A review of green tariffs and renewable energy guarantees of origin (REGOs) – do they bring about genuine emissions reductions for individuals and organisations?

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Introduction:

The European Commission, in 2009, carried out the liberalisation and unbundling of the European market leading to an increase in energy companies, producers and suppliers (Castellano *et al*., 2017). With the increase in competition and the little differentiation in the final product – electricity and gas – suppliers based their competitive advantage on differentiating the offer (Hast *et al*., 2015). Green tariff backed up by the purchase of Guarantee of Origins (GOs) certificate allowed suppliers to attract the customers that were willing to pay a premium price for electricity produced by renewable energy (Mulder and Zomer, 2016). This marketing strategy led to the expectation that by purchasing a green tariff, a customer would encourage new investments in renewable energy (Hamburger, 2019). However, that may not be always the case. This report analyses first the electricity GOs market, focusing on the interaction between GOs and other incentives policies; the rising problem of double counting renewable energy and the found solutions; the impact that GOs have on new investments based on the supply and demand when GOs are used as a marketing strategy, and their market price. This report concludes with a focus on the green gas and the gas GOs market.

GOs background:
The European Commission with the directive 2001/77/EC introduced the GOs to provide information on the origin of the energy consumed by the customers, from electricity to renewable gas. They were then defined in the 2009/28/EC directive as "An electronic document which has the sole function of providing proof to a final customer that a given share or quantity of energy was produced from renewable sources". One GO is equivalent to one MWh of electricity or renewable gas generated, energy producers issue the certificate in an electronic registry, when a buyers purchase a certificate, this is cancelled from the registry. Electricity GOs expires after 12 months, while gas GOs after 24 (Hamburger, 2019; Long and Murphy, 2019). GOs must include at least: the energy source, start and end dates of production; whether it is relating to electricity, gas, heating or cooling; the type of installation where the energy was produced; if the installation also received other financial incentives; the date on which the installation became operational; when and where it was issued and a unique identification number (2018/2001/EU).

Methods:

The report was conducted on peer-review articles, the Official Journal of the European Commission, governmental institutions websites and websites of regulators. The literature search was conducted using database and library services, Scopus and UCL library. Keywords used were "Guarantee(s) or Origin", "Renewable energy guarantee of origin", "Green tariff", "Energy certificate", "Energy Market", "GOs Market", "Biogas", "Renewable gas". The Official Journal of the European Commission was used to retrieve official policy information regarding Guarantees of Origin. To collect official and updated data and information, institutions of competencies' websites and reports were adopted. For example, Ofgem – the UK office of gas and electricity market – and the

Association of Issuing Body – that coordinate energy certificate scheme. A google search was conducted to compare and analysed UK energy suppliers' fuel mix.

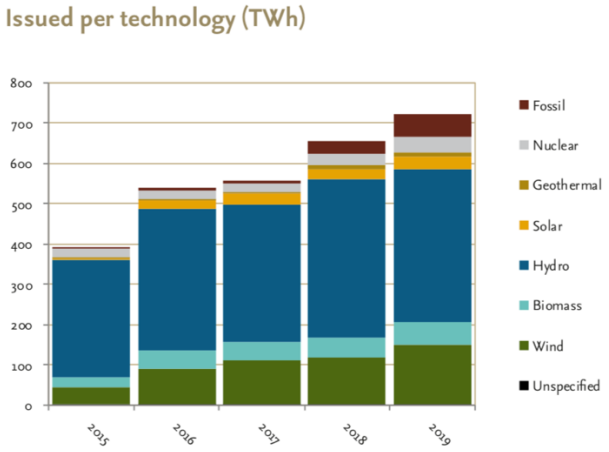
Results and Discussion:

How GOs interact with other policies:
In 2008 there was a strong debate whether to allow GOs trading between EU countries. GOs market would stimulate investments where it is less expensive to develop renewable energy (RE) infrastructures, which are often the more mature technologies. This would allow countries where it is expensive to build RE technologies to buy GOs from other EU countries to reach their national renewable energy consumption target (CEC, 2008). However, this system would fail to promote diversification and new technologies development, which would be better supported by a feed-in-tariff (FIT) system, a government program that aims to promote small-scale renewable energy generation technologies (Ofgem, 2021; Nilsson *et al*., 2009). Finally, in 2008, the EU decided that the GO certificates would be used purely to certified the origin of the energy, through a 'flexible mechanisms allowing member states to "trade-in statistics" to reach their target' (Nilsson *et al*., 2009).

