes also where these ingredients come from.

As described in section 2.1, it is not possible for electricity customers to know or choose where the electricity they receive comes from. However, it is possible to document the production mix in a geographical area at a given time or on average during the year. In addition, it is possible to keep statistics on trading in guarantees of origin for electricity, i.e. that a certain amount of (renewable) power of a certain type has been produced in a certain location.

3.2 Framework for the design of product declarations

3.2.1 EU regulation

The EU Electricity Market Directive (EU, 2009) requires member states to ensure that electricity suppliers disclose the origin of supplies of electrical energy to their customers in an understandable and, at a national level, clearly comparable manner. Information must also be provided on the environmental impact, where the minimum requirements are information on CO2 emissions and radioactive waste. The requirement applies to invoicing and in all promotional material to the end customer.

EU regulation has so far left a great deal of room for maneuver in terms of how member states solve the directive's requirement that electricity suppliers must inform customers about the origin of their electrical energy. The EU Renewable Energy Directive (2009) states that electricity suppliers can ("may") use guarantees of origin to document the proportion of renewable energy sources.
Within the current EU directive, it would also have been possible to use production statistics to provide information on origin (Ministry of Petroleum and Energy, 2015-2016).

3.2.2 Norwegian regulation

The Norwegian authorities have, in the Regulations on power sales and grid services (Ministry of Petroleum and Energy, 2017), decided that power suppliers must either provide their customers with individual product declarations based on guarantees of origin, or refer to NVE's product declaration for power purchases without guarantees of origin.

3.2.3 Voluntary international cooperation

In the development of the schemes with guarantees of origin and declarations of origin, NVE has, together with foreign organizations, participated in the joint European project RE-Diss (Reliable disclosure systems for Europe). This project resulted in guidelines for calculating product declarations[17] , which NVE follows in the preparation of its product declaration for power purchases without guarantees of origin.

3.3 Individual product declarations to buyers of guarantees of origin

Buyers of electricity with guarantees of origin receive proof (individual product declaration) from the electricity supplier that the same amount of renewable electricity of a certain type has been produced somewhere as the amount they consume.

Individual product declarations can be designed in different ways. In the example in Figure 3-1 (next page), the product declaration shows which power plants the guarantees of origin have been purchased from and that they are Norwegian renewable production. Other product declarations may also contain information about greenhouse gas emissions and other environmental characteristics associated with the production from which the guarantees of origin are purchased. This information can be used in customers' greenhouse gas reporting, ecolabeling and marketing.

[17] http://www.reliable-disclosure.org/

Figure 3-1: Example of individual product declaration (based on guarantees of origin)

Facsimile from Glitre Energi (2018). Retrieved 17.08.2018

3.4 NVE's product declaration to those who do not buy guarantees of origin

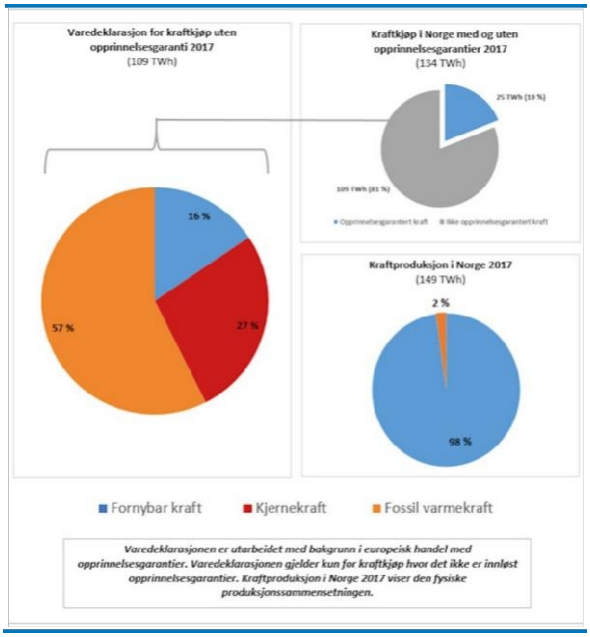
If electricity suppliers have not purchased guarantees of origin for their electricity deliveries, they are required by regulation to refer to the website of NVE[18], which is responsible for the national product declaration (Ministry of Petroleum and Energy, 2017).

How NVE's product declaration is designed is mainly governed by NVE's practice, and is not further regulated in Norwegian regulations, EU regulations or other legislation. As previously mentioned, NVE follows RE-Diss's guidelines for the calculation of the product declaration. These decisions are in turn influenced by the requirements set by buyers of guarantees of origin.

According to our interviewees, several foreign customers and regulators will not accept Norwegian guarantees of origin unless Norwegian authorities ensure that power suppliers (electricity sellers) do not market electricity from the same energy sources as renewables, without buy guarantees of origin. Norwegian authorities have chosen to design rules and practices in a way that, in our opinion, largely accommodates this market requirement. According to the Regulations on electricity sales and grid services (Ministry of Petroleum and Energy, 2017), Norwegian electricity suppliers must either provide their customers with individual product declarations, based on guarantees of origin, or refer to NVE's product declaration. Furthermore, NVE's choice, with regard to the design of NVE's product declaration, has so far resulted in a practice there:

- NVE's product declaration is presented under the title "National product declaration"
- The information in the product declaration is presented in pie charts, see Figure 3-2.

Figure 3-2: NVE's product declaration ("National product declaration for electricity")



Source: NVE (2018)

- The pie chart showing "Product declaration for power purchases without guarantee of origin" is rendered as twice the size of the pie charts for "Power purchases in Norway with and without guarantees of origin" and "Power production in Norway".
- The contents of the three pie charts are calculated in a way that gave the following result in 2017:
  - "Product declaration for power purchases without guarantee of origin":
    - 57 percent fossil thermal power

- 27 percent nuclear power
- 16 percent renewable

[18] https://www.nve.no/reguleringsmyndigheten-for-energi-rme-marked-og-monopol/varedeklarasjon/

  - "Power purchases in Norway with and without guarantees of origin":
    - 19 percent with guarantees of origin
    - 81 percent without guarantees of origin
  - "Power production in Norway":
    - 98 percent renewable
    - 2 percent fossil thermal power
- CO2 emissions of 531 g/KWh are calculated for the "national product declaration".

3.4.1 Calculation of "Product declaration for power purchases without guarantee of origin"

The largest pie chart in NVE's product declaration, "Varedeklarasjon for kraftkøb uten ursprungelsesgaranti", mainly reflects the European energy sources for which no one buys guarantees of origin[19], namely fossil thermal power and nuclear power. The renewable share in this is by definition low and may give the impression that power consumption without guarantees of origin is based mainly on non-renewable energy sources. This gives a different impression than the statistics, which show that the physical power production in Norway is 98 percent renewable and that Norway's exchange capacity with other countries corresponds to about 20 percent of the production capacity.

In Appendix 9.1, we reproduce the mathematical calculation of the "Product declaration for electricity purchases without a guarantee of origin". In summary, this is calculated as the sum of:

- The origin of European power for which no guarantees of origin have been purchased or for which no guarantees of origin have been issued ("European Attribute Mix"), calculated by AIB (96.1 TWh). This is calculated on the basis of the production composition in a selection of European countries, as well as trade in guarantees of origin, and consists mostly of fossil thermal power and nuclear power.
- The origin of Norwegian production for which no guarantees of origin have been issued and Norwegian production for which guarantees of origin have been issued but which have expired (not been redeemed) (12.9 TWh).

3.5 The relationship between NVE's product declaration and the value of Norwegian guarantees of origin

The EU's current Electricity Market Directive and Renewable Energy Directive provide few guidelines for how electricity suppliers (and authorities on their behalf) should prepare product declarations. However, there is less room for maneuver in the design of NVE's product declaration if foreign and Norwegian customers are to be willing to pay for Norwegian guarantees of origin.

According to our interviewees, several foreign customers and regulators, individually or in coordination, will not accept Norwegian guarantees of origin unless NVE's product declaration takes into account the trade in guarantees of origin. This view was shared by the majority of the Storting's Energy and Environment Committee, which wrote in its recommendation that *"a change in the product declaration to the production mix could ultimately make guarantees of origin worthless for Norwegian producers in a European market"* (Energy and Environment Committee, Storting, 2015-2016).

For Norwegian electricity customers, this means that, unless they purchase guarantees of origin, they will receive a declaration of origin that gives the impression that their electricity consumption is based on non-renewable energy sources.

The regulations on electricity sales and network services' provisions on product declarations for electricity are aimed at the electricity suppliers' behavior. It does not regulate how electricity customers (e.g. industrial companies) use or do not use the declarations they receive from the electricity supplier. Under the current regulation, electricity customers can choose to disregard the electricity supplier's product declaration when informing their own customers about their energy sources.
How this is done is described in the next chapter.

[19] Or for which no guarantees of origin are issued.

4. Environmental reporting and marketing: How business customers document energy sources

4.1 Business customers need to document their energy sources and can do so in different ways

4.1.1 Need to document energy sources in goods and services markets

Some consumers and investors prefer to buy goods, services and securities from companies that can demonstrate that they operate in a climate and environmentally friendly manner. As a result of this, and possibly for other reasons, many companies produce documentation that their products and services are produced in a climate and environmentally friendly manner. This documentation can be used to develop certified environmentally friendly products, obtain eco-labels, such as "Bra Miljöval", and/or achieve good environmental accounts/climate accounts, which can be aimed at both investors and consumers. For example, Norsk Hydro has launched certified low-carbon aluminum products to meet its customers' needs.[20]

The desire to achieve eco-labels or good climate accounts results in a demand for documentation of all input factors in the value chain. This includes emissions related to fuel and material use, as well as electricity.

4.1.2 Little government regulation of power customers' documentation of energy sources

While the power supplier's documentation of energy sources to end users is determined by regulations and NVE's practice, it is up to the market (customers and investors) to decide how end users can document their greenhouse gas emissions and energy sources to their own customers further down the value chain.

