Technical assistance to monitor functioning of the guarantees of origin (GO) system

Final Report

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Final Report

Technical assistance to monitor functioning of the guarantees of origin (GO) system

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Technical assistance to monitor functioning of the guarantees of origin system and develop options for labelling to promote new RES production

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Table of Contents

List of Tables

Abbreviations

AIB	Association of Issuing Bodies
CBAM	Carbon Border Adjustment Mechanism
CEN/CENELEC	European Committee for Standardization/European Committee for Electrotechnical Standardization
CfD	Contract for Difference
COM	European Commission
CSRD	Corporate Sustainability Reporting Directive
EEA	European Economic Area
EECS	European Energy Certificate System
EmpCo	Empowering Consumers Directive
GCD	Green Claims Directive
GO	Guarantee of Origin
H2	Hydrogen
H/C	Heating and Cooling
ISO	International Organization for Standardization
MS	Member State
NECP	National energy and climate plans
PoS	Proof of Origin
PPA	Power Purchase Agreement
PV	Photovoltaic
RE	Renewable energy
RED	Renewable Energy Directive
RES	Renewable energy sources
RES-E	Renewable electricity sources
RFNBO	Renewable Fuel(s) of Non-Biological Origin
T1-4	Tasks 1-4
T5-7	Task 5-7
UDB	Union Data Base

1. INTRODUCTION

1.1. Objective and Scope

Recital (55) of the Renewable Energy Directive (EU) 2018/2001 (RED II) provides the legitimation of guarantees of origin (GOs) to *"have the sole function of showing to a final customer that a given hare or quantity of energy was produced from renewable sources"*. As such, GOs has been established as a market-based instrument, which *"can be transferred, independently of the energy to which it relates, from one holder to another"* while it must be ensured that *"double counting and double disclosure of guarantees of origin [is] avoided"*. Although not the main purpose of GOs, Recital (56) the RED II states GOs as the instrument to *"allow the consumer market for renewable electricity to contribute to the development of energy from renewable sources"* by requiring *"electricity suppliers who disclose their energy mix to final costumers […] or who market energy to consumers with a reference to the consumption of energy from renewable sources, to use guarantees of origin […]"*. Thus, guarantees of origin (GOs) have been established as a market-based instrument to inform consumers and to drive decarbonisation from consumer empowerment.

Following Art. 19 (13a) of the amended RED II the European Commission is obligated to:

- Monitor the functioning of the guarantees of origin system;
- Assess the balance of supply and demand of guarantees of origin in the market;
- Identify relevant factors affecting supply and demand.

In order to support the European Commission in this task we **first** (Chapters 2.2-2.5) analyse various **market dimensions** of the **electricity GO market** (including transparency, liquidity and competitiveness[1]) to evaluate whether supply and demand of GOs is in balance, and identify which key factors influence the market balance (including, for example, RES technology, subsidisation and regional/national origins). These chapters also include an evaluation of renewable PPAs and their influence on the market, how different referencing to methodologies (such as in the Corporate Sustainability Reporting Directive (CSRD) and environmental footprint methods, which may indirectly affect GOs, influence the market, and the interaction of State Aid with GO markets across Europe.

Chapter 2.4 analyses financial streams, providing a cost breakdown of GOs and insights on the revenue streams of GOs for the most important stakeholder groups participating in the GO market, such as energy producers, energy suppliers, traders, and issuing bodies.

Where possible, the analysis is based on quantitative data of GO flows and prices.

Second, we discuss the **effectiveness** of the **GO system** (Chapter 2.6). We first elaborate on the underlying purpose of the GO system and GOs as instruments themselves, then we elaborate on goals explicitly and implicitly assigned to the GO market. We conclude the section discussing whether the stated goals are achieved, namely proof of renewable energy procurement, consumer information and support to the roll-out of renewable energy sources (RES). In this chapter we also discuss whether consumers' expectations in relation to the buying of behaviour renewable energies based on the information of GOs are met.

[1] We will use the term responsiveness throughout this report.

In Chapter 2.7, we discuss the gas GO market (including available information on prices and the interaction of UDB and GOs), and provide an outlook on potential market developments (including the gas directive's billing information requirement).

Third, we semi-quantitatively assess how supply and demand may develop for the **GO market towards 2030** and beyond (Chapter 3). This chapter includes an analysis of the expected influence of the emerging RFNBO market, which requires GOs to prove that the electricity used for production or of increased consumer awareness is renewable, as well as the RE100 initiative which fosters the additionality criterium by restricting their RES consumption to installations not older than 15 years. Moreover, the chapter provides an estimate of market volume for three different pathways towards 2030. Further, by analysing the existing and potential GO market in Serbia, we aim to provide an understanding of the impacts on the European GO market in the event of countries listed as Contracting party of the Energy Community joining the EU market. Furthermore, we provide an overview of currently discussed **measures and development options,** and structure these into fields of action.

2. ANALYSIS OF THE EXISTING MARKET OF GUARANTEES OF ORIGIN IN EUROPE

The assessment of the functioning of the GO system and of the related market balance is motivated by DG ENERs monitoring obligation pursuant to Art. 19(13a) of the amended RED II:

> *The Commission shall monitor the functioning of the guarantees of origin system and assess by 30 June 2025 the balance of supply and demand of guarantees of origin in the market and, in the case of imbalances, shall identify relevant factors affecting supply and demand.*

The main objectives of this report are:

- the identification of imbalances in the GO market, which we structure along the dimensions of liquidity, competitiveness, stability, transparency, efficiency and harmonisation;
- the identification of the relevant factors affecting supply and demand;
- the analysis of the effectiveness of the GO system with regards to fulfilling its purpose of consumer information and to support the roll-out of renewable energy sources.

2.1. Short methodological approach and shortlisting of indicators

The following analysis is based on the methodology as described in the last chapter of this report. Using literature, available datasets, interviews, and a survey, the analysis is structured around six dimensions of the GO market:

1. **Liquidity,** in the sense that a critical mass of participants and trading is reached;
2. **Completeness and harmonisation**, in the sense that the market is homogeneous throughout the EEA;
3. **Stability**, in the sense that GOs as a market instrument are reliable and predictable;
4. **Transparency**, in the sense that all relevant information is available to the stakeholders;
5. **Efficiency**, in the sense that the goals are reached with reasonable resources;
6. **Responsiveness/competitiveness**, in the sense that prices reflect imbalances of supply and demand.

Based on a first draft of possible data-based indicators (see ANNEX) we shortlisted several indicators per dimension, in order to provide a transparent assessment of the market. Particular attention is given to the responsiveness dimension, in order to understand the key factors influencing supply and demand, and prices. The shortlisted indicators are:

Table 2-1: Overview of shortlisted indicators per market dimension for GO system monitoring

ID#	Indicator	Methodology for calculation	Data source / Interview partner
Liquidity			
1.1	Market length	Cumulative amount of GOs issued, cancelled and expired by month	AIB statistics 2024[2]
1.2	Expiration rate	Expired GOs as share of issued GOs per year	AIB statistics 2024, AIB statistics 2021[3], [Hulshof et al. 2019][4]
1.3	Issuance rate	Issued GOs as share of net electricity production per technology (hydro, solar, wind) per year in EU/EEA	AIB statistics 2024, Eurostat[5]
1.4	Annual GO volumes issued and cancelled	GOs issued and cancelled per year in AIB countries	AIB statistics 2021, AIB statistics 2024
1.5	Net-importers and net-exporters of GOs per country	Exported GOs – imported GOs per year per AIB country	AIB statistics 2024
Harmonisation			
2.1	GO market access	Countries with access to EU/EEA-wide GO market, number of AIB members, countries with access to Energy-Community GO market and countries with national schemes;	AIB domain protocols[6], AIB website[7], Energy Community website[8]
2.2	Operational harmonisation: supported electricity	Classification per AIB country of handling of GOs for supported electricity pursuant to Art 19(2) of RED II	AIB Domain protocols
2.3	Operational harmonisation (of registries)	Overview of applied cancellation restrictions for stakeholder groups and implementation of expiry rule per AIB country	AIB Member Survey of imposed conditions 2024[9], [UBA 2023][10]
Stability			
3.1	Volatility of average monthly GO spot price	Running 12-month standard deviation of monthly average GO spot price per technology (absolute and relative)	S&P Platts, [Hulshof et al. 2019]

[2] https://www.aib-net.org/facts/market-information/statistics/activity-statistics
[3] https://www.aib-net.org/facts/market-information/statistics/activity-statistics
[4] https://www.sciencedirect.com/science/article/pii/S0301421519300709
[5] https://ec.europa.eu/eurostat/web/main/data/database
[6] https://www.aib-net.org/facts/aib-member-countries-regions/domain-protocols
[7] https://www.aib-net.org/facts/aib-member-countries-regions/aib-members
[8] https://www.energy-community.org/news/Energy-Community-News/2023/06/06.html
[9] https://www.aib-net.org/facts/market-information/imposed-conditions-trade-expiry-and-cancellation
[10] https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/24_2023_cc_analyse_eines_unternehmensentwertungsrechts_fuer_strom-herkunftsnachweise_in_deutschland.pdf