The United Kingdom in 2002 initiated the Renewable Obligation (RO) scheme, a support mechanism for renewable electricity projects, suppliers had to increase the share of renewable energy in their energy mix, through Renewable Obligation Certificate (ROC) (Hast *et al*., 2015). ROCs, are issued to renewable accredited plants, they can be traded among operators to meet their obligations. With the development of GOs in the EU, the UK named the GOs certificate for renewable energy produced in the UK Renewable Energy Guarantee of Origin (REGO) (Hast *et al*., 2015).

Double counting:
Like the UK, every European country has its legislation and regulation on renewable incentives, to avoid trading mistakes and double counting, a trading EU harmonised system was needed (Hast *et al.*, 2015). Double counting refers to one unit of energy accounted twice, for example, country A sells one GO, which is accounted by country A to reach their national target, to country B which also uses it to reach their national target. Counting the same GO, twice. The same mechanisms can also happen within a country, a supplier that uses one GO to reach their renewable energy share in their fuel mix and also sell that GO to a consumer as part of the green tariff. The EU directive encourages each country to draw regulations to avoid double counting internally. Regarding regulations between countries, the Association of Issuing Bodies (AIB) and the European Energy Certification System (EECS) developed rules to prevent double counting, for countries to trade GOs, the issuing country have to renounce to count the traded GOs towards their national target (Mulder and Zomer, 2016).

GOs demand and supply:



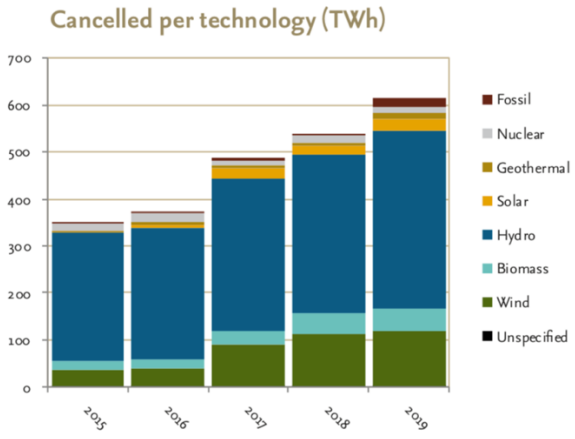


Figure1a: Issued GOs (AIB, 2019)

Figure1b: Cancelled GOs (AIB, 2019)

Hulshof *et al*. (2019) recorded an increase in certification rate from 2001 to 2015 from 0.2% to 35.5%. AIB report shows a clear increasing trend in issued certificates just above 700TWh in figure1a, and cancelled (purchased) certificate figure1b, just above 600TWh in 2019 (AIB, 2019). This data highlights the oversupply of approximately 100TWh which have not been purchased in 2019. Even if there is an increasing trend of supply and demand, the supply is still too high and every year certificate expires. The presence of an abundance of GOs in the market leads to a very competitive price, allowing the infrastructure with lower marginal cost to enter the market at a lower price. In this case, GOs supplied from the old hydropower plants, of which 133TWh from Norway, which have already amortised the costs (AIB, 2019).

Prices:
While GOs' quantitative data is publicly available through the AIB, GOs market price is not transparent as trades occur between parties (Hulshof *et al.,* 2019). To investigate the GO price Mulder and Zomer, (2016) compared the suppliers' prices of the grey and green tariff, assuming that the price of the certificates would be passed on entirely onto the consumers. The result of the price difference is extremely low. Hast et al. in 2015 calculated that the premium price in the UK fluctuated between -7% to 10% with an average of 1-3% compared to the retail price. Concluding that the price that the generator has to sustain to produce electricity is not related to the cost of buying green electricity.