In this chapter, we will look at the framework for how Norwegian and foreign companies can document the energy sources of their electricity consumption (chapter 4.2) and how businesses in Norway choose to document the renewable share of their electricity consumption (chapter 4.3). Finally, we will discuss the impact of emissions, and requires companies to report on Scope 1 and Scope 2 emissions as a minimum. Scope 1 emissions are direct emissions from

[20] https://www.hydro.com/en/press-room/Archive/2017/hydro-launches-certified-low-carbon-aluminum-products/

[21] GHG-P distinguishes between direct and indirect

that different methods are used to document the energy sources of the same electricity (chapter 4.4).

4.2 Framework for companies' documentation of energy sources to their customers

In many cases, customers and investors require companies to document their greenhouse gas emissions and energy sources according to greenhouse gas reporting standards.

The standard that appears to be most important internationally and in Norway is the international standard "A Corporate Accounting and Reporting Standard", developed by The Greenhouse Gas Protocol, GHG-P, initiative (2015).[21]

According to the Greenhouse Gas Protocol's guidance on how companies can document the energy sources associated with their power consumption, companies should report on greenhouse gas emissions from power consumption on the basis of *both:*

- Location-based method (physical production mix), *and*
- Market-based method (trading in guarantees of origin)

This means that, according to the standard, the company must show the production mix for the area from which it uses electricity and, if the country has established a tracking system based on guarantees of origin, this must also be used as documentation (Greenhouse Gas Protocol, 2015).

The large Norwegian industrial companies we interviewed consider the Greenhouse Gas Protocol as guidance. They choose to report on emissions from purchased energy based only on a location-based method (production mix)[22] and state that their customers prefer or accept this.

own production, Scope 2 is indirect emissions from purchased energy, while Scope 3 is indirect emissions from purchased goods and services.

[22] Only refers to "Power production in Norway"/production mix in NVE's product declaration and not "Product declaration for power purchases without guarantee of origin".

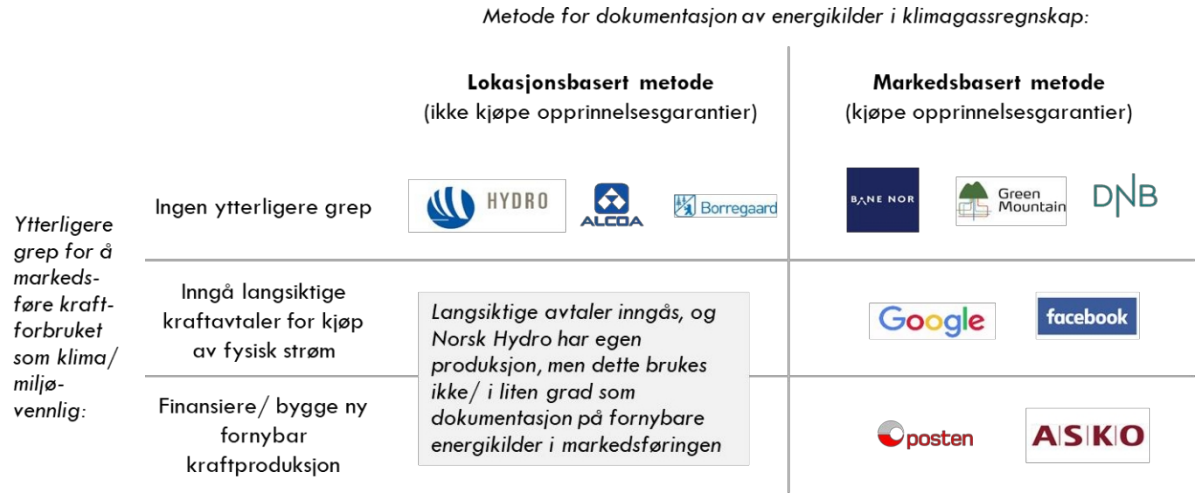
4.3 How companies in Norway document the energy sources of their electricity consumption

Companies that want to document that their electricity consumption is renewable in their greenhouse gas accounts do this either according to the location-based method (without guarantees of origin) or according to the market-based method (with guarantees of origin).

In addition to following one of these methods, companies can do several things to market themselves as more climate/environmentally friendly to their customers and investors. This could be, for example, entering into long-term agreements for the purchase of physical electricity from renewable power generation and financing/building new renewable power generation.

In Figure 4-1, we show how different types of Norwegian businesses document the energy sources of their power consumption.

Figure 4-1: Examples of how Norwegian companies document and market the renewable share in the energy sources for their electricity consumption



Source: Oslo Economics

Location-based method: Norwegian power consuming industry refers to renewable generation share in the countries they operate in

Large power-intensive industrial companies in Norway (e.g. Alcoa, Hydro, Borregaard) do not purchase Guarantees of Origin and document the energy sources for their consumption by referring to the national physical production mix of the countries in which they operate. For example, Alcoa refers to Norway's production mix (which is 98 percent renewable) for its operations in Norway.

The aluminum producers we interviewed (Alcoa and Norsk Hydro) indicate that their customers prefer greenhouse gas reporting based on a location-based methodology and that this is the industry standard. They state that they do not currently have a challenge with competing aluminum producers in countries with a large share of fossil fuel power production buying guarantees of origin to show that the production is renewable.

The industrial company Borregaard states that their customers accept that they use a national production mix

to document the energy sources for electricity consumption. Borregaard emphasized that there are many customers who do not request environmental documentation, but that the proportion who do is increasing.

The three Norwegian power-consuming industrial companies we interviewed, and their trade association, Norsk Industri, justify the choice of the location-based method because, in their opinion, it provides the most accurate picture possible of the energy sources from which their electricity comes, and thus what environmental and climate impacts their production actually causes. In addition to referring to the physical production mix, some of them justify their choice by pointing out that the transmission capacity between Norway and abroad is limited and that Norway often exports rather than imports power. Moreover, for strategic reasons, they do not want to support a system that they fear could enable competing businesses to establish themselves in areas with predominantly fossil fuel power production

and still document that they use clean power by purchasing Norwegian Guarantees of Origin.[23]

Norwegian power-consuming industry obviously also has direct financial incentives to use the location-based method and oppose a development in favor of documentation based on guarantees of origin. They can now, as before, document that the energy sources for their electricity consumption are renewable, without paying extra for it. For example, if Alcoa, with its electricity consumption in Norway of 4.8 TWh, had to purchase guarantees of origin to document that its energy consumption was 100% renewable, it could cost them NOK 77 million annually at the guarantee of origin price (1.65 EUR/MWh) and the exchange rate (9.7 NOK/EUR) in August 2018.[24]

The aluminum producer Norsk Hydro is in a special position in that it has its own power production equivalent to 10 TWh of hydropower annually in Norway, which covers over 70 percent of its power consumption in Norway of around 14 TWh. Norsk Hydro chooses to have its guarantees of origin issued and cancel them itself, rather than sell them, but does not use its own guarantees of origin to document the energy sources for its electricity consumption. Hydro chooses to report its emissions based on the IEA's international overview of individual countries' physical production mix.

Hydro, Alcoa and Borregaard enter into long-term agreements for the purchase of physical power, and many of these agreements are entered into with producers of renewable energy. However, the agreements we have seen do not include guarantees of origin, nor do the companies use the agreements to document that their electricity consumption is based on renewable energy sources.

Market-based method: More businesses are documenting that their consumption is based on renewable energy sources using Guarantees of Origin

Many companies buy power contracts with guarantees of origin or buy guarantees of origin separately from the power contract. This gives them individual product declarations (see chapter 3.3) that they can use to document the renewable share of their energy consumption.

Mainly foreign, but also Norwegian, companies document that their own energy use is renewable using guarantees of origin. For

[23] Most interviewees did not perceive this as an actual problem, but considered it a potential risk. [24] This example calculation is purely hypothetical and not performed/checked by Alcoa.

For many foreign companies, guarantees of origin may be the best option for documenting that consumption is renewable as the production mix in their country consists mainly of non-renewable energy sources.

Norwegian companies may choose to purchase guarantees of origin because their customers require it as documentation (and do not accept the location-based method), or because they are part of a larger group where guarantees of origin are used as a uniform method for documenting the energy sources of electricity consumption in all countries where the company is present. In addition, there may be other reasons why Norwegian companies choose to document the energy sources of their consumption with guarantees of origin. According to our interviewees and written sources, the data center Green Mountain, the bank DNB, the state infrastructure company BaneNor (Jernbaneverket, 2014) and Norway Post are examples of Norwegian companies that purchase guarantees of origin to document that their electricity consumption is renewable.

For many Norwegian and foreign buyers of electricity with guarantees of origin, the guarantee of origin products used in the electricity contract are important for the marketing value (see section 2.7.2). For example, many Dutch customers prefer guarantees of origin from Dutch wind, while some Swedish customers prefer products with the "Bra Miljöval" eco-label, which sets requirements for the design of hydropower plants. Similarly, according to interviewees, Icelandic guarantees of origin are in low demand on the continent as there is no physical transmission capacity and the guarantees of origin are therefore perceived as unreliable.

Further steps to market power consumption as environmentally friendly to customers and investors

For some companies, the purchase of guarantees of origin alone is not enough to document and market their electricity consumption as renewable in a credible way to their customers and investors. Many power customers choose to enter into long-term power purchase agreements (PPAs - Power Purchase Agreements) with a renewable project and document this with guarantees of origin. On this basis, they can market that they have purchased renewable power[25] with guarantees of origin, and not just guarantees of origin alone.

[25] The power a company actually uses is not the same as the renewable power purchased through long-term power contracts (otherwise the company would have to stop when the wind stopped blowing at the wind farm they had a power contract with).