3.2	Perception of stability of GO market among stakeholders and consideration of GO price for business models	Rating of perceived/expected stability (1-10) in 2018-2020, today and 2030 Yes/No: Does the GO price allow you to build a business model around it?	Survey
Transparency			
4.1	Qualitative rating of access to information of different categories: • Market participants • GO market prices • Price formation • Traded GO volumes, issuance and cancellation • Product Attributes • Regulatory Framework	Rating of access to information concerning the availability of sources (good/limited/highly limited access) based on assessment of access to information per category	AIB website, [Wimmers & Madlener 2023][11], [RE-Source 2021][12], GO auction websites[13], survey, S&P Platts
4.2	Qualitative rating of reliability of available information regarding different categories	Rating of information concerning the origin of sources (good/limited/highly limited reliability) based on assessment of reliability of information per category	AIB website, [Wimmers & Madlener 2023], [RE-Source 2021], GO auction websites, survey
4.3	Stakeholders' dependence on third parties for information/know-how to participate to the GO market	Yes/No: Are you dependent on information/know-how from third parties to participate in the GO market Select: Which third parties? – Producers / Consumers / Market Makers	Survey
Efficiency			
5.1	Stakeholders' experience with regard to administrative efficiency of the GO market	Open-ended question concerning stakeholders' experience	Survey
5.2	Stakeholders' experience with regard to economic efficiency of the GO market	Rating of experience (Very important / Important / Minor / No revenue generated)	Survey
Responsiveness			
6.1	Price developments of monthly average GO prices	Monthly average GO prices	S&P Platts, Italian GO auction results
6.2	Balance of GO issuance and cancellation	Issued volumes, cancelled volumes and issued minus cancelled volumes (total, hydro and solar/wind GOs)	AIB statistics 2024
6.3	Qualitative comparison of annual average GO prices to changes in issuance-cancellation balance	Changes in issuance-cancellation balance compared to preceding year, price difference to preceding year and comparison of price change with expectation of bullish/bearish price development	AIB statistics 2021, AIB statistics 2024, S&P Platts

[11] https://ntnuopen.ntnu.no/ntnu-xmlui/handle/11250/3120176
[12] https://resource-platform.eu/wp-content/uploads/Guarantees-of-Origin-and-Corporate-Procurement-Options.pdf
[13] https://www.aib-net.org/facts/market-information/auctioning-gos-aib-members

6.4	Monthly correlation of chances in the GO transfer rate and GO price changes	Calculation of Pearson correlation coefficient for monthly GO price changes and changes of transfer rate (transfers over issues)	AIB statistics 2024, S&P Platts

Effectiveness
The discussion of effectiveness of the market is to the extent possible based on data-based indicators. The nature of the topic, however, generally requires also a qualitative assessment, which in this work is informed by the survey and by semi-structured interviews with stakeholders from a wide range of stakeholder groups.

If not specifically mentioned otherwise, transaction-based data is used instead of production-based data. Transaction-based data refers to market information referring to the respective transaction of the GO (e.g., issuance, cancellation, transfer etc.). Production-based data refers to the production of the electricity for which GOs are issued.

2.2. Detailed analysis of indicators to identify imbalances in market

The discussion in this and the following chapters will focus on the electricity market, due to its relative size and importance. Renewable gas GOs will be covered in chapter 2.7. As of today, there is no relevant guarantees of origin market for heating and cooling (H/C). Thus, since there is no data available, the monitoring of the H/C GO market was not included in this report. The indicators discussed below allow to conclude on the status quo of the electricity GO market, and this serves as a basis for conclusions on the effectiveness of the GO System as a whole. The data-based metrics also serve as foundation for a more continuous monitoring processes of the GO market in the future. In the following, we provide in-depth analysis for each of the defined dimensions (Chapters 2.2.1 to 2.2.6).

2.2.1. Liquidity

Market liquidity is crucial in ensuring that no single actor or event can disproportionately influence the entire market. Hence it is a prerequisite for the market to reach stability and predictability. Furthermore, it is an indication of general acceptance of the GO system. Excess liquidity at any point in time, however, also means that the market may be oversupplied.

To analyse the liquidity of the GO market, the following four indicators are assessed:

1. **Market length**: The market length is the cumulated volume of issued GOs minus the cancelled and expired volumes of GOs on a monthly basis. Hence, this indicator reflects how many GOs have been theoretically available in the market for each month.
2. **Expiration rate**: The expiration rate is derived from the quotient of expired GOs and issued GOs per year and provides indications on the balance of supply and demand. GOs typically expire after 12 months after production if they have not been cancelled within this period.
3. **Issued and cancelled GOs per year:** The numbers of annually issued and cancelled GOs provides a picture of the development of the overall GO market size. The supply of GOs is directly reflected in the issued volumes and the demand for GOs which provide evidence for renewable electricity consumption, and it is understood as the number of cancellations.

4. **Issuing rate**: The issuance rate is the share of issued GOs per produced electricity in the EU for hydro, wind and solar sources. This indicator reflects the size of the GO market and the theoretical capacities to increase supply and hence liquidity.

Market length

The market length describes the amount of GOs available on the market and thus (the monthly) liquidity at each moment in time. The term "available on the market" refers to GOs which are valid and transferable, which may also include GOs "held on reserve" or already having reached the portfolio and being reserved for cancellation, until they are cancelled or expire. Figure 2-1 shows that for the considered timeframe (from January 2019 to August 2024) almost all cycles of issuing and cancellation have been net positive[14], hence the (theoretical) availability of GOs compared to the previous year has increased. Only for the year 2022 cancellations exceeded the respective supply of the adjacent years (and most importantly the year before, see also Table 2-2 below).

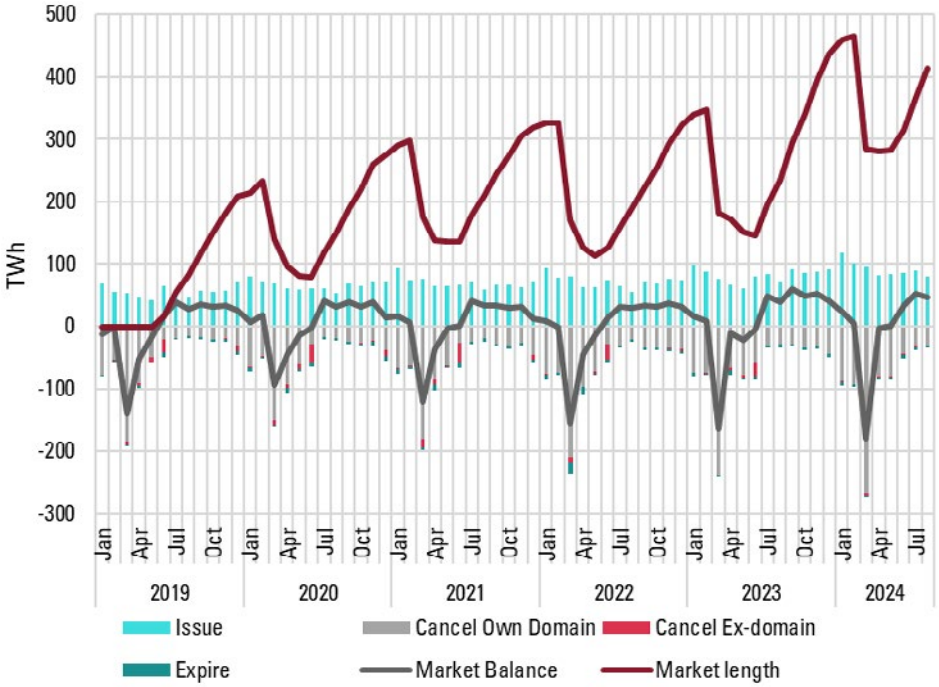


Figure 2-1: Monthly market length and balance of the GO market

Based on own calculations, AIB statistics 2024 (transaction-based data)

Market length describes the amount of GOs available on the market and is calculated by accumulating issued GOs each month and deducting the volumes cancelled and expired. The market balance describes the balance between GOs entering the market (issued) and exiting the market (cancelled/expired) for each month.

Table 2-2: Maximal and minimal monthly GO market length per year

	2019	2020	2021	2022	2023	2024*
Max (TWh)	208	274	318	326	436	464
Min (TWh)	0	78	136	112	146	281

[14] Note that the market length has been artificially set to 0 in the beginning of 2019, where the monthly balance would provide negative values. This is justified given that GOs were already in the market before 2019 and in the beginning of each year close to disclosure deadlines cancellations usually reach their maximum.

Difference of oversupply to previous year (TWh)	--	+78	+57	-23	+34	+135

*2024 only covers data until and including August 2024
Based on own calculations, AIB statistics 2024

During 2022, the EU experienced a drought, which led to low hydro power reservoirs. As a result, 55 TWh fewer of hydro power GOs were issued compared to 2021. At the same time, renewables build-out allowed an increase of 53 TWh of GOs for solar- and wind-based electricity. Due to increasing overall demand for GOs in 2022, the minimum of the market length was below the 2021 minimum, but the GO market remained oversupplied by about 100 TWh. **It must therefore be concluded that the market is structurally oversupplied**. Note that the market length has been artificially set to 0 from 2019 onwards, when in fact already GOs were traded, showing that the market length assessed here must be considered as conservative estimation and actual oversupply is likely even larger. These conclusions can be confirmed by the analysis of the cumulative market balance by Veyt, where an oversupply of roughly 180 TWh for the year 2023 was identified[15]. The trend to more liquidity in the market is confirmed by stakeholders in our survey, and it is expected to further increase towards 2030.