A recent paper by Morais *et al.*, (2020) has an optimistic view regarding GOs, first by stating that this market is still underdeveloped and therefore adjusting as such. They believe that by itself the existence of the GOs market already bring extra revenues to the energy producers, as they can collect income by selling the energy on the electricity market and the GOs certificate on the GOs market. They conducted a case study on real market data, from the Iberian market. In this realistic scenario, the price of electricity from the electricity market fluctuated over the day from 4.98c€/KWh to 8.38c€/KWh, while the price of GOs was assumed constant during the day and was

averaged at 0.0048165c€/KWh, the value of one GOs would be 4.8165c€/MWh. Despite the price being low, in their scenario where a generator produces 100MWh and sells all day the GO at 10c€/MWh collect 2400€ daily as extra revenue. As it is, even if the GOs market brings additional revenue to renewable energy generators, it appears to not be enough by itself to guide new investments (Hulshof *et al*., 2019). To adjust this market problem one can take different approaches, fixing the market or adjusting the demand, as suggested in the following section.

Market Suggestions:

Regarding possible solutions so that the GOs market would be able to stimulate new investments, literature papers make different suggestions. From excluding Norway from the GOs market, an option considered but also excluded by Mulder and Zomer, (2016) because Norway already implemented the EU RES scheme, setting a national target to reach. Mulder and Zomer, (2016) also suggested that only new plants should be able to produce GOs, excluding the hydro plant, the supply would be reduced and the cost of production would increase, leading to an increase in GOs price. After Brexit the situation in the UK is still unsure, the UK currently declared that they would accept GOs only if the EU would accept REGOs, if GOs are not to be accepted in the UK, then this may solve the oversupply problem (Ofgem, 2021b). Hast *et al.,* (2015) also suggested increasing transparency on how the premium price is utilized, and if it goes to environmental benefit. Suppliers such as Ecotricity do reinvest the bill money in new renewable energy infrastructures (Home, 2021). Other companies help customers consume renewable energy and create new ones, for example, ECOHZ allows companies to reduce their carbon footprint by purchasing renewable energy backed by GOs while supporting renewable energy project financing (ECOHZ, 2021). Additionally, the Carbon Trust suggestions, explain how certain green tariffs are greener than others and have a bigger impact on new investments (Carbon Trust, 2019).

Demand Suggestions:

Before purchasing a green tariff, the consumer can collect information regarding the energy supplier, differentiate between the suppliers that use green tariff as a marketing strategy and those who have a greener impact. The first key indicator, suggested by the Carbon Trust, is the supplier's annual fuel mix, whether it is all green or a mix of grey and green sources (Carbon Trust, 2019). In the UK since the introduction of the RO, suppliers have had to include renewable energy in their fuel mix. If suppliers have a fuel mix containing both grey and green electricity, it may be the case where they supply the already existing share of green energy to the customer who chose the green tariffs by reducing the green energy share from the non-green tariff. However, there are also suppliers that have only green energy, supporting these businesses would indicate an increased interest in a green energy transition.

Another suggestion is whether the company sells renewable electricity and the REGOs bundles together (Carbon Trust, 2019). Castellano *et al.* (2017) found that in Germany the premium price that consumers paid at the suppliers were on average 20.76€/MWh, while the price of the GOs on the market was 0.43€/MWh. By purchasing a green tariff from a supplier that sells the electricity and REGOs together, one is incrementing more the income of renewable energy producers. One critic that is often proposed to this system is that energy suppliers can buy REGOs certificates without buying electricity produced from renewable resources, this system allows them to sell grey energy at the premium price of green energy by buying at a much lower price REGOs or GOs certificate form the market. Because of the low price of the certificate, this system is not supporting new investments, on the contrary, buying electricity from suppliers which purchase it from

renewable generators and bundle it to a certificate would support renewable business, an example is Good Energy (Goodenergy, 2021).