For example, Facebook has purchased Norwegian wind power from Rogaland (Bjerkheim) for its Nordic data centers in Odense and Luleå. The long-term power purchase agreement (PPA) Facebook has entered into with the investment company Luxcara covers 294 MW for 15 years (DatacenterDynamics, 2018).[26] Similarly, Google entered into an agreement to purchase all production from the Tellenes wind farm in Rogaland over twelve years (160 MW), including guarantees of origin (Zephyr, 2016).

Some companies consider that even the purchase of long-term power contracts with guarantees of origin is not a sufficient contribution to renewable energy production. Such companies consider it necessary to physically expand their own power production in order to credibly claim that their power consumption is renewable. For example, ASKO uses guarantees of origin to document production from solar cell systems on its buildings and wind power production in its own facilities (ASKO, 2018). Posten Norge also chooses to use guarantees of origin in combination with its own electricity production (Posten Norge, 2018).

4.4 Implication of using multiple methods to document the same energy sources

The Norwegian industrial companies we interviewed (Hydro, Alcoa, Borregaard) document that their energy sources are renewable by pointing out that the production mix in Norway is 98 percent renewable, sometimes also that the trading capacity in/out of Norway is limited. At the same time, the guarantees of origin for some of the same power are sold, mainly to foreign companies, who can use them to document that their electricity consumption is renewable. The fact that different methods are used to document the energy sources of the same electricity means that some of the same renewable energy sources are in practice marketed twice.

In the next chapter, we will assess the effects of this, and of guarantees of origin and declarations of origin in general, for various stakeholders in Norway.

[26] Partly because it is not always windy, and because the power from Bjerkheim is fed into the power grid and in other price zones than where Facebook has its data centers, it is not the wind at Bjerkheim that physically powers the data centers, but the combination of power sources that drives power consumption in

Odense and Luleå at all times. To ensure that they have physical power to run the production, Facebook has an agreement with a large power producer to sell the long-term power production and trade physical power to the plants.

5. How guarantees of origin and declarations of origin have affected Norwegian players so far

5.1 Introduction

In this chapter, we will describe how the trade in guarantees of origin and the design of individual product declarations, as well as NVE's product declaration, have affected Norwegian players.

First, in section 5.2, we describe how trading in guarantees of origin has affected power producers and power generation. Then, in section 5.3, we describe how Norwegian companies, particularly industrial players, have been affected by guarantees of origin. Then, in section 5.4, we will describe the effects of the design of NVE's product declaration on the choice of energy sources and consumer choice. Finally, in section 5.5, we summarize the effects and assess whether the schemes have so far been economically profitable for Norway as a whole.

5.2 Impact of guarantees of origin on power producers and power generation

5.2.1 Revenue impact

Prices on guarantees of origin

As mentioned in section 2.7.3, prices for guarantees of origin have risen significantly in recent years, from around 0.3 EUR/MWh in 2017 to around 1.65 EUR/MWh. This is the price in August 2018 for "ordinary" guarantees of origin for large, older Norwegian hydropower production, expiring in 2018. The price for guarantees of origin from newer hydropower plants is higher, especially if they have not received public support for the development (electricity certificates).[27]

As a share of the power price as of August 17, 2018 (47.52 EUR/MWh), the guarantee of origin price in August 2018 amounts to 3.5 percent.[28] For power producers' profits, guarantees of origin are even more important than this percentage value of the power price would suggest. This is because:

[27] Many buyers of guarantees of origin prefer to buy guarantees of origin from new power plants that have not received public support, because many consider that they thereby contribute more to new renewable power production.

[28] https://www.nordpoolgroup.com/

[29] With the simplifying assumption that the power producers' costs associated with the sale of guarantees of origin are virtually zero. 0.5 EUR/MWh was the price for Norwegian Guarantees of Origin in December 2017 (Oslo Economics, 2017).

- The price is almost a pure margin, as the power producers have very low/almost no costs related to the sale of guarantees of origin.
- Income from guarantees of origin is only taxed with ordinary corporate tax and not resource rent tax and other special taxes, as is the case with income from physical power sales.

Revenue and profit from the sale of guarantees of origin

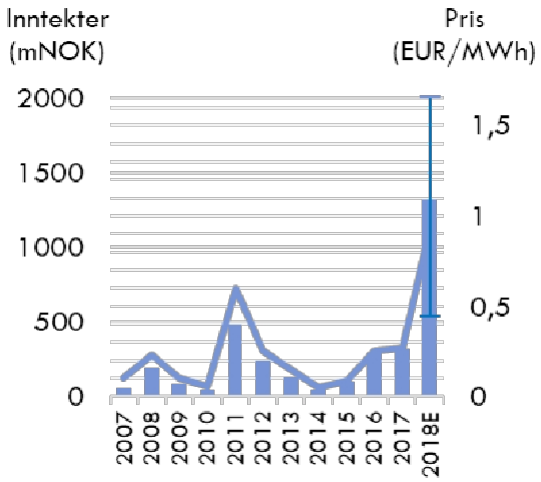
In 2017, Norwegian power producers were issued around 141 TWh of guarantees of origin. Approximately 10 TWh hours of this went to Norsk Hydro, which cancels the guarantees itself and does not sell them. On this basis, we estimate that Norwegian power producers sell around 131 million guarantees of origin (1 MWh each).

The power producers' total profit can be calculated as the price of guarantees of origin times the amount of guarantees of origin sold. For 2018, using this method, we estimate that the power producers' revenues and profits (before tax) from the sale of Guarantees of Origin will be 0.[529] to 1.[6530] EUR/MWh times 131 million Guarantees of Origin, which gives approximately 600 to NOK 2,000 million (with an exchange rate of 9.72 NOK/EUR)[31]. The range in the estimate is large because the price variation has been high in 2018, because many guarantees of origin for 2018 have been sold as forward contracts in previous years, and because the prices in 2018 are very high in a historical perspective.

Similar calculations made for previous years show that Norwegian power producers' revenues and profits (before tax) from the sale of guarantees of origin have grown from approximately NOK 100 million in 2015 to NOK 600 to 2,000 million (estimated for 2018), see Figure 5-1.

[30] 1.65 EUR/MWh is the price for Norwegian guarantees of origin in August 2018. In the beginning of September 2018, we have received observations of forward prices for 2019 on Nordic hydropower of more than 2 EUR/MWh. [31] In reality, many guarantees of origin are sold as forward contracts. This means that the power producers' actual revenues and profits from the sale of guarantees of origin issued in 2018 are probably lower than estimated in this calculation, because many of them were sold at lower prices in previous years.

Figure 5-1: Norwegian power producers' revenues and profits from the sale of guarantees of origin



Source: ECOHZ (prices of guarantees of origin), Statnett/NECS (quantity of guarantees of origin), Norges Bank (exchange rates), Oslo Economics.

This surplus can be expected to benefit the state, municipalities and county councils that own power producers through increased dividends. In addition, the increased income per MWh may provide incentives for increased investment in renewable energy production, which we will analyze in the next section.

5.2.2 Impact on new production

Impact on financing of individual projects

As the price of guarantees of origin has risen to a significant level, it is part of the overall assessment of the profitability of investments in existing and new renewable power plants in Norway. All other things being equal, the value of guarantees of origin will make investments in renewable production capacity more profitable than it would otherwise be. This effect is reinforced by the fact that new power generation can achieve higher prices for guarantees of origin than established power plants.

For example, one power producer we interviewed stated that the price of guarantees of origin was included in the assessment in two examples of renewable investments, both when investing in a new power plant and when upgrading an old one. In the case of the new power plant, the power producer also received electricity certificates, but not in purchase of documented renewable energy with the financing and construction of new renewable energy. The product price is set at EUR 4/MWh, which is far higher than current market prices for guarantees of origin. 80% goes to

[32] https://www.medvind24.no/bygg-og-industri/bygde-power-plant-with-assistance-from-european-power-investors [33] https://www.ecohz.com/renewable-energy- solutions/GO2-Projects/hm-top-finances-tagerod-wind-farm/

[34] ECOHZ's GO2 guarantee of origin product combines the

the upgrade. Because the power producer does not receive other support (electricity certificate revenues) for the renovation, it received a higher price for the guarantees of origin from this. The reason is, as mentioned in section 2.7.2, that many customers consider that guarantees of origin for new renewable production without other support provide greater additionality (increased renewable production capacity) than guarantees of origin granted to power plants that have received support.

There are examples of Guarantees of Origin products that are designed for top financing of new renewable production that would otherwise not have been realized. Examples of projects that have received top-up financing with guarantees of origin are Sandvik hydropower plant, which is top-up financed by a Dutch technology company, and Tågeröd wind power plant in Sweden, which the clothing chain HM pays for.[32,33,34]

Necessary for documentation of own power production and some long-term power contracts

In addition to financing individual projects, according to our interviewees, guarantees of origin are an important prerequisite for larger end users (such as business and industry) to enter into long-term power agreements and possibly also choose to invest in their own power production.

Long-term power purchase agreements (PPAs) with a duration of 15 years or longer ensure a stable income for the power plant over many years. This reduces investment risk by giving investors confidence in the project's profitability so that the power plant can obtain financing. A significant reason why industrial and commercial customers choose to enter into long-term power agreements with new renewable power plants, as well as build their own power generation, is that they want to use it for marketing purposes and present themselves and their products as environmentally friendly to customers. Several of these companies consider guarantees of origin to be the only credible way of documenting that they have actually purchased or produced a certain amount of renewable energy for their customers again. They say that without a well-functioning system for guarantees of origin in Norway, they would not have chosen to enter into such agreements or build their own production. Alternatively, they would do it in other countries instead.[35]

the ECOHZ Renewable Energy Foundation, which provides top funding to small renewable energy developers who are unable to secure sufficient funding through equity and loans.