Expiration rate

The oversupply of GOs is further confirmed by the **expiration rate** of GOs (see Figure 2-2). Expired GOs represent GOs which have been issued but are not cancelled (within typically 12 months). The expiration rate has been more volatile in the early phases of the GO market and reached above 25% in 2003, which can be linked to small GO market volumes in an immature market. Since 2011, the expiration rate it has been balanced between 5-8%[16].

The question arises why GOs close to expiration are not cancelled or traded at very low prices. There is no indication of in which stakeholder group's possession the largest GO volumes expire. Overall, different factors can be considered, such as:

- Tactical detention to induce an artificial market shortage.
- Expiration as guerilla-style claiming of attributes when cancellation is not officially possible (e.g. by having cancellation restrictions for non-suppliers).
- Neglection of trade or cancellation, when the expected income is not enough incentive compared to administrative effort and fees.

The expiry of GOs in the light of oversupply can especially be considered a side-effect of the book-and-claim nature of the GO market. As confirmed in interviews, market makers such as traders usually maintain a certain buffer of GOs as a strategy. There are high changes that in this case in a cost-benefit consideration, GOs close to expiration are in disadvantage for further trade.

It is worth mentioning that a study by r2b energy consulting and Öko-Institut for the German Environmental Agency[17] concludes deviating expiration rates across technologies for Germany, with e.g. the expiration

[15] https://veyt.com/articles/adjusted-2024-cumulative-market-balance-assessment/ (last accessed 23 May 2025)
[16] Note, that the data for 2024 only includes data until and including August 2024.
[17] https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/10_2025_cc.pdf

rate for GOs for biomass-based electricity is overproportioned, while it is underproportioned for hydro GOs. This could give indications to consumer preferences and price sensitivity.

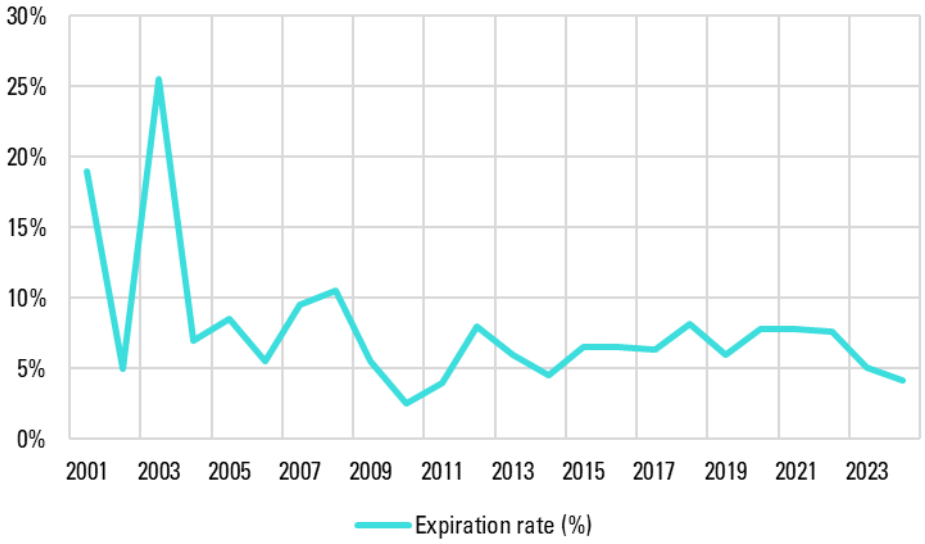


Figure 2-2: Expiration rate of issued GOs

Based on own calculations, AIB statistical dataset 2024, AIB statistical dataset 2021 and Hulshof et al. 2019
*2024 data includes only data until and including August 2024

Issued and cancelled GO volumes

The number of issued and cancelled GOs per year, as shown in Figure 2-3, shows that both the issuances and the cancellations have steadily increased year-on-year from 2015. **In average, the amount of issued GOs has increased by 74 TWh per year**. Here, especially wind GOs have largely added to the volume of issued GOs with an increase of 202 TWh from 2015 to 2023. **Cancellations have increased by 59 TWh per year in average** since 2015. Thus, the overall size of the GO market has been increasing since 2015, as well as the liquidity of the GO market with regard to a critical mass of tradings. Comparing the average annual growth of issued and cancelled GOs however, the higher number for issued GOs added per year contributes to the further increasing oversupply of GOs.

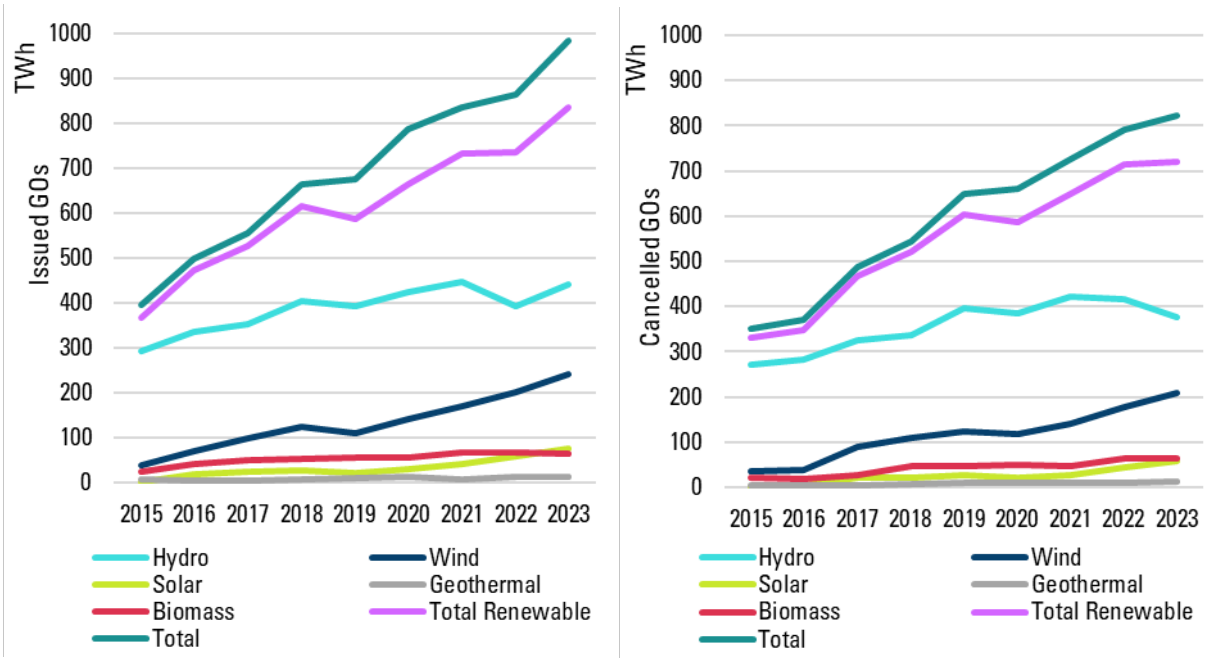


Figure 2-3: Volume of issued and cancelled GOs per year

Based on AIB statistics 2021 and 2024

*Note that the values for 2019 and 2020 show inconsistencies between the two AIB datasets, leading to the apparent drop in issues and cancellations in 2019

Issuance rate

The **issuance rate** (see Figure 2-4) varies across technologies and indicates that serving the market demand of GOs does not require to tap the full theoretical capacity of GO issuance across Europe. While hydro GOs are issued for over 90% of the produced electricity from hydro in 2022 and 2023, the issuance rate for wind GOs rate reached 52% in 2023, and only 32% for solar GOs. The issuance rates of solar and wind increase from year to year are, to some extent, limited because new installations receive subsidies in many countries (and are then restricted from GO issuance), and the administrative burden for small installations such as rooftop PV remains high, preventing them from participating in the GO market.[18]

[18] https://recs.org/download/?file=go-monitoring-2018-report.pdf&file_type=documents

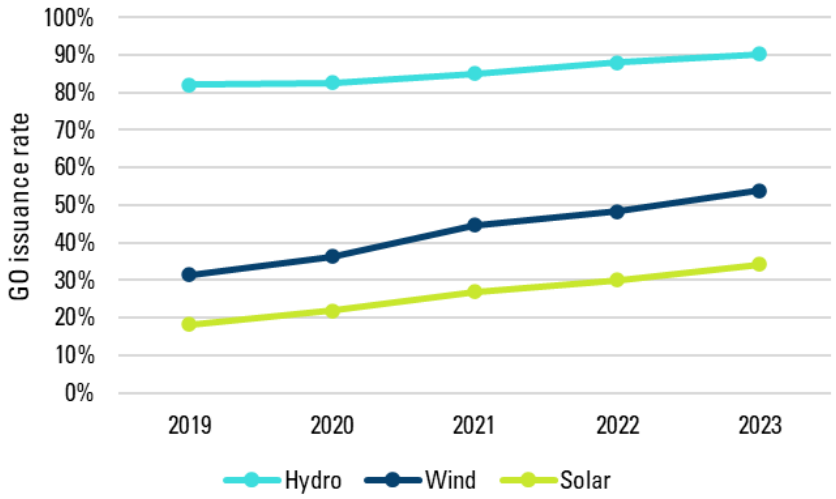


Figure 2-4: Issuance rate compared to technology-specific net electricity production in the EU, Norway and Iceland for hydro, wind and solar GOs issued by AIB countries

Based on own calculations, AIB statistics 2024 (production-based data), Eurostat

BOX 1: Market participation - Norway is the main GO exporter, while Germany is the main GO importer

Below the Import-Export balance is shown for the various AIB members. It becomes apparent that Germany is by far the biggest import market of GOs, followed by the Netherlands and Ireland. On the export side, Norway dominates followed by Sweden.