Green Gas:

Green gas includes biogas (CH_4), biomethane (CH_4), and hydrogen (H). The difference between biogas and biomethane lies in the percentage of CH_4, biomethane is purer, containing at least 97% of CH_4 (Long and Murphy, 2019). However, this difference is not universally accepted, as for some countries like Germany and Swiss biogas and biomethane are exchangeable (Long and Murphy, 2019). Hydrogen can be produced from biological feedstock and through a renewable pathway, renewable hydrogen was first mentioned in 1995 by the National Renewable Energy Laboratory, but there is not an agreed definition (NREL, 1995). This un-harmonisation of the definition of renewable gas, biogas and biomethane, makes international trading more difficult (Velazquez Abad and Dodds, 2020). For this reason, in 2014 the UK Department of Business, Energy and Industrial Strategy (BEIS) started to develop definitions, standards and rules for green hydrogen (Velazquez Abad and Dodds, 2020).

Use of Biogas and production:

Biogas can be used for different functions, from power production, vehicle fuel, to renewable heat as main use in the UK (Schmid *et al.,* 2019). Biogas can also play a role in waste reduction and resource management, as it can be produced from biological processes through the anaerobic digestion of food waste, solid waste, slurry from farming, gasification of woody crops and grass silage. Methane can also be produced from electricity, and it is considered biological only if that electricity comes from renewable resources, in this case, it is named e-gas (Long and Murphy, 2019).

Biogas Market:

Approximately half of the world biogas production is located in Europe, as a pioneer in this sector saw the number of biogas infrastructures increase from 187 in 2011 to 497 in 2017. The European market for biogas is the biggest, including more than 500 plants in 2017 (Schmid *et al.,* 2019). In 2018 in Europe there were 610 Biomethane operating plants, with a production of 22,787 GWh, which was 0.5% of the total natural gas consumption (Herbes *et al.,* 2021). The UK represent the second biggest player with 85 upgrading plants after Germany with 194 (Schmid *et al.,* 2019). The UK is one of the few countries that directly support biogas through the Renewable Heat Incentive (RHI). This scheme has incentivised the rapid growth in biomethane plants in the UK as an alternative to traditional gas, to reduce emissions for the heating systems (Herbes *et al.,* 2021).

Green gas GOs:

In the 2018/2001/EU directive, biogas, biomethane and hydrogen are included in the GO scheme. The GO market for gas received less attention compared to the electricity one, as in Europe only the UK, Austria, Italy, France, Germany and Hungary have a green gas certification scheme (Long and Murphy, 2019). The GOs market for green gas is slightly different compared to the electricity one, since gas can be physically tracked there are three possible systems that allow green gas to be traded as shown in figure2, also known as the chain of custody. The segregation approach tracks the commodity throughout the entire supply chain, in this system the green gas is not mixed with non-green gas. The mass balance approach does not require gas of different nature to remain segregated, they can be mixed inside the gas grid, as long as the volume of green gas entering the grid is equal to the one exiting it. In the book and claim approach, the physical flow of gas is

independent of the trade of its GOs. Due to the untraceable nature of electrons once in the grid, the electricity market follows only the book and claim approach (Velazquez Abad and Dodds, 2020).