[35] For example, Google has entered into an agreement with BlackRock, Zephyr and Norsk Vind Energi to purchase the entire power production for a period of 12 years from a Norwegian wind power plant to be built south of Stavanger.
Guarantees of origin corresponding to power production

5.2.3 Impact on total production

Overall impact on renewable energy production in Norway in light of other support schemes

Although guarantees of origin have helped to realize some power projects, it is not a given that they have contributed to higher total production of renewable electricity in Norway. The main reason for this is the electricity certificate market, which is designed to increase renewable power production to a total of 28.4 TWh in Norway and Sweden in 2020[36].

The electricity certificate scheme is a market-based support scheme that means that new producers of renewable electricity receive one electricity certificate per MWh of production, and can sell these to power suppliers/consumers who are required to purchase electricity certificates for a certain proportion of their electricity purchases/consumption. This provides additional income for the producer over and above the electricity price, which will help to ensure that more projects can be realized. In a well-functioning market, the most cost-effective projects should be realized first, and the price of electricity certificates should reflect the support required to realize the last MWh of new production necessary to achieve the total increase of 28.4 TWh in Norway and Sweden.

In the same way as the sale of electricity certificates, the sale of guarantees of origin will generate additional income on top of the electricity price. The higher the expected income a producer can receive from the sale of guarantees of origin, the less the need for support through electricity certificates to achieve profitability in the projects. Projects that are partly financed with guarantees of origin before the electricity certificate scheme expires will thus help to reduce electricity certificate prices in the market. This will in turn contribute to other power plants with higher marginal costs not being realized. In this sense, the effects of the two schemes on the establishment of new production will work against each other until the end of 2021.

However, there are reinvestment and maintenance projects that are not supported by electricity certificates, but which can be partly financed by guarantees of origin. Nevertheless, we conclude that guarantees of origin have so far not been of significant importance for total renewable energy production in Norway, as none of the interviewees claim. The reasons are mainly the electricity certificate market, and that the prices

included in the agreement, which gives Google the opportunity to say that the agreement means that their European data centers are supplied with renewable energy: https://www.vindenergi.no/news/google-inn-i-norsk-fornybarsatsing-i-samarbeid-med-norsk-vind-energi-og- zephyr.

until recently have been low and unimportant compared to the price of physical power.

Impact on distribution of power production

Although guarantees of origin have so far not been of significance for total electricity production and price, the scheme may have been of significance for the distribution of electricity production between Norway and Sweden and within Norway; in a hypothetical situation where only Sweden, and not Norway, had a scheme with guarantees of origin, Swedish renewable energy projects would have gained a competitive advantage in the joint Swedish-Norwegian electricity certificate market.

In addition, price differences on different guarantee of origin products may have some impact on which power projects in Norway are realized within the electricity certificate market. The power projects that achieve the highest prices for guarantees of origin products are new, small, renewable power, which may even achieve top financing through the sale of guarantees of origin. Such projects are so far rare, but according to our interviewees, they can receive up to EUR 4/MWh for their guarantees of origin. Customers may consider that support for such projects gives them particularly great benefit or value in the form of the presentation of smaller Norwegian power plants realized through the purchase of guarantees of origin can be used for marketing purposes. Trading in guarantees of origin may therefore to some extent benefit the financing of smaller power plants in rural areas, rather than larger, centralized power plants. However, the effect has so far been small, because few power plants have been financed in this way so far.

Potential impact on future power production

In the future, revenues from the sale of guarantees of origin may become more important for total power production. This may be the case when Norway withdraws from the electricity certificate scheme after 2021 and will no longer counteract the effect of guarantees of origin, especially if the prices of guarantees of origin increase.

5.3 Effects of guarantees of origin for industry and other electricity customers

5.3.1 Cost impact

As described in section 4.3, most Norwegian industrial companies choose to use location-based methods to document which energy sources

[36] Norway is responsible for financing 13.2 TWh and Sweden 15.2 TWh of the development target, regardless of where the production comes from. Sweden has also extended the joint electricity certificate system with a target of 18 TWh in 2030.

the electricity they consume comes from.

Because they can point to the production mix in Norway to document that their energy sources are renewable, they have no costs associated with the purchase of guarantees of origin.

However, there are other power customers, both companies such as DNB, Green Mountain data center and BaneNor, as well as households, who choose to buy power with guarantees of origin. According to "NVE's product declaration for 2017", 25 TWh of the power sold in Norway was sold with guarantees of origin (NVE, 2018). Excluding Norsk Hydro's cancellation of guarantees of origin from its own production (10 TWh), Norwegian power customers purchase around 15 TWh of power with guarantees of origin.

If the amount of Guarantees of Origin sold to Norwegian customers remains stable in 2018, we can estimate that Norwegian electricity customers' costs associated with the purchase of Guarantees of Origin will be between NOK 70 and 240 million (0.[537] and 1.[6538] EUR/MWh times 15 million Guarantees of Origin).

The purchase of these Guarantees of Origin is of value to customers, who can use them to document and market that their consumption is renewable, or to feel that they have helped to support renewable power producers. However, this is a value that all Norwegian electricity customers could alternatively receive for free, through the knowledge that Norwegian production is renewable and that transmission capacity is limited. Compared to an alternative situation where these customers could know and market that their electricity consumption was based on renewable sources without paying for it, the need to purchase guarantees of origin has resulted in a cost increase.

5.3.2 Impact on existing industry

According to our interviewees from the Norwegian power-consuming industry, the Guarantees of Origin scheme has not yet had a noticeable impact on existing business. The reason is that they do not buy guarantees of origin and therefore do not incur increased costs, and that their foreign competitors in traditional industries (metal/chemical) do not use guarantees of origin either. In summary, the costs for the traditional Norwegian industrial companies we have spoken to so far appear to be limited. What is nevertheless perceived as a problem for Norwegian industry is the design of NVE's product declaration, which they believe could harm

[37] 0.5 EUR/MWh was the price for Norwegian guarantees of origin in December 2017 (Oslo Economics, 2017). [38] 1.65 EUR/MWh is the price for Norwegian guarantees of origin in August 2018.

their marketing of Norway as a production location with a high share of renewables.

An important reason why Norwegian industrial companies are opposed to the system of guarantees of origin and the design of NVE's product declaration is that they fear a future development where foreign competitors in more and more industries use guarantees of origin to document that their production is renewable and/or that they will no longer be able to document their energy sources based on physical production mix/consumption mix. In such a scenario, they see a risk of losing a competitive advantage they have today and having to buy guarantees of origin, perhaps at even higher prices than today. This could in turn contribute to operations becoming unprofitable, or that they would be more profitable in competing locations outside Norway.
We analyze this risk in more detail in the next chapter.

5.3.3 Impact on new business

As an example of how the guarantee of origin scheme affects the establishment of new businesses in Norway, we will describe the effect that guarantees of origin may have had on the establishment of data centers in Norway.

There are at least two examples of data centers in Norway, Bitfury[39] and Green Mountain, which have chosen to purchase guarantees of origin to document their power consumption. This, and observations from power purchases with guarantees of origin from Facebook, Google, etc. indicate that it is common in the data center industry to document that consumption is renewable using guarantees of origin.

Compared to a hypothetical situation without guarantees of origin in Europe, Norway's attractiveness as a location for data centers can be said to have been weakened by the scheme. The scheme has made it easier to establish data centers in other countries and market them as renewable with the help of guarantees of origin from Norway (with or without long-term power agreements from Norwegian power plants). For example, Facebook can market that the electricity consumption for their data centers in Odense and Luleå is renewable because they have purchased guarantees of origin from, among others, Bjerkheim wind farm in Norway.

In our opinion, it is likely that the guarantee of origin scheme in several industries, including data centers, has reduced

[39] https://www.ranablad.no/nyheter/naringsliv/bitfury/bitfury-investerer-274-millioner-og-vil-skape-mer-enn-30-jobber-pa-mo/s/5-42-365956

Norway's competitive advantage as one of very few production sites where suppliers could say, without paying extra for it, that the electricity was predominantly from renewable sources. Hypothetically, it is therefore possible that Norway would have attracted more new power-consuming activities if the scheme had never existed.

However, this does not mean that Norway will automatically attract more business by weakening the scheme as much as possible once it is in place. In several industries, international corporations prefer and/or require guarantees of origin as documentation of the energy sources for electricity consumption. However, it is conceivable that changes can be made to the schemes with guarantees of origin and the design of NVE's declaration of origin that will benefit the establishment of new power-demanding businesses, while at the same time safeguarding international customers' need for documentation in the form of guarantees of origin. This is described in chapter 7.

5.4 Effects of product declarations on the choice of energy sources

5.4.1 Introduction

In addition to the effects of guarantees of origin and product declarations on power producers and power users, the design of NVE's product declaration and individual product declarations has potentially significant effects in terms of the energy choices made by private companies, public sector entities and households.

NVE's website states that the CO_2 factor for Norwegian power production is estimated at 16.4 grams per kWh, while the CO2 emissions associated with NVE's product declaration are 531 grams per kWh. At the same time, individual product declarations can give end users the impression that they only get renewable energy, and some end users market this to their customers as if they actually get their electricity from a certain energy source.
In particular, the design of NVE's product declaration, and to some extent also the marketing to buyers of guarantees of origin, can lead to irrational and, in some cases, not very environmentally friendly energy choices.

5.4.2 Effects of NVE's product declaration on the choice of energy sources

NVE's product declaration is designed so that both the illustration and text can be read in many ways, and it does not state which energy sources and emission figures

[40] https://www.glitreenergi.no/strom/all-var-strom-er-100- renewable/
[41] We note that many power suppliers reproduce NVE's product declaration in other ways. This example is

which should be used as a basis for assessing alternative energy use in Norway. On NVE's pages about NVE's product declaration, it states that "A CO_2 emission of 531 g/KWh has been calculated in connection with the national product declaration". It also states that the CO_2 factor for Norwegian power production is estimated at 16.4 grams per kWh (NVE, 2018).