Several developments are observable: while Germany imports more and more GOs (~ +15 TWh/a) the Netherlands import less and less GOs (~ –5 TWh/a), Italy has changed from being an exporter to being an importer in the last two years, and countries such as Norway and Sweden showed a dip in exports particularly in the year 2021.

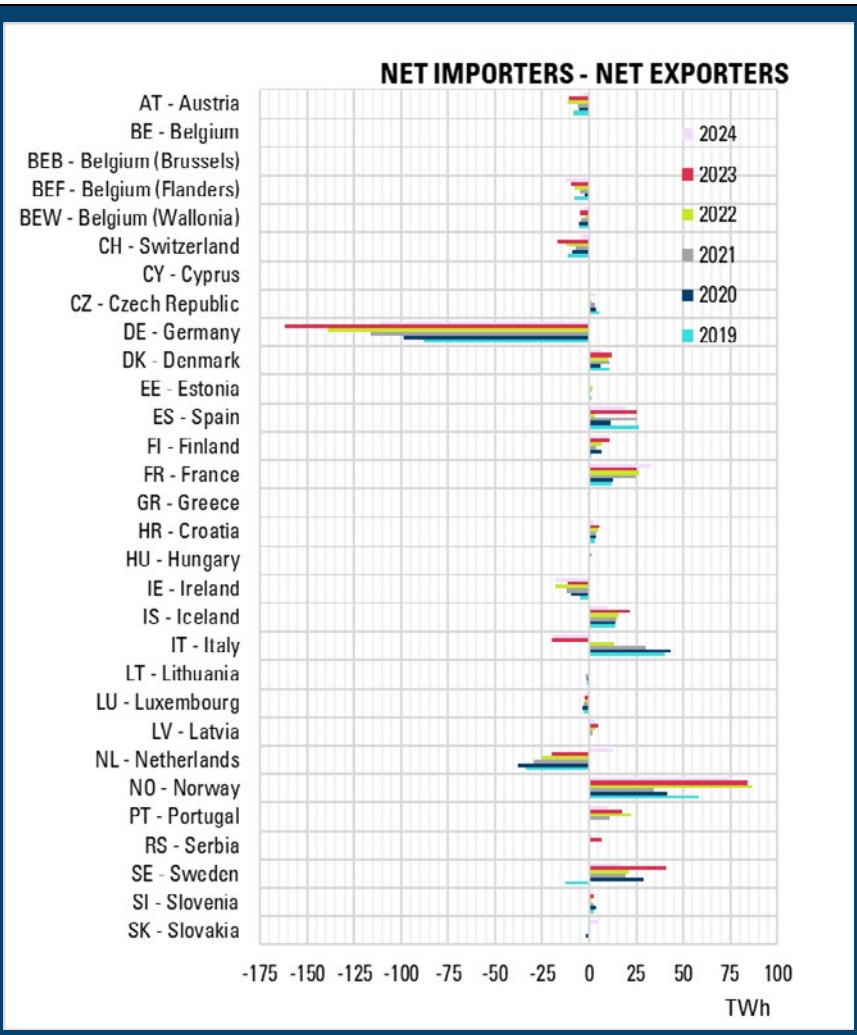


Figure 2-5: Net importers and net-exporters of GOs in the AIB region

Note that "exports" and "imports" refer to the transfer of GOs to/from the domain of another AIB country. Ex-domain cancellations are not reflected in these values.

Based on AIB statistics 2024

In Germany, the double marketing ban ("Doppelvermarktungsverbot") applies, leading to the circumstance that GOs cannot be issued for supported renewable electricity. Thus, with the overall trend to GHG reduction efforts across all sectors, Germany (together with Ireland where similar provisions apply) is the biggest importer per GDP (~28 TWh_{GOs}/ $1000_{billion\ USD}$). The large numbers in Ireland are likely associated with the European headquarters of the very large renewable PPA signatories (incl. e.g. Google, Amazon and others). The Dutch trend may be explained with increasing availability of regional wind energy, the statistical dips for Norway and Sweden are correlated with Brexit excluded from mutual recognition in 2021. The case of Italy can be explained by a combination of a scandal around wrongly issued GOs for synthesis gas-based electricity[19] and a temporary measure on export restrictions as a consequence. Furthermore, reduced hydro generation required Italy to replace a relevant share of GOs from suppliers outside the country. As a consequence, the market in 2023 was still out of balance and e.g. auctions scheduled were not successful (noting also the overall price rally). It is worth

[19] https://www.aib-net.org/newsletter/web.html?n2g=exu6l9s3-oqa67a1v-l57

mentioning that while the data for 2024 are only including the months until August, France already exceeds its previous exports, potentially connected to the fact that since mid-2023 France allows to issue GOs for nuclear energy[20]. Finally, despite the export restriction temporarily applying to Icelandic GOs in 2023[21], the exports in that year in fact exceeded the previous years' average.

Conclusion on the liquidity of the GO market and summary of identified imbalances

To evaluate the liquidity of the GO market, and thus answer the question whether a critical mass of participants and trading is reached, the following can be concluded:

The GO market is generally **liquid with regard to GOs available** on the market (see market length) and has **continuously grown in size, both on supply and demand side**. While for almost all of the electricity generated from hydro GOs are issued (90%), issuance rates for solar and wind GOs are restricted for administrative reasons in the case of small-scale installations, and for legislative reasons as newer installations are often subsidised and thus non-eligible for GO issuance in some countries[22].

However, the GO market shows a structural imbalance towards supply ('**oversupply**'). Current developments on the volumes of GOs issued and cancelled indicate that the oversupply will rather remain and may even further increase. Moreover, as the issuance rates for solar and wind GOs are growing and may have not yet reached the "maximum output of GOs per year", the effect of renewables build-out adding to oversupply is multiplied.

Table 2-3: Summary table liquidity dimension

#	Imbalance identified (qualitative description)	Quantification (if possible)	Associated indicator(s)	Potential influencing factor	Severity
1	**Structural oversupply of the GO market**	Volumes issued exceeding cancellations by ~ 100 TWh per year	Market length and expiration rate	Factors impacting supply and demand, e.g. RES build-out	**High** Oversupply implies that on the demand side, a critical mass is not reached
2	**Supply volumes grow faster than demand volumes**	Average annual growth: issued GOs: 74 TWh/a cancelled GOs: 59 TWh/a	Issued and cancelled GO volumes	Build-out of RES, demand-side regulations	**High**
3	**Issuance rates differ widely across technologies**	Hydro: 90% (2023) Wind: 54% (2023) Solar: 34% (2023) (GO issuance in AIB countries vs. net electricity production in EU/EEA)	Issuance rate	Eligibility of GO issuance for supported electricity, administrative burdens for small-scale installations	**Low**

[20] https://veyt.com/articles/nuclear-fallout-first-french-atomic-gos-are-on-the-market/
[21] https://www.landsvirkjun.com/news/aib-lifts-ban
[22] Further information on the different handling of GOs for supported electricity is provided in section 2.2.2.

2.2.2. Harmonisation

The GO market is expected to be homogenous throughout the EEA to facilitate GO trading across borders and thus align with the internal market rules of the European Union. Moreover, it may reduce efficiency if no harmonisation is reached.

While the RED II itself allows relatively wide freedom on the national transpositions of the GO market, the book-and-claim system clearly supports an EU-wide market instrument. Harmonisation plays a crucial role to facilitate GO (cross-border) trading. Furthermore, understanding the GO instrument is dependent on harmonisation and associated simplifications , which may enhance trust in the overall system. Under the assumption that consumer choice is guided by trust in the GO system, harmonisation is a fundamental prerequisite for effectiveness of the GO system overall.