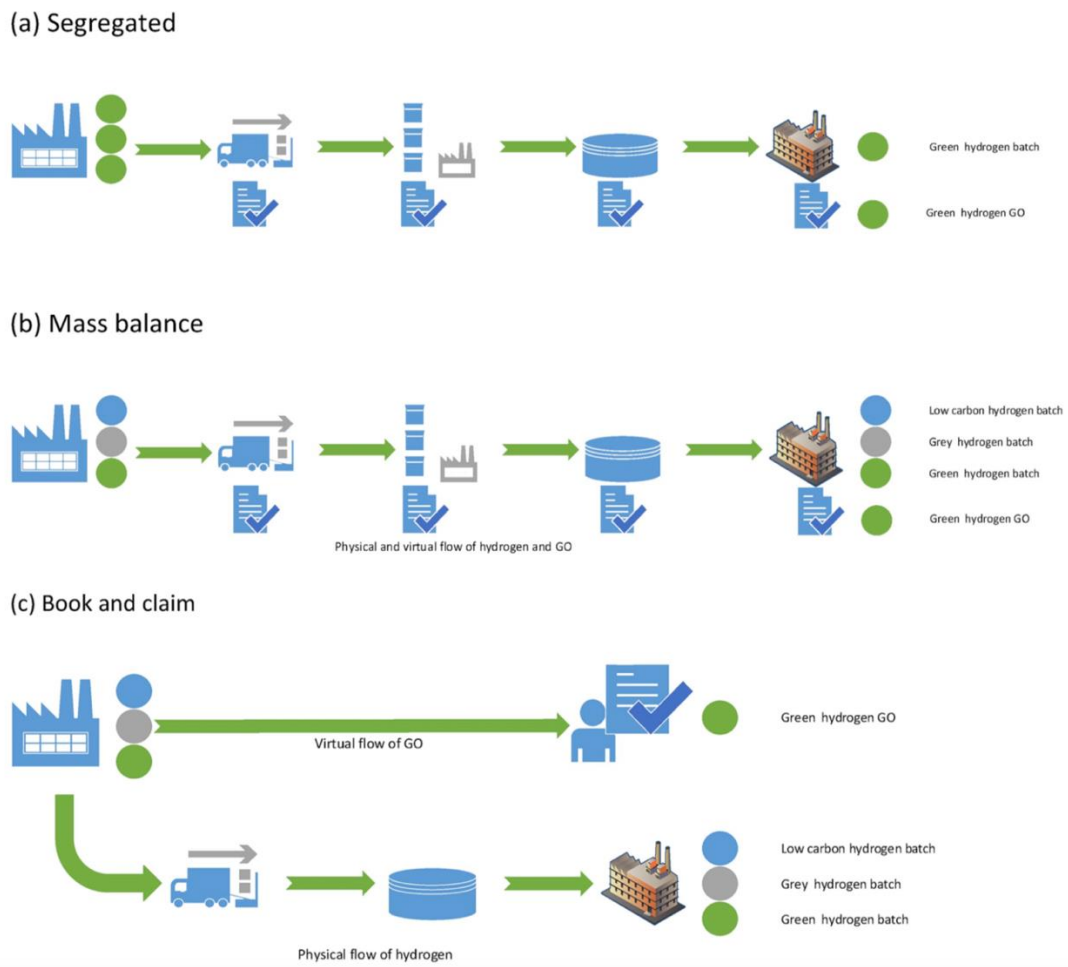


Figure2: Green hydrogen chain of custody. From Velazquez Abad and Dodds, (2020)

Biogas is currently considered a mature technology, Herbes, *et al.* (2021) states that at the present time, the main obstacle is political priorities and decisions. Biogas is expected to become the long-term fuel for homes, industries and transports. Following Boris Johnson 2020 plan for the UK 'green industrial revolution' energy companies started to plan their transition (Business, Energy & Industrial Strategy, 2021). One example is the first town to be powered 100% by hydrogen planned for 2030. The plan to deliver a hydrogen transaction start from domestic pilot projects, to building new pipelines in 2030, to industry and transport sectors. In 2040 a full hydrogen transition will occur (ENA, 2021).

Conclusion

Guarantees of origin were created to increase transparency and soon after they became tradable certificates, with the creation of the GOs market. Regarding the electricity market, there is an increasing trend in GOs demand showing an interest in renewable energy and a shift from the traditional fossil fuels. The inability of this market to deliver new investment is due to the low price of the GOs certificate, however, the existence of the market itself also means more income for renewable energy generators. Following the suggestions of the carbon trust consumers can

understand that certain green tariffs have a greener impact on the environment compared to others. For example, there are energy companies that adopt a transparent communication on how they reinvest the premium price, some reinvest them in new renewable infrastructures, while other companies sell only renewable energy. The green gas GOs market, appears less developed compared to the electricity one, with a need for harmonising definitions and international criteria for trading. Green gas seems an optimal alternative to traditional gas with additional co-benefits. As of now, the main obstacle is politics, but the UK planned a green gas transition from pilot projects to net zero.

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