The design of NVE's product declaration may give some people a false impression of the actual climate impact of physical electricity consumption in Norway. This can have a negative impact on the use of physical electricity from the grid, in favor of self-generation of electricity and the use of other energy sources, such as gas, rather than electricity.

The effects on energy choices of the design of NVE's product declaration are also affected by how power suppliers communicate the information to their customers. For example, the power supplier Glitre Energi writes on its website on 22.08.[201840]:

"Although 98 percent of electricity production in Norway is based on hydropower, according to NVE, as much as 90 percent of the electricity purchased here is based on production from nuclear and coal power, unless you have a guarantee of origin. (...) Most households think they are buying electricity that does not pollute, but only a small proportion of Norwegian electricity customers can actually be sure of this."

This type of inaccurate representation of information from NVE's product declaration can potentially also play a role in investments and consumer choices.[41]

5.4.3 Effects of individual product declarations on the choice of energy sources

Just as NVE's product declaration, and its dissemination, can give an incorrect impression of the energy sources of Norwegian electricity consumption, individual product declarations can give an incorrect picture of the actual environmental impact of electricity consumption with guarantees of origin. For example, some electricity suppliers advertise "100% renewable electricity" and "100% renewable energy".

There have previously been cases of power suppliers (electricity sales companies) that have gone even further than this in the marketing of guarantees of origin. In 2011, the Consumer Ombudsman ordered the power supplier
"For Better Days" to change their marketing, after they had claimed that "with us you only get electricity from the cleanest renewable energy sources" (Forbrukerombudet, 2011).

randomly selected and cannot be said to be representative of how Norwegian electricity suppliers generally market Guarantees of Origin.

The issue of the marketing of guarantees of origin and the consequences this can have for consumer choice and energy choices is not limited to the marketing of the power supplier. The Swedish company Polarbröd was recently ordered by the Swedish Consumer Agency to change its claim that Polarbröd is "baked with its own wind power" (Miljö & utveckling, 2018). In its reasoning, the Swedish Consumer Agency said that "the average consumer of bread ... may not know that what comes out of the power outlet is a mixture of everything". Following the decision, Polarbröd changed its marketing to "We have our own wind power".

A possible negative effect of misleading marketing of guarantees of origin is that they may give electricity customers and consumers a false understanding of the actual environmental impact of their energy use and consumption. For example, a power customer who buys Guarantees of Origin may get the impression that saving electricity is not an effective environmental measure, even though the direct environmental impact of their electricity consumption is the same as for their neighbors who do not have such agreements.

5.5 Comparison of effects for Norwegian stakeholders

In Figure 5-2, we summarize the main impacts of the Guarantees of Origin scheme and the design of product declarations we have identified.

In summary, our analysis shows that the power producers (and thus their mainly public owners and employees) will receive significant revenues and profits from the sale of guarantees of origin this year. As the power-consuming industry documents the renewable share of its power consumption by referring to the production mix, it has so far not lost significantly from the schemes. Guarantees of origin may have made it easier for our neighboring countries to attract new business activities, including data centers, that would otherwise have been located in Norway. The scheme has helped to realize some new power projects in Norway, but has done little or nothing to increase overall power production. The design of NVE's product declaration may give some people a false impression of the climate impact of Norwegian electricity consumption, which may lead to irrational and less environmentally friendly investments and consumer choices. However, we do not have the impression that the extent of misunderstandings of this type is particularly large.

Overall, our assessment is that Norway as a whole has probably benefited financially from the schemes so far. The main reasons are that guarantees of origin provide increased revenue for Norwegian power production, while many customers of Norwegian industry accept/prefer to use physical production mix to document that their energy sources are renewable.

Figure 5-2: Comparison of impacts for different stakeholders

Aktør i Norge	Type virkning	Størrelse (estimat 2018)
Kraftprodusenter	Inntekter	600 til 2 000 millioner kroner
(eiere/stat/kommune, ansatte)	Ny produksjon	Marginalt hittil, men økende
	Samlet produksjon	Ingen/ svært liten virkning
Industriaktører og andre kraftkunder	Kostnader	70 til 240 millioner kroner
(eiere, ansatte)	Eksisterende virksomhet	Liten virkning hittil, men risiko i fremtiden
	Ny virksomhet	Kan ha gått glipp av investeringer
Offentlige og private virksomheter Forbrukere	Misforståelser av faktiske miljøvirkninger av strømforbruk i Norge	Eksempler på irrasjonelle investeringer/energivalg, samt risiko for irrasjonelle forbrukervalg
Samlet økonomisk virkning for Norge som helhet		Sannsynligvis positiv

Source: Oslo Economics

There are many uncertainty factors that may affect how various Norwegian players will be affected by these schemes in the future. We will describe this

in more detail in the following chapter.

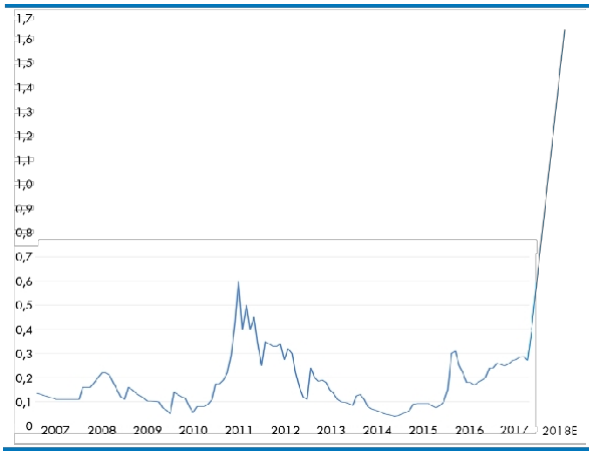
6. Uncertainty factors and possible future effects for Norwegian players

6.1 Introduction: Great uncertainty about the future importance and price of Guarantees of Origin

6.1.1 Historical price development

Since 2006, prices for Norwegian guarantees of origin have varied widely, from less than 0.1 EUR/MWh to 1.65 EUR/MWh in August 201842, see Figure 6-1.

Figure 6-1: Price development (EUR/MWh) for guarantees of origin from Nordic hydropower



Sources: ECOHZ, interviews, Oslo Economics. August 2018.

The price of guarantees of origin is important for several reasons:

- Firstly, it is almost exclusively the price that determines how much revenue and profit Norwegian power producers receive from the sale of Guarantees of Origin.
- In a hypothetical future situation where Norwegian industrial companies are forced to buy guarantees of origin in order to document their energy sources, the price will determine how large their cost increase will be, compared to the current situation where they can document their energy sources free of charge by referring to the physical production mix.

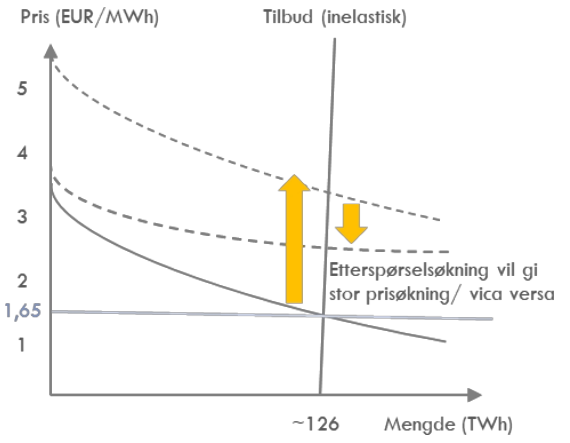
6.1.2 Inelastic supply: Changing demand can have a major impact on prices

The supply of Norwegian guarantees of origin is very little affected by the demand for and price of guarantees of origin (supply is inelastic).

This is because the amount of guarantees of origin is determined by the amount of renewable electricity production, which is determined by other factors, including natural conditions, historical power development, the price of physical power, development and operating costs, and the current electricity certificate market. That said, it is clear that guarantees of origin with higher prices, in a future electricity market without electricity certificates, will act as a positive incentive for the development of new renewable electricity production.

The fact that factors other than price mainly determine the supply of guarantees of origin means that any future increase in demand for guarantees of origin in general, and Norwegian guarantees of origin in particular, will mainly be reflected in increased prices for Norwegian guarantees of origin rather than increased production from existing renewable production or development of new power production, and thus more guarantees of origin, see Figure 6-2. Similarly, any reduction in demand could result in sharp price falls, as the supply of already installed renewable power generation will not be significantly reduced.