The harmonisation of the GO market is assessed using the following indicators:

1. GO market access: Countries with access to EU/EEA-wide GO market, number of AIB members, countries with access to Energy-Community GO market and countries with national schemes;
2. Operational harmonisation with regard to handling of supported electricity per AIB country;
3. Harmonisation of registries: Cancellation restrictions and implementation of expiry rules per AIB country

The Association of Issuing Bodies (AIB) has been established in 2002 to facilitate the standardised issuance, transfer and cancellation of GOs across Europe. It operates the European Energy Certificate System (EECS)[23], which harmonises GO procedures and prevents double-counting of renewable energy claims. Furthermore, the AIB serves as a central hub for transferring GOs between national registries, ensuring a streamlined and consistent approach to GO management across different European countries[24]. This standardisation is considered instrumental in fostering trust and efficiency in the international trade of GOs.

Access to the GO market across Europe

Pursuant to Article 19(9) of RED II, "*Member States shall recognise guarantees of origin issued by other Member States in accordance with this Directive*". RED II is an EEA-relevant act pursuant to the EEA Agreement and therefore binding for EU Member States and EEA EFTA States, except for Liechtenstein for which the Directive does not apply. Thus, by legislation, the GO market is defined to be an EU/EEA-wide market.

Article 19(9) further states "*A Member State may refuse to recognise a guarantee of origin only where it has well-founded doubts about its accuracy, reliability or veracity. The Member State shall notify the Commission of such a refusal and its justification."* And Art. 19(10) provides that *"If the Commission finds that a refusal to recognise a guarantee of origin is unfounded, the Commission may adopt a decision requiring the Member State in question to recognise it."* For the time being, some import restrictions apply or have recently been applied: Flanders (Belgium) is currently not allowing imports of GOs issued in

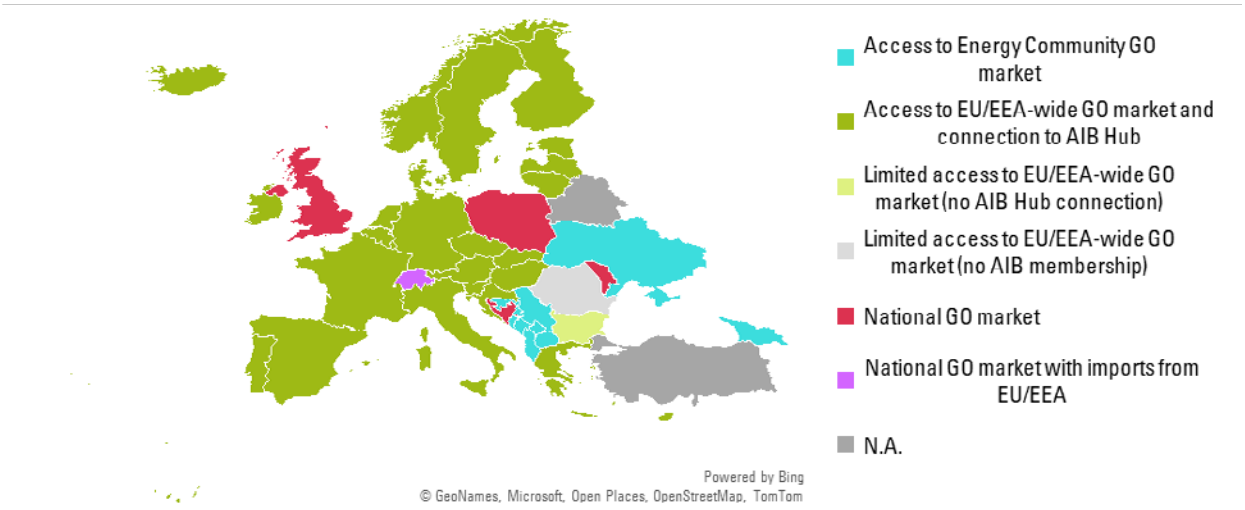
[23] https://www.aib-net.org/eecs
[24] https://www.aib-net.org/facts/eecs-registries

Sweden[25] and Germany has had a ban on Icelandic GOs in 2023[26]. Despite Poland being an EU Member State, it only operates a national GO system.

According to Art. 19 Par. 11 of the RED II, for the recognition of GOs from a non-EU country, an agreement between the EU and the third country must be in place. As such, Swiss GOs and UK REGOs have been excluded from mutual recognition in 2021. While Switzerland continues to import GOs from the EU, GOs are no longer eligible for disclosure purposes in the UK since 2024.[27]

During the Energy Community Ministerial Council of 14 December 2023, the European Commission presented the Roadmap for the Recognition of guarantees of origin issued by Contracting Parties of the Energy Community in the EU[28]. One criterion is the functioning of the Energy Community's regional system for guarantees of origin[29]. An initiative to establish a regional system for GOs in the Energy Community has been launched in 2022. The initiative aims at developing national registries for the contracting parties in line with EU rules with the service provider Grexel ,and to facilitate GO trading among the contracting parties of the Energy Community and to prepare for the connection to the AIB Hub[30]. As of today, Albania, Georgia, Kosovo*, Montenegro, North Macedonia, Republika Srpska and Ukraine are part of the regional GO market of the Energy Community.

The AIB currently counts 31 members countries, of which four are currently applying to join the Electricity Scheme Group leading to a connection to the AIB Hub31. Although the AIB membership facilitates the access to a larger GO market, the requirement of mutual recognition for third countries limits the access to a European market for some countries. A map indicating the access to cross-border GO markets is provided in Figure 2-6 and Table 2-4. Overall, 25 countries have access to the EU/EEA-wide GO market, 8 countries are part of the Energy Community GO market and 9 countries have national GO market only.



[25] https://www.aib-net.org/facts/market-information/imposed-conditions-trade-expiry-and-cancellation
[26] https://www.umweltbundesamt.de/dokument/import-islaendischer-herkunftsnachweise-ab-sofort
[27] https://recs.org/news/swiss-and-uk-gos-no-longer-eligible-for-export-to-the-eu/
[28] https://www.energy-community.org/dam/jcr:d751247a-69d0-4f7c-abbd-006d789b5314/Conclusions%20of%20the%2021st%20Ministerial%20Council%20meeting.pdf
[29] https://balkangreenenergynews.com/eu-readies-criteria-for-recognizing-energy-communitys-guarantees-of-origin/
[30] https://www.energy-community.org/news/Energy-Community-News/2023/06/06.html
[31] https://www.aib-net.org/facts/aib-member-countries-regions

Figure 2-6: Overview AIB Members and national schemes for electricity GOs

Based on Domain protocols, RED II provisions, Energy Community Secretary initiative

Three EU Member States (Malta, Poland and Romania) are not yet members of the AIB and are not connected to the AIB Hub, and thus their access the EU/EEA-wide GO market is restricted from an administrative perspective. Among the Energy Community contracting parties, Serbia is already connected to the AIB Hub, but the pending formal mutual recognition of GOs with the EU restricts Serbia's access to the EU/EEA-wide GO market.

Table 2-4: AIB membership status of European countries

	Full AIB member	Applicant of Electricity Scheme Group	Active observer	Country to observe[32]	Connection to regional Energy Community GO market
EU Member State	23	1 (Bulgaria)	0	3 (Malta, Poland, Romania)	0
EEA country	2 (Norway, Iceland)	0	0	1	0
Contracting party of the Energy Community	1 (Serbia)	3 (Albania, Montenegro, Ukraine)	2 (Georgia, Bosnia and Herzegovina)	3 (Kosovo*, Moldova, North Macedonia)	8
Other	1 (Switzerland)	0	0	0	0

Based on AIB website[33]

Table 2-5: Number of countries with access to EU/EEA-wide GO market and Energy Community market respectively and number of countries with national market only

	Access to EU/EEA-market	Access to Energy Community market	National market only
Number of countries	25	8	9

Own analysis based on AIB website, RED II provisions, Energy Community initiative

Handling of supported electricity

Despite the great harmonisation efforts by the AIB, various differences between AIB member states remain, particularly on issuance and export restrictions. These restrictions arise from the different handling of GOs for subsidised electricity, see Table 2-6. Due to regulatory and market considerations, in some AIB countries, GOs for supported electricity are not issued, treated as national GOs or are auctioned. When

[32] Terminology as used in AIB source

[33] https://www.aib-net.org/facts/aib-member-countries-regions/aib-members

electricity production is subsidised through public mechanisms, issuing GOs may lead to double compensation, as producers already benefit from subsidies. To prevent this, some countries opt not to issue GOs for subsidised energy or auction them instead, ensuring transparency and fair pricing while avoiding excess financial support in alignment with Article 19(2) of RED II

Table 2-6: Overview of handling of GOs for subsidised electricity in AIB member states

Category	Number of countries	Countries
No issuance of GOs for subsidised electricity	4	Germany, Lithuania, Ireland, Serbia
Subsidised GOs are auctioned	8	Croatia, France, Greece, Hungary, Italy, Luxembourg, Portugal, Slovakia
Subsidised GOs are traded only nationally	2	Austria, Spain
Subsidised GOs are immediately cancelled	2	Bulgaria
Subsidised GOs are earmarked	3	Estonia, Switzerland
No subsidy system in place	1	Iceland
GOs are issued for subsidised electricity	9	Albania, Belgium, Cyprus, Czech Republic, Denmark, Finland, Latvia, Netherlands, Norway, Slovenia, Sweden

Based on AIB domain protocols

Subsidized electricity generation is regulated in several AIB countries, mostly by restriction on issuance and thus market access for producers. Export restrictions, i.e. a national GO system for supported GOs, apply in Spain and Austria, and in Bulgaria supported GOs are immediately cancelled. Some countries regulate via auctions of subsidised GOs, whereas subsidised electricity is strictly excluded for GO issuance in Germany, Lithuania, Ireland and Serbia, reducing liquidity.

Operational harmonisation of registries

Connection to the AIB Hub and eligibility to issue and export EECS GOs requires an application process for Scheme membership of the EECS Electricity or Gas Scheme. Fundamental prerequisite for the successful evaluation of such an application is a Domain Protocol specifying the operation of the market in the respective geographical area. As of today, there are 33 Hub connections for electricity and gas EECS.[34]

Different positions and understandings on use of the GO instrument are reflected in the domain protocols and in the underlying transposition of RED II into the national legislations. There is the understanding of GOs as a certification instrument to meet certain criteria on the one hand and to simply serve as a tracking instrument of information required for accounting on the other hand. The EECS is designed such that it aligns with Art. 19 of the RED II as well as with the mandatory standard EN16325 while accounting for national circumstances to allow for an efficient and reliable GO system.[35]

[34] https://www.aib-net.org/facts/eecs-registries
[35] https://www.aib-net.org/eecs

Although the EECS rules provide clear guidance on the required registry infrastructure, the different understanding of the purpose of GOs is reflected in the operation of the national registries. Particularly, there are large differences as to who is eligible to cancel GOs which has implications on the usability and on the traceability of the purpose of GO cancellations.

Table 2-7: Overview of cancellation restrictions for AIB countries

Cancellation of GOs by…	Amount	Countries
Electricity supplier only	7	Germany, Ireland, Italy, Greece, Austria, Belgium (Wallonia), Belgium (Brussels)
Electricity producer and supplier	4	Spain, Cyprus, Belgium (Flanders), Serbia
Electricity producer, supplier and other economic operators[36] (trader)	8	Croatia, Iceland, Switzerland, Czech Republic, Slovakia, Slovenia, France, Netherlands
Account holder of registry without explicit restrictions excluding end consumers	8	Belgium, Denmark, Hungary, Norway, Finland, Sweden, Estonia, Luxembourg
Account holder of registry without explicit restrictions excluding end consumers including end consumers	3	Portugal, Lithuania, Latvia

Based on AIB Member Survey of imposed conditions 2024, UBA 2023

Furthermore, there are discrepancies in how the GO expiry rule is applied. Article 19(3) of the revised RED II provides that GOs shall have a validity of 12 months and shall expire at latest 18 months after the production of the energy unit. According to most national RED II transpositions, GOs expire after 12 months after the end of the production month. However, some countries including **Ireland, Italy, Lithuania and Portugal allow for GOs to expire only after 18 months after the date of production** with a validity of these GOs for trade for 12 months. While GOs expire after 12 months in France, stricter temporal matching rules for cancellations apply: in accordance with Article R311-64 of the French Energy Code, GOs must be cancelled for disclosure for the same month as the production month.[37] From the non-strict implementation of a harmonised expiration rule in an already oversupplied market, this practice of "vintage swapping" can have a large impact on prices ("dumping").

Across the results, 19 of 49 stakeholders confirmed in a survey conducted with GO market participants that they face barriers to access the GO market. As presented in Figure 2-7, the main barriers mentioned include lack of harmonisation with regards to legislative implementation of the GO system, technical, operational and regulatory issues to access registries, market barriers and lack of transparency. Particularly, the technical implementation of registries requires significant administrative efforts for market participants active in more than one MS and can lead to general frustration with the GO system.

[36] By registering for a trader account, firms can directly cancel GOs in France and in the Netherlands
[37] See French Domain Protocols, to be found here: https://www.aib-net.org/facts/aib-member-countries-regions/domain-protocols

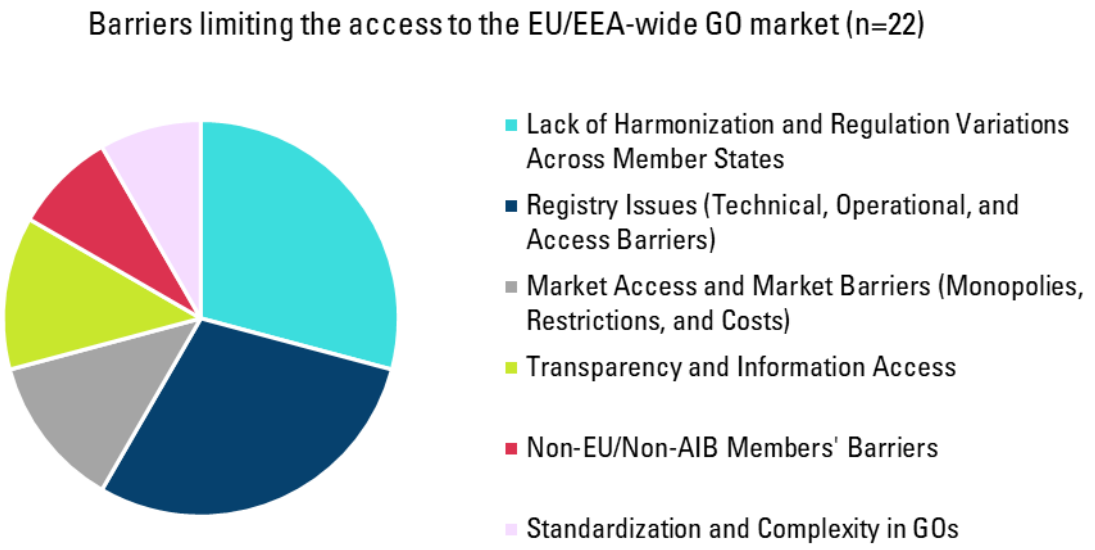


Figure 2-7: Survey result on barriers limiting stakeholders' access to the EU/EEA-wide GO market

Based on survey

BOX 2: State of harmonised application of the market-based instrument in legislation – or "why it is not that simple"

The GO-system was created as voluntary system in Article 19 of the RED II (Article 15 of RED). Due to it being referenced in other pieces of legislation, the GO system has become an important and widely accepted approach for tracking of renewable energy. Yet, the voluntary nature of the GO system does not allow to impose traceability via the GO system directly (as this would abolish the voluntary nature of the instrument) and is hence usually more generally referenced as **market-based approach** for tracking. In order to avoid double-counting, the GO-system ideally is as comprehensive as possible (recognised e.g. in the revised RED II[38]). The larger the boundaries are set across nations, the higher is the risk for variations in implementation and loop-holes. Since Europe is comparatively homogenous, however, the GO system in fact works well within European boundaries and as long as considered a closed system (in a sense that GOs are not used outside of countries in principle acknowledging important pieces of legislation such as RED II).

International reporting standards such as the GHG protocol allow reporting of GHG emissions via market-based approaches. This causes confusion among stakeholders about the differences between renewable energy and carbon footprint and how the two can be tracked with systems such as GOs. It must be emphasized that renewable electricity is defined as zero emissions, which is why the simple information on origin can be used by corporations as evidence of their carbon footprints. Yet, the GO instrument is not to be confused with appropriate full life-cycle carbon accounting methods. The most important umbrella standard is ISO 14044 on LCAs, in principle only requiring stakeholders to report footprints on the basis of scientific and argumentatively sound criteria. More specific contexts (or

[38] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02018L2001-20240716

"products"), e.g. the methodology defined for RFNBOs[39][40], do require PPAs to proof renewable electricity procurement, these PPAs in turn require GOs, because the GO certificate itself contains the respective information. Other "products" may or may NOT be suited to apply the same methodology; i.e., the Regulation (EU) 2023/1542 "New Battery regulation"[41] as well as the CBAM, somewhat acknowledge[42] to be mainly applicable for products coming from outside Europe and hence production sites might lack a coherent and trusted GO-system and hence prefer the application of locational grid information.

Much of the confusion and associated mistrust of the GO system appeared since some energy consumers in countries with very large renewable energy production prefer location-based reporting (between 2020 and 2022 72-87% of Norwegian companies reporting to the CDP have chosen location-based reporting, and 29-37% of companies in Germany[43]), arguing that physical energy delivery and renewability need to remain interconnected. While the GHG Scope 2 guidelines require dual reporting[44], note that a limited number of companies report using both accounting methods[45]. Thus, the primary communication by companies focuses on the most advantageous approach. While this may seem coherent from a single-actor perspective (e.g. Norwegian companies), it creates much of the confusion in the market and potentially leads to an overall distorted perception of renewability shares for consumers.In contrast, other energy consumers in the European market see the need to have market-based reporting as default, on the one hand considering the fact the double-counting can only be avoided if the GO-system is as comprehensive as possible but also arguing that GOs may guide a more efficient systemic build-out of renewables.

Hence the GO system is not referenced to in all potential European legislations, but due to its voluntary nature as instrument among others and GHG footprint methodologies requiring product specific considerations it may not necessarily be the most appropriate approach in all cases. Further discussions are presented in chapter 2.5.