Figure 6-2: Illustration of supply and demand for Norwegian guarantees of origin



Sources: Oslo Economics

This special feature of the market for guarantees of origin - that supply is largely independent of demand - means that we can expect major price fluctuations in the coming years. Whether the price will fluctuate upwards or

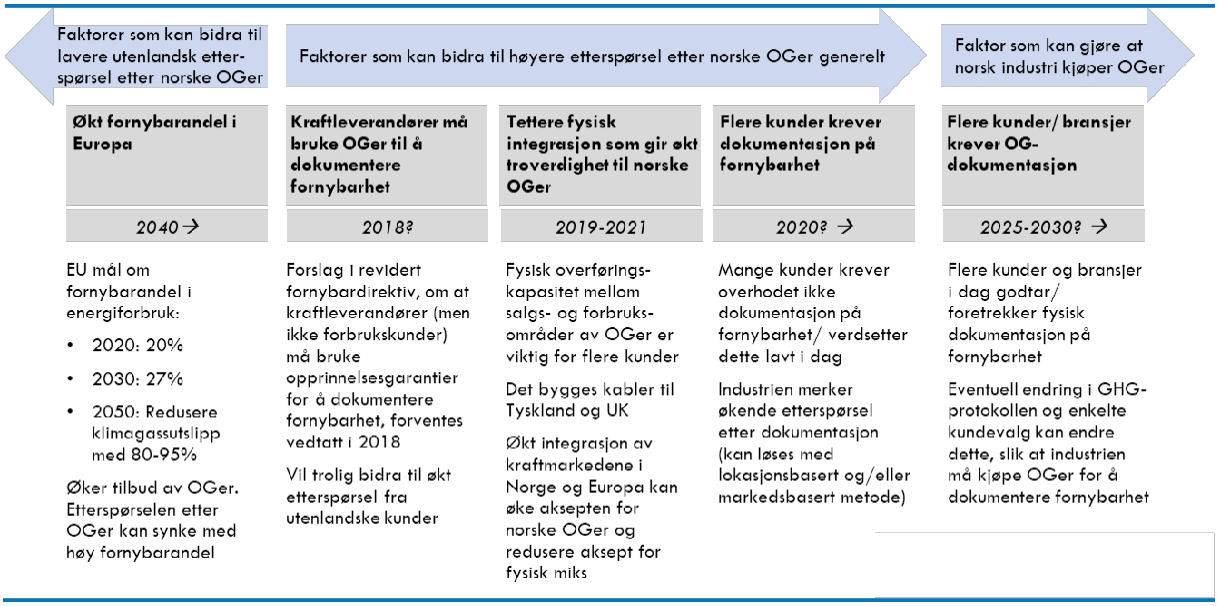
[42] In the beginning of September 2018, we have received observations of forward prices for 2019 on Nordic hydropower above 2 EUR/MWh.

downwards, and to what extent, depends mainly on the development in the risk factors that affect the demand for Norwegian guarantees of origin. These will be analyzed in the next section.

6.2 Uncertainties and their possible effects

In Figure 6-3, we show how five key uncertainty factors can affect the demand for and price of Norwegian guarantees of origin.

Figure 6-3: Uncertainty factors that may affect the price of Norwegian guarantees of origin in the future



The first uncertainty factor, "increased share of renewables in Europe", may in the long term contribute to reduced demand for Norwegian guarantees of origin, while the other uncertainty factors point towards higher demand and prices. Three of the uncertainty factors may contribute to higher demand from European customers, including a likely EU regulation that power suppliers must use guarantees of origin to document the power as renewable, more customers becoming concerned about climate and the environment, closer physical integration (international cables), which gives higher credibility to Norwegian guarantees of origin. Finally, we describe what Norwegian industrial players believe is necessary for them to buy Guarantees of Origin, namely that their customers directly, or through reporting standards, require them to document the energy sources for their electricity consumption with Guarantees of Origin.

The timing of when the uncertainty factors may affect the demand for Norwegian guarantees of origin varies between the uncertainty factors. While it is likely that during 2018 the EU will decide that electricity suppliers will have to ("shall") use Guarantees of Origin to prove the share of energy coming from renewable sources, the effect of increased renewable share in Europe will

probably only make itself felt in ten to thirty years.

In the rest of this section, we will describe each of these uncertainty factors in more detail, as well as how they may affect Norwegian power and industrial producers.

6.2.1 Factors that may contribute to lower foreign demand for Norwegian guarantees of origin

Increased share of renewables in Europe

The EU has a current, binding target that 20 percent of energy consumption in the EU in 2020 should come from renewable sources. The proposed target for 2030 is 32% (European Commission, 2018), while the strategic ambition for 2050 is to reduce greenhouse gas emissions by 80-95% (European Commission, 2012), which would imply a high share of renewable energy sources.

If this occurs, it will firstly have a supply effect (increase in the number of Guarantees of Origin), which in isolation will contribute to a lower price. In addition, an increasing share of renewables may have a negative demand effect. In a future scenario where the share of renewables in Europe is very high, many continental Europeans may consider it unnecessary to support producers of renewable energy. Both supply and

The potential impact on demand of a possible increase in renewable power generation in Europe is largely far in the future and is considered highly uncertain.

6.2.2 Changes that can contribute to higher foreign and consumer demand

Power suppliers must use OGs to document the energy sources of their electricity supply

As mentioned in section 3.2.1, the EU's current regulation (2009) leaves a great deal of room for maneuver as to how the member states will solve the directive's requirement that electricity suppliers must inform customers about the origin of their electrical energy. The EU Renewable Energy Directive (2009) states that electricity suppliers can ("may") use guarantees of origin to document the proportion of renewable energy sources, but other sources, such as production mix (Ministry of Petroleum and Energy, 2015-2016), can also be chosen.

In the EU's current (August 2018) proposal for a revised Renewable Energy Directive, this room for maneuver is proposed to be tightened. The Commission has proposed that member states should require electricity suppliers to ("shall") use guarantees of origin to document the share of electricity from renewable sources (European Commission, 2018), (Ministry of Petroleum and Energy, 2018).

According to written sources (European Commission, 2018) and our interviewees, as part of the concluded tripartite negotiations, there is agreement between the European Commission, the European Parliament and the Council on the mandatory use of guarantees of origin ("shall") (European Commission, 2018). It therefore appears highly likely that the amendment will be adopted by the Parliament during 2018, and then approved by the Council. Furthermore, that the regulations will eventually be incorporated into Norwegian law through the EEA Agreement.

The proposal will probably have little or no impact on the demand for guarantees of origin among Norwegian consumers. The reason is that Norwegian power suppliers, according to their own industry standard, should only market electricity as renewable if it can be documented with guarantees of origin (Energi Norge/Point Carbon, 2007), and that NVE's National Product Declaration, according to our preliminary assessment, seems to be in line with such a requirement already. However, this limits NVE's ability to create NVE's product declaration on the basis of physical mix if the Norwegian authorities should wish to do so at a later date.

However, the change may lead to increased demand from countries where power suppliers may have previously been able to market their power as renewable using documentation other than guarantees of origin.

Thus, the proposed amendment may contribute to increased prices for guarantees of origin and thus increased revenues for Norwegian power producers and their (public) owners.

The change only affects how power suppliers (electricity sales companies) market the power they sell, and not how other businesses (such as aluminum plants) document the way the products they sell are produced. In the long term, however, there may be a risk that the tightening of the regulations that apply to electricity suppliers may also make it more difficult for larger consumers to document their energy sources using methods other than guarantees of origin (for example, referring to the production mix, see section 6.2.3).

Closer physical integration that adds credibility to Norwegian OGs

Physical transmission capacity between sales and consumption areas of guarantees of origin is important for several customers. For example, according to our interviewees, many customers do not want guarantees of origin from countries that do not have physical transmission capacity to the continent, and would rather have guarantees of origin from their own country.
The latter is also reflected in the prices of guarantees of origin from Dutch wind power and Swiss hydropower, which are several times higher than guarantees of origin from Norwegian hydropower.

In August 2018, Norwegian guarantees of origin are priced at the same level as several types of guarantees of origin from EU countries, but lower than some others. Some of the reasons why Norwegian guarantees of origin are not as highly priced as guarantees of origin from Switzerland and the Netherlands may be that:

- There is little Norwegian demand for Norwegian guarantees of origin, partly because many Norwegian electricity customers consider that they will receive renewable energy anyway.
- Some foreign electricity customers may consider guarantees of origin from Norway to be less credible, as trading in them exceeds physical transmission capacity.
- Some foreign electricity customers may consider guarantees of origin from Norway to be less credible because the use of a physical production mix to document energy sources, and the simultaneous sale of guarantees of origin from similar production, means that electricity consumption from some of the same energy sources is marketed twice.

Norway's exchange capacity with other countries is currently 6,200 MW. This corresponds to about 20 percent of

Norway's installed production capacity. Two new international cables to Germany and the UK are scheduled for completion in 2019 and 2021 respectively, with a capacity of 1400 MW each. This will increase the total Norwegian exchange capacity with other countries to around 9,000 MW (Ministry of Petroleum and Energy, 2017). In comparison, the total installed capacity in Norway was 33 200 MW as of January 1, 2017 (Ministry of Petroleum and Energy, 2017).

Increased physical exchange capacity between Norway and abroad may affect the reasons for not buying Norwegian guarantees of origin. With increased transmission capacity, Norwegian electricity customers and their customers may again be less confident about which energy sources their consumption is actually based on. It may also weaken the credibility of the physical production mix as documentation of the energy sources of Norwegian electricity consumption. In addition, it may be easier to convince foreign customers to buy Norwegian guarantees of origin to document that their electricity consumption is based on renewable energy sources.

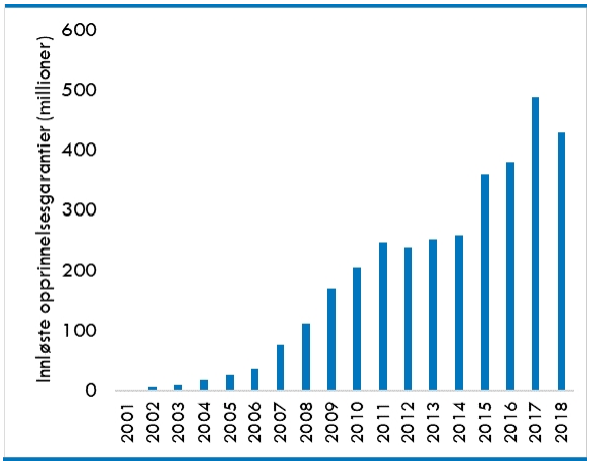
All in all, it is therefore possible that closer physical integration can contribute to increased demand for Norwegian guarantees of origin, both from foreign and Norwegian customers. This could result in higher prices and thus increased revenues for producers, but at the same time increased prices and costs for Norwegian electricity users.

More customers require documentation that consumption is based on renewable energy sources

The Norwegian industrial companies we interviewed report an increasing demand for documentation of the climate and environmental impact of their products, for example in the form of product sheets, certifications, climate reporting, eco-labeling or other documentation. These companies address this need mainly by referring to the distribution of energy sources in the total power production of the countries in which they operate.