Conclusion on the harmonisation of the GO market and summary of identified imbalances

Overall, the Association of Issuing Bodies (AIB) has largely contributed to the harmonisation of the GO market by defining the EECS standard and implementing the AIB Hub connecting national registries. As a result, it fosters the internal market rules of the EU and enhances the completeness of the GO system by providing access to a larger European market. General restrictions on the access to a larger European GO market arise from the RED II provisions of the required mutual recognition of GOs from third countries.

With the intention to allow for adaptation to varying circumstances, AIB's standards are widely defined, which however may indirectly cause unwanted effects such as "dumping" of GOs. As pointed out by stakeholders, the major limitations arise from administrative issues associated with different implementation of registries (mainly technical and operational barriers, such as varying IT interfaces etc.).

[39] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023R1184&qid=1704969010792
[40] Notice that the primary evidence of renewability attributes of the electricity used for RFNBO production is defined to be PPAs. However, GOs are required in addition to avoid double counting according to
[41] https://eur-lex.europa.eu/eli/reg/2023/1542/oj
[42] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=PI_COM:Ares(2024)3131389
[43] https://onlinelibrary.wiley.com/doi/epdf/10.1111/jiec.13553
[44] https://ghgprotocol.org/sites/default/files/2023-03/Scope%202%20Guidance.pdf
[45] https://cdn.cdp.net/cdp-production/cms/reports/documents/000/007/967/original/CDP_Energy_Report_2024_.pdf?1731582839

While the GO system is especially dependent on completeness to avoid double-counting of renewable electricity consumption, the varying understanding of the purpose of GOs creates issues in GHG reporting (location-based vs. market-based reporting). This diminishes the general trust in the system and limits its effectiveness.

Table 2-8: Summary table for harmonisation dimension

#	Imbalance identified (qualitative description)	Quantification (if possible)	Associated indicator(s)	Potential influencing factor	Severity
1	**Market access limited for some EU/EEA Member States and for other European countries**	31 AIB countries, 9with national systems	Access to the GO market	AIB membership; RED II provisions; Agreements with the EU Commission	**Medium**
2	**Strictness of 12-month expiry rule**	Ireland, Italy, Lithuania and Portugal allowing for expiration after 18 months	Operational harmonisation of registries	National legislation	**Medium**
3	**National registries provide technical, operational and access barriers**	N.A.	Operational harmonisation of registries	National registries, IT infrastructure, AIB Hub connection	**Medium**

2.2.3. Stability

Closely related to the liquidity is the stability of the market. Stability in the GO market is reached if it is considered a reliable and predictable instrument. Stability is especially reflected in stable GO prices. As long as factors influencing the market are known, while general market conditions such as liquidity are maintained over long times, associated risks can appropriately be hedged. Therefore, stability is a prerequisite for strategic decisions and thus effectiveness.

The analysis on liquidity shows that the supply of GOs is continuously growing. On the demand side, GOs, legitimated by RED II provisions, serve as the recognised tracking instrument to fulfil reporting obligations which in turn led to steady increases of demand. The most relevant dimension to describe stability of the GO market is the stability of the GO price. The stability of the GO market is thus analysed using the indicator "Volatility in monthly GO spot prices compared to the running 12-month average GO spot price". This indicator estimates the absolute and relative running 12-month standard deviation of monthly GO prices.

As visible in Figure 2-8, the GO spot price has shown a large sudden price increase from the beginning in 2022. Correspondingly, the rolling 12-month standard deviation peaked at 2.42 €/MWh in the period of Jan 2022- Jan 2023, corresponding to a relative standard deviation from the annual price average of up to 59% (see Figure 2-9). For the period of Sep 2022 to Sep 2023, where the price increases, fluctuates around the

price peak and then again decreases, the monthly standard deviation falls to 0.81 €/MWh corresponding to a volatility of 12%.

For the rolling 12-month periods from July 2020 to Dec 2021, the standard deviation of monthly average GO prices lied below 0.22 /MWh (Dec 2021). In comparison to the rolling 12-month average GO price, the volatility lied between 20% and 56%. For the period of Feb 2021 to Feb 2022, the volatility peaks at 72%, caused by the price jump of ~1 €/MWh from Dec 2021 to January 2022.

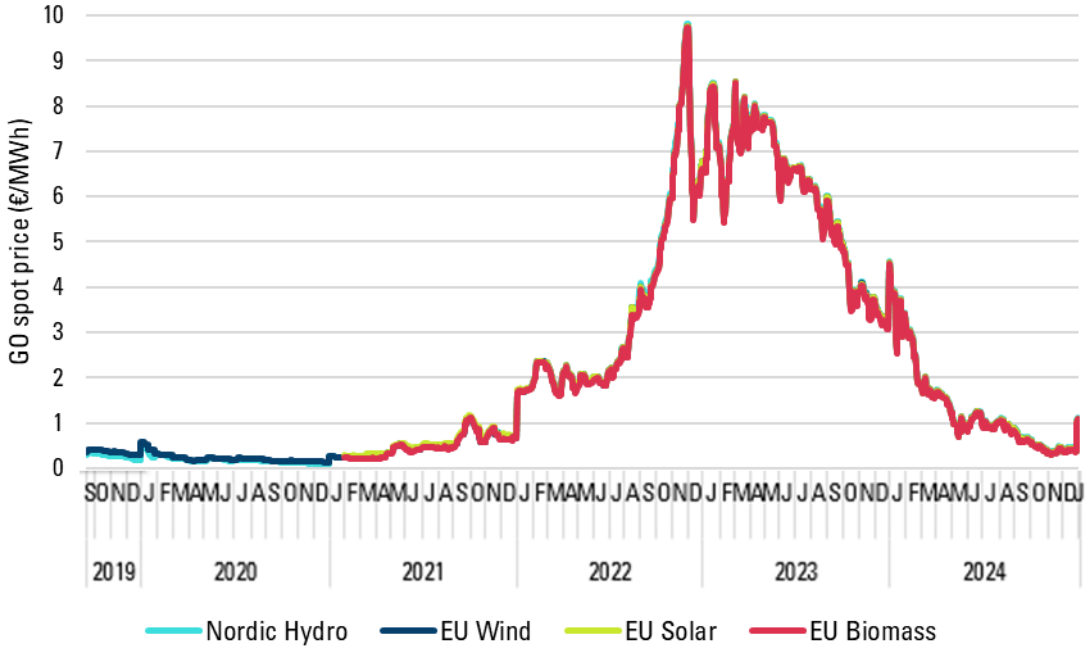


Figure 2-8: Daily GO spot price per technology

Based on S&P Platts

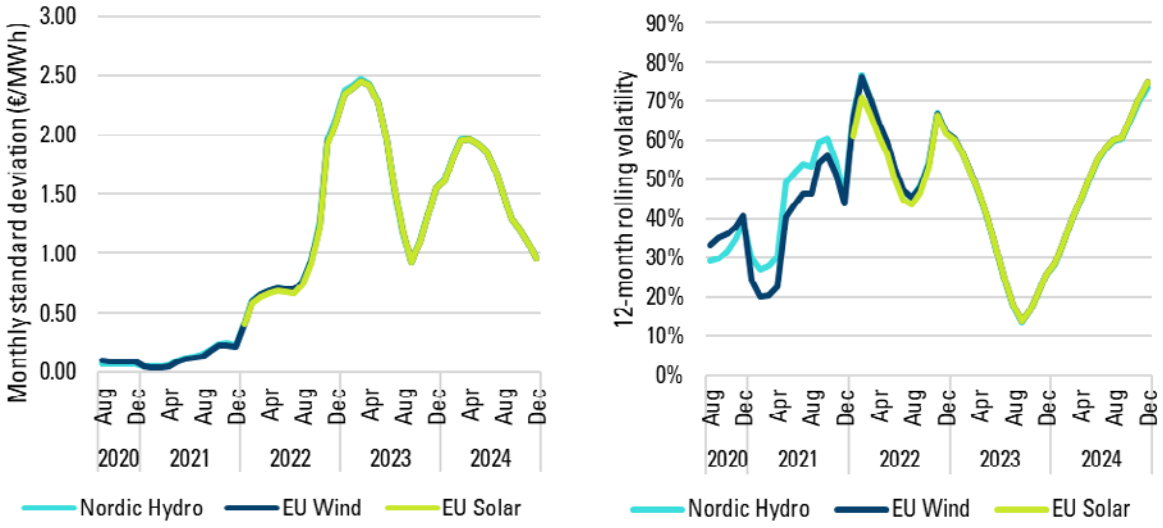


Figure 2-9: Absolute and relative 12-month rolling standard deviation of monthly average GO spot prices per technology

Based on own calculations and S&P Platts

Hulshof et al. (2019) concluded that already before 2019, the volatility of monthly average GO prices are high (see Table 2-9). The relative standard deviation for EU solar lied between 10 % in 2016 and 78 % in 2017 (annual averages). EU wind price fluctuations compared to the annual average spot price peaked at even 198 % in 2014. Nordic Hydro GO spot prices were more stable with relative fluctuations below 35 % between 2012 and 2017.