This impression is confirmed by statistics on the sale of EECS-certified guarantees of origin, i.e. guarantees of origin that can be traded internationally through the AIB Hub. Figures from AIB show that the amount of redeemed guarantees of origin has increased from 246 million (equivalent to 246 TWh) in 2011 to 488 million in 2017, see Figure 6-4. This increase has been made possible by more countries (and their renewable production capacity and thus guarantees of origin) joining the AIB Hub.

Figure 6-4: Redeemed guarantees of origin in AIB, 2001-2018



Source: AIB Stats 2018Q2 (Association of Issuing Bodies, 2018)

If more and more important customers of Norwegian (and foreign) businesses[43] require documentation of energy sources, it may mean that:

- Many Norwegian companies, especially power-intensive industries, are increasingly referring to the Norwegian production mix in their documentation (location-based method for documenting energy sources).
- Many foreign companies, and some Norwegian companies, are increasingly demanding guarantees of origin, including Norwegian guarantees of origin.

[43] For example, by several multinational companies joining the RE100 group, see http://there100.org/.

6.2.3 Changes that can make Norwegian industry buy OGs

More customers/ industries require OG documentation

It is hypothetically possible that the aforementioned uncertainty factors could occur in a way that results in increased demand for Norwegian guarantees of origin, while Norwegian industry can still document the energy sources of its products by referring to the production mix. In this case, the socio-economic effects for Norway as a whole could be even more positive, as the income of Norwegian power producers would increase further, without the industry experiencing significantly higher costs or lower demand.

However, it is possible that the aforementioned uncertainty factors and other reasons will lead to more customers/industries not only requiring documentation of energy sources, but also for Norwegian power-consuming industry to be documented by means of guarantees of origin. This may happen if individual customers demand it or, probably in the longer term, if standards for environmental and climate reporting, especially the GHG protocol,

be changed so that the market-based method (purchase of guarantees of origin) is the only valid method in areas where such a scheme is in place.

Ultimately, it is conceivable that Norwegian industry will be forced to buy guarantees of origin at a time when demand has already historically risen significantly, so that the price is already higher than today. If the entire Norwegian power-consuming industry (excluding industrial production, which Norsk Hydro already covers with its own power production), this will lead to a significant increase in demand for Norwegian guarantees of origin in a market with inelastic (fixed) supply. The price can therefore be expected to rise significantly if Norwegian industrial players eventually find it necessary to buy Guarantees of Origin for their electricity consumption.

For illustrative purposes, consider the cost impact such a scenario could have had on aluminum producer Alcoa Norway.

Alcoa Norway (formerly Elkem Aluminium) operates the aluminum plants at Lista and Mosjøen and has an electricity consumption of about 4.8 TWh. With a

[44] Assumed a spot price of 50 EUR/MWh for physical electricity (August 2018). In reality, large power consumers such as

guarantee of origin price of 1.65 EUR/MWh (August 2018), their costs for a potential purchase of guarantees of origin would have amounted to NOK 77 million, increasing their energy costs by around 3 percent.[44]

However, in a scenario where Norwegian power-consuming industry is forced to buy guarantees of origin, it is likely that the price will be higher than current levels, both because the development is driven by a greater demand for guarantees of origin from foreign customers and because Norwegian industry, with its significant consumption, will buy it itself. In a hypothetical scenario where increasing demand results in a price of 3 to 5 EUR/MWh for guarantees of origin, Alcoa Norway's energy costs would increase by approximately NOK 140 to 230 million, corresponding to an increase in energy costs in the order of 6 to 10 percent.[46]

If future developments ultimately lead to an increase in energy costs for industrial operations in Norway, it will make it relatively less attractive to establish and maintain industrial operations in Norway, compared to the current situation.

Alcoa entered into long-term power agreements with others, and lower power prices than that.

7. Outlines of possible changes to the schemes for guarantees of origin and declarations of origin

7.1 Introduction

In the course of the study, we have asked representatives of the energy sector and the industry what changes they would propose for the schemes for guarantees of origin and product declarations. In addition, we have briefly assessed which changes could provide benefits from a societal perspective.

It is emphasized that any specific measures will require further investigation. Nor have we conducted a legal assessment of which measures will actually be possible to implement within Norwegian legislation, the EEA Agreement and other relevant legal sources.

We have selected seven outlines of possible changes, which we describe in more detail in this chapter.
The description is divided into changes related to NVE's product declaration, changes in the Guarantees of Origin scheme and changes in taxation:[45]

- Possible changes to NVE's product declaration
  - Change NVE's product declaration to prevent people from getting the wrong impression of the climate impact of Norwegian electricity consumption
  - Make it mandatory for electricity suppliers to purchase guarantees of origin on behalf of all customers
  - Design Norwegian government statistics on energy sources in a way that reduces the export of guarantees of origin
- Possible changes to the guarantee of origin scheme
  - Withdraw Statnett from AIB and thereby reduce export of Norwegian guarantees of origin
  - Promote more efficient trade and increase the value of Norwegian guarantees of origin
- Conceivable changes in taxation
  - Resource rent taxation etc. on income from the sale of guarantees of origin

The only amendment proposed by both the power sector and the industry is to change the wording of NVE's product declaration to prevent people from getting the wrong impression of the environmental impact of Norwegian electricity consumption.

[45] In addition to these conceivable changes, the National Association of Hydroelectric Power Municipalities and Power Counties has proposed as an input to this report that

The other proposed amendments involve some redistribution of the value of renewable energy from one group to another. For example, Norwegian industry, in a hypothetical scenario where their customers require them to document energy sources with guarantees of origin, may be interested in measures that make it more difficult to export the guarantees of origin and thus lower the price they have to pay for the guarantees. However, it is uncertain whether this would be possible and whether it would actually benefit the industry and not just result in losses for the power industry and prevent new renewable power production.

In addition to redistribution between the power industry and Norwegian industry, a relevant measure could be to redistribute value to the community, specifically by taxing income from the sale of guarantees of origin in the same way as income from the sale of physical power.

In the following sections, we describe each of the possible changes in more detail.

7.2 Possible changes in the design of NVE's product declaration

Norwegian authorities' room for maneuver in the design of NVE's product declaration

In the EU's current (August 2018) proposal for a revised Renewable Energy Directive, it is proposed that member states should require electricity suppliers to "shall" use guarantees of origin to document the share from renewable sources (European Commission, 2018), (Ministry of Petroleum and Energy, 2018).

Even if this regulation is adopted, the Norwegian authorities will probably have some room for maneuver with regard to the design of statistics on the sources of Norwegian energy consumption. This applies, among other things, to who should produce which statistics, what they should be called, what they include and how they should be communicated and illustrated.

All of these choices can have an impact on people's perception of the climate and environmental impact of their electricity consumption and thus their energy choices.

licensees of concession power also receive associated guarantees of origin.

Those who ultimately decide what is accepted as documentation of energy sources are the market, i.e. customers and investors. In addition, foreign regulators who decide whether Norwegian guarantees of origin can be canceled in their country may affect the market-related scope of action of Norwegian companies. This in turn affects how it is appropriate for NVE to design its statistics.

In this section, we will describe three possible changes to NVE's product declaration:

- Change NVE's product declaration to prevent people from getting the wrong impression of the climate impact of Norwegian electricity consumption
- Make it mandatory for electricity suppliers to purchase Guarantees of Origin on behalf of all customers
- Design Norwegian government statistics on the energy sources of electricity consumption in a way that reduces the export of guarantees of origin

7.2.1 Change NVE's product declaration to prevent people from getting the wrong impression of the climate impact of Norwegian electricity consumption

What the measure would entail

Changing NVE's product declaration in a way that prevents misinterpretation of the actual climate impact of Norwegian electricity consumption is something that is supported by several representatives of both power customers and power producers. Among other things, Energy Norway has proposed the following changes in its input to the Ministry of Petroleum and Energy on improving the guarantee of origin scheme (Energy Norway, 2017):

- Change the name from "National product declaration" to "Overview of power documentation" (to avoid confusion between physical and financial information).
- Clearly state that the product declaration should not be used as a decision-making basis for the choice of energy solutions and provide clearer information about the climate benefits of electrification (and prevent socio-economically unfortunate investment decisions).

In addition to the proposed changes from Energy Norway, we have identified the following possible steps to prevent people from getting the wrong impression of the statistics:

[46] The same applies to the average calculation for the amount of radioactive waste.
[47] In Austria, the requirement is on power suppliers, while in Switzerland it is on operators of power generating installations (CEPS, 2016). In several other countries, such as the Netherlands and Sweden, power producers can voluntarily request guarantees of origin from fossil energy sources and

- Remove the calculation of average CO2 emissions from the residual mix and only report CO2 emissions from different types of power generation (to prevent this from being used in the calculation of the climate impact of different energy choices)[46].
- Reconsider the size of the different pie charts and whether they should be presented together or separately.

What effects it can have

One possible benefit of such a change is that fewer people will have a false impression of the climate impact of Norwegian electricity consumption. This in turn can help to promote rational energy choices and environmental measures in the public sector, the private sector and among consumers. For example, it can promote electrification and energy saving where appropriate, by making it clear that energy saving is almost as effective for customers who buy guarantees of origin as for customers who do not.

It is uncertain how many of the aforementioned changes are practically feasible for NVE and whether any of them may have a negative impact on demand for Norwegian guarantees of origin. This should be investigated as part of any change process.

7.2.2 Make it mandatory for electricity suppliers to purchase Guarantees of Origin on behalf of all customers

What the measure would entail

If Norwegian authorities wish to promote guarantees of origin as a method of documenting energy sources for electricity, they may choose to require power suppliers to purchase guarantees of origin from renewable or non-renewable sources for all their power sales.

This will mean that power suppliers who want to sell power with documented renewable energy sources to their customers will buy relatively expensive guarantees of origin from renewable power generation, while other power suppliers will buy very cheap guarantees of origin from non-renewable power generation to their customers.

In such a scheme, which is already in place in Austria and Switzerland[47,48], NVE or other organizations do not need to calculate a "Product declaration for power purchases without guarantees of origin", as everyone has

nuclear power (https://www.ei.se/sv/for-energiforetag/el/ursprungsmarkning-av-el/).

[48] See also Energy Norway's description of the so-called Austrian model: https://www.energinorge.no/contentassets/fe7b84c248b5417ea022eee292f9da2c/focus-on-austria.pdf

guarantees of origin. Power customers who choose not to pay extra for power contracts with guarantees of origin will then receive individual product declarations (see section 3.3) that reflect the cheapest guarantees of origin the power supplier was able to obtain, for example production based on coal-fired power.

This method is promoted by AIB, which sees the calculation of residual mix/undocumented power as "an intermediary step towards a full disclosure system where all electricity disclosure is done through GOs" (AIB, 2017).

Even if NVE does not calculate NVE's product declaration on the basis of trade in guarantees of origin, there will probably still be statistics that say something about the physical production mix in Norway and that end users will still be able to use to document the energy sources in their production if they still want to use the location-based method.

What effects it can have

Making the purchase of guarantees of origin mandatory for Norwegian power suppliers may increase demand for (power agreements with) guarantees of origin from renewable production. If the system is perceived as legitimate, an individual declaration of origin could conceivably have a greater impact on customers than the current reference to NVE's declaration of origin. This could then lead to more power customers choosing to pay extra for contracts with guarantees of origin from renewable power production. If, on the other hand, the system lacks legitimacy, we can imagine that Norwegian electricity customers will not care significantly (and no more than they do today) about receiving an individual declaration of origin that shows, for example, that the guaranteed origin consumption originates from coal-fired power plants.

7.2.3 Design Norwegian government statistics on energy sources in a way that reduces the export of guarantees of origin

What the measure would entail

In a scenario where customers of Norwegian industry require their suppliers to document energy sources with guarantees of origin, Norwegian industry may have an interest in measures that make it more difficult to export the guarantees of origin and thus lower the price of the guarantees for them.

Should the Norwegian authorities wish to reduce the export of Norwegian guarantees of origin, they may be able to contribute to this in two ways:

- Design Norwegian government statistics on the energy sources of electricity consumption in a way that

reduces export of guarantees of origin (discussed in this section).
- Withdraw Statnett from AIB and make it practically difficult to export Norwegian guarantees of origin (discussed in section 7.3.1).

For example, the following changes could be considered in the design of statistics:

- That Norwegian authorities only refer to the physical production mix in Norway and highlight this as the most important statistic.
- That calculation and communication of "Product declaration for power purchases without guarantees of origin" is not made by NVE, but rather by each individual power supplier, reducing its significance.

What effects it can have

It is uncertain whether such a change to NVE's product declaration would be legally possible. If implemented, there is a risk that foreign regulators and customers would not accept Norwegian guarantees of origin. The effect could therefore be similar to the effects of Statnett withdrawing from AIB, which is discussed in the next section.

7.3 Possible changes to the Guarantees of Origin scheme

7.3.1 Withdraw Statnett from AIB and make it practically difficult to export Norwegian guarantees of origin

What the measure would entail

Another hypothetical way to reduce the export of Norwegian guarantees of origin for the benefit of the industry could be to withdraw Statnett from AIB. This could either be done by a direct decision, or by Statnett doing something that does not correspond to the EECS standard and thus leads to Norwegian Guarantees of Origin not being traded over the AIB Hub, and/or that Norwegian Guarantees of Origin are not accepted as canceled by foreign regulators.

What effects it can have

We note that there are several European authorities that are not members of the AIB cooperation, including the UK (which has never been a member) and Portugal (which withdrew on December 31, 2015 (AIB, 2018)). However, we have not considered whether it would be possible for Norway to withdraw from the cooperation if the purpose is to reduce the export of guarantees of origin.

If Statnett withdraws from AIB, Norwegian guarantees of origin will probably not/only with great difficulty be canceled in other countries.

This will likely result in a large decrease in demand for Norwegian Guarantees of Origin. As the supply of Norwegian Guarantees of Origin (equivalent to Norwegian renewable power production) is inelastic, a large drop in demand is likely to lead to a large reduction in the price, perhaps even down to the low operating cost for Norwegian power producers to issue them.

Such a measure would therefore reduce the revenues and profits of Norwegian power producers by approximately NOK 600 to 2,000 million from current levels, and perhaps from even higher (or lower) alternative price levels in the future.

In addition, the measure may make it less attractive for foreign power customers, such as data centers in other European countries, to enter into long-term power agreements with Norwegian power plants (as it is more difficult for them to document them with Norwegian guarantees of origin). In isolation, this effect can contribute to reducing the development of new renewable energy production.

However, for some companies that currently refer to guarantees of origin, such as data centers, this could be an advantage, because they could obtain cheaper guarantees of origin in Norway than in competitor countries. This effect is uncertain and depends on whether or not the customers of Norwegian industry in such a hypothetical scenario would consider Norwegian guarantees of origin as credible documentation of energy sources.

An additional challenge that could arise from such a measure is obligations related to guarantees of origin for future years that have already been sold by Norwegian power producers (forward contracts).

7.3.2 Promote more efficient trade and increase the value of Norwegian guarantees of origin

What the measure would entail

If the Norwegian authorities wish to contribute to increasing the value of Norwegian guarantees of origin for Norwegian power producers, there are several possible measures that can be taken.

A study by Oslo Economics on the trade in Norwegian guarantees of origin (Oslo Economics, 2017) showed that while the wholesale trade (mainly between power producers and power suppliers) was well-functioning, there were challenges related to a lack of information in the retail market (including in sales from power suppliers to consumers).

To increase confidence in guarantees of origin and the proportion of the consumer's payment that goes to the power producer, Norwegian authorities could, for example, consider working towards:

- Industry standards for the sale of guarantees of origin in Europe.
- Clear labeling of the share of the customer's payment that goes to the renewable energy producer.
- Price comparison tool for electricity contracts with guarantees of origin in Norway and other European countries.
- Preparation of market reports on the trade in guarantees of origin, both from the wholesale and retail markets.

What effects it can have

Measures for more efficient trading can, among other things, contribute to increased confidence in and thus demand for guarantees of origin, as well as lower marketing costs. Together, this can contribute to higher revenues from the sale of guarantees of origin to Norwegian power producers.

7.4 Conceivable changes in taxation

7.4.1 Resource rent taxation etc. on income from the sale of guarantees of origin

What the measure would entail

In addition to redistribution between the power industry and Norwegian industry, a relevant measure could be to redistribute value to the community, specifically by taxing income from the sale of guarantees of origin in the same way as income from the sale of physical power.

The tax legislation contains a number of special rules for taxation of income related to the production of electric power from hydropower plants. All companies are subject to ordinary income taxation in accordance with the Tax Act. In addition, there are several forms of special tax: resource rent tax, natural resource tax and a property tax that is calculated according to special rules (SNL, 2018). The resource rent tax applies to hydropower plants with generators larger than 10 MVA and was 34.3 percent in 2017 (Ministry of Petroleum and Energy, 2017).

In comparison, the sale of guarantees of origin, the amount of which depends on the same production that creates the physical power, is only taxed with ordinary income tax, i.e. 23 percent (Government, 2017).

Revenue from the sale of guarantees of origin derives from the same natural resources that generate revenue from the sale of physical power. One possible measure would be to tax the two sources of income equally.

What effects it can have

An increased taxation of guarantees of origin will first and foremost entail a redistribution from

power producers (and their main public owners) to public authorities and society as a whole.

Increased taxation of guarantees of origin may also reduce the incentives to invest in new renewable power generation. This suggests that

The taxation of guarantees of origin should be seen in the context of other aspects of hydropower taxation. It may therefore be natural for the expert committee on hydropower taxation (Government, 2018), which is due to submit its report by October 1, 2019, to consider this in a holistic perspective.

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9. Attachments

9.1 Appendix 1

Table 9-1: Calculation of "Product declaration for power purchases without guarantee of origin 2017"

Production Thermal power	3 407 641	MWh
Production Wind power	2 849 551	MWh
Production Hydropower	142 995 967	MWh
Issued guarantees of origin (OG) 2017 production	140 892 826	MWh
Expired OG (2016 and 2017 production) Hydropower 1.4.2017-31.3.2018	4 106 763	MWh
Expired OG (2016 and 2017 production) Wind power 1.4.2017-31.3.2018	28 553	MWh
Cancelled OG as of 31.3.2016 used in individual product declaration for 2017	25 427 917	MWh
Consumption Norway 2017	134 088 677	MWh
Consumption by Norwegian customers who do not purchase power for which guarantees of origin have been redeemed	108 660 760	MWh
Kraft with "known properties" in the product declaration:		
Heating power - bio	121 522	MWh
Thermal power - fossil fuels	3 202 183	MWh
Hydropower	9 039 446	MWh
Wind power	132 498	MWh
"Unknown power" - replace with "European attribute mix" EAM	96 089 022	MWh
"European Attribute Mix" EAM (2016):		
Renewable power	7,87 %	
Nuclear power	30,56 %	
Heating power	61,57 %	
EAM in the product declaration:		
Renewable power	7 562 206	MWh
Nuclear power	29 364 805	MWh
Thermal power - fossil	59 162 011	MWh
Product declaration for customers who do not purchase power for which guarantees of origin have been redeemed:		
Renewable power	16 %	
Nuclear power	27 %	
Thermal power (fossil fuels)	57 %	

Source: NVE https://www.nve.no/reguleringsmyndigheten-for-energi-rme-marked-og-monopol/varedeklarasjon/nasjonal-product-declaration-2017/

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