Table 2-9: Volatility in monthly spot prices (historic) (annual averages), 2011-2017

Country	Technology	2011	2012	2013	2014	2015	2016	2017
Nordic	Hydro	66.6%	13.4%	31.2%	22.2%	19.0%	34.5%	14.3%
Belgium	Biomass							63.9%
	Solar							84.8%
	Wind							105.6%
EU (unspecified)	Biomass		22.2%		54.4%	8.9%	41.7%	33.3%
	Hydro					33.6%	40.7%	34.4%
	Solar					23.1%	10.4%	78.1%
	Wind	16.0%	69.0%	32.6%	198.0%	54.7%	30.0%	34.3%
Italy	Hydro					15.7%	47.9%	59.8%
Netherlands	Biomass							30.9%
	Wind							3.4%
Switzerland	Hydro							28.1%

Based on Hulshof et al. 2019

Despite the relatively high volatility of GO prices, the GO market in general allows to build a business model around it, as can be concluded from a survey conducted with relevant stakeholders and was confirmed in interviews. This is valid across stakeholder groups[46]. Stakeholder feedback via a survey indicates that the GO market was perceived slightly more stable in the past (mean of 5.4 in a rating of 1 (unstable) to 10 (stable)) compared to today (mean of 5.2). Thus, especially the price peaks in Q4 of 2022 and Q1 of 2023 seem to have induced some uncertainties among stakeholders.

GOs accounted for less than 0.5% of the electricity price before 2022, and peaked at about 3 to 4% during the price peaks (see also BOX 4). Thus, although the volatility of the isolated GO prices can be high, the impact on overall energy contracts remains small.

[46] "Yes"-responses according to the survey conducted in this study: 6 of 8 traders; 6 of 9 electricity producers; 2 of 3 electricity suppliers; 5 of 5 issuing bodies; 4 of 4 market platform or technical enablers

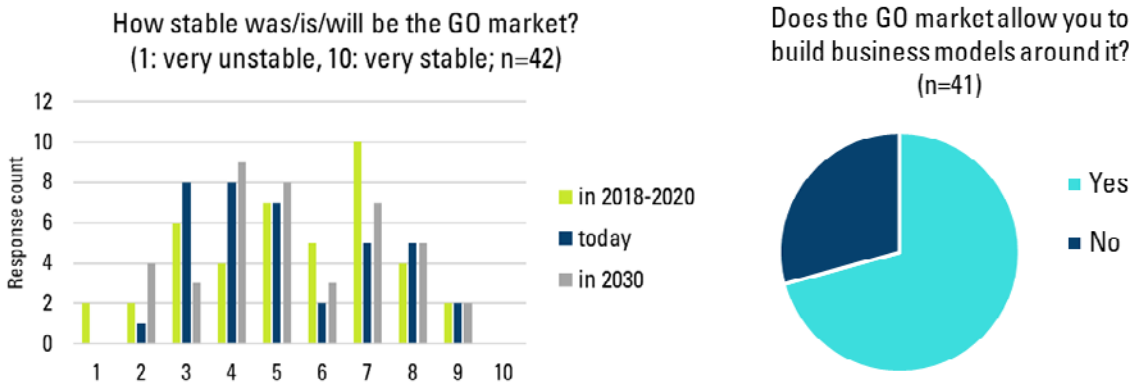


Figure 2-10: Stakeholders' rating of GO market stability and consideration of the GO market for business models
Based on a survey

The price levels and the respective stability of the GO price is tied to the long-term balance of supply and demand of GOs as analysed in more detail in section 2.3.1. This effect arises from the low elasticity of the demand: GOs are the trusted instrument to disclose the use of electricity from renewable sources and are thus a crucial part of green tariffs, PPAs and corporate strategies. Furthermore, GOs are bundled in renewable PPAs[47] required in compliance markets (RFNBO market) or serve as evidence in state aid schemes. Thus, in times of oversupply, when GOs are abundantly available, the value of GOs can be close to zero, whereas if the GO market was undersupplied or expected to be undersupplied – even by a small amount – the value of GOs can increase immensely (see also chapter 2.3 on responsiveness and the example of UK in BOX 3).

Conclusion on the stability of the GO market and summary of identified imbalances

To some extent, the GO market has shown a high volatility of monthly GO prices, especially during the 2022/2023 price peaks. Despite overall low prices for GOs, the market allows for various stakeholder groups to build business models. For example, traders are active and trust the market to further grow, but also the growing issuing rates confirm that costs vs. returns are sufficient for stable participation. However, stakeholder feedback also confirmed that the price peak in 2022/2023 did induce some uncertainty.

Table 2-10: Summary table for Stability dimension.

#	Imbalance identified (qualitative description)	Quantification (if possible)	Associated indicator(s)	Potential influencing factor	Severity
1	**High volatility of GO prices**	Standard deviation of monthly GO price average up to 2.42 €/MWh (Jan 2023) and up to 72% (Feb 2022) in relative terms	Volatility of monthly average GO price Stakeholder feedback on perception of stability of GO market and consideration of	Supply and demand balance (Oversupply); low demand elasticity; Price response to external factors	**Low** Despite high volatility, overall, the market is considered stable enough to build

[47] For the purpose of avoiding double-counting of renewability attributes

	GO price for business models	business models around it

2.2.4. Transparency

To enable appropriate price discovery, markets should reach a sufficient level of transparency on the influencing factors, and transparency is a prerequisite for market participants to reach informed decisions and adjust procurement strategies.

The GO market is considered transparent if all relevant information is available to all stakeholders involved. To assess the GO market transparency the indicators

4. access to information, and

1. its reliability across different relevant information categories

were assessed qualitatively. A summary of the analysis for information related to the participation to the GO market is provided in Table 2-11 and a detailed explanation in the subsections below. Thirdly, stakeholder feedback has been collected regarding their dependence on third parties.

Table 2-11: Availability and reliability of information relevant to participate on the GO market

Category	Accessibility to information	Reliability of available information
Market Participants	Lists of account holders available in 20 out of 30 AIB domains but sometimes limited to specific stakeholder groups.	Information provided through official channels
GO Market Prices	Most platforms tracking current and past GO market prices are behind paywalls. Auction ask prices are published only a few days before auctions; No price index available	Auction price levels generally align with private market data, but the market exhibits characteristics of monopolistic competition with differentiated products.
Price Formation	Bilateral trades and the lack of clear price indications in energy procurement contracts	Historical price trends appear arbitrary, and external factors such as supply-demand volatility and varying GO attributes add further unpredictability
Traded GO Volumes, Issuance and Cancellation	AIB statistics on past GO volumes are publicly available with high granularity from 2001; reduced transparency on currently traded GO volumes	Information provided directly by issuing bodies, with minor deviations noted and explained transparently.
Product Attributes	GOs provide detailed information on the underlying product as required by RED II and further standards.	Information must be verified by issuing bodies and is subject to audits, ensuring high quality.
Regulatory Framework	National frameworks for market operations in the AIB region are publicly available through domain protocols.	Information comes from official sources, ensuring all participants understand the rules governing the market.

Market participants

With the GO market functioning on a book-and-claim basis, GOs can be traded over the counter, on exchange platforms, through brokers or during auctions allowing for trading interactions between different stakeholder groups. Transparency on market participants is essential as it fosters trust and credibility in

the GO system and helps to understand market dynamics which can reduce uncertainty in trading and support fair pricing.

Although tradings proceed via national registries, only in 20 of 30 AIB domains a list of account holders is made publicly available[48], and sometimes limited to specific stakeholder groups, e.g. suppliers only. It should further be noted that not all stakeholder groups are eligible to become an account holder or to cancel GOs (see also section 2.2.2on harmonisation). Thus, overall, information on market participants is partially transparent as well as the reliability and completeness of the information.

GO market prices

It is crucial for market players to have information on current GO prices. Although, there are platforms available, tracking current and past GO market prices, they are usually only accessible through a paywall. For GO auctions, ask prices are usually published a few days to about two weeks prior to the auctions. A GO price index or similar is not available.

Comparing the weighted average auction prices with privately available price data, the levels of EU GO market prices and resulting auction prices in general align. The average standard deviation between the auction prices is 0.33 €/MWh. However, the GO market exhibits characteristics of **monopolistic competition**, where numerous producers offer differentiated products (e.g., GOs tied to specific countries, technologies) that are not perfect substitutes depending on consumer preferences. While GOs are functionally homogeneous in tracking renewable energy, differentiation arises from consumer preferences for attributes like "local" production or wind/solar origins, enabling producers, suppliers and traders to profit from a higher willingness-to-pay. For example, Dutch wind GOs were traded at five-fold the current GO price in 2021 enabled by the strong regional demand.[49] However, demand remains price-sensitive, as buyers can seek cheaper alternatives for basic disclosure needs.[50]

[48] https://www.aib-net.org/facts/market-information/imposed-conditions-trade-expiry-and-cancellation
[49] https://resource-platform.eu/wp-content/uploads/Guarantees-of-Origin-and-Corporate-Procurement-Options.pdf
[50] Wimmers & Madlener 2023: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4446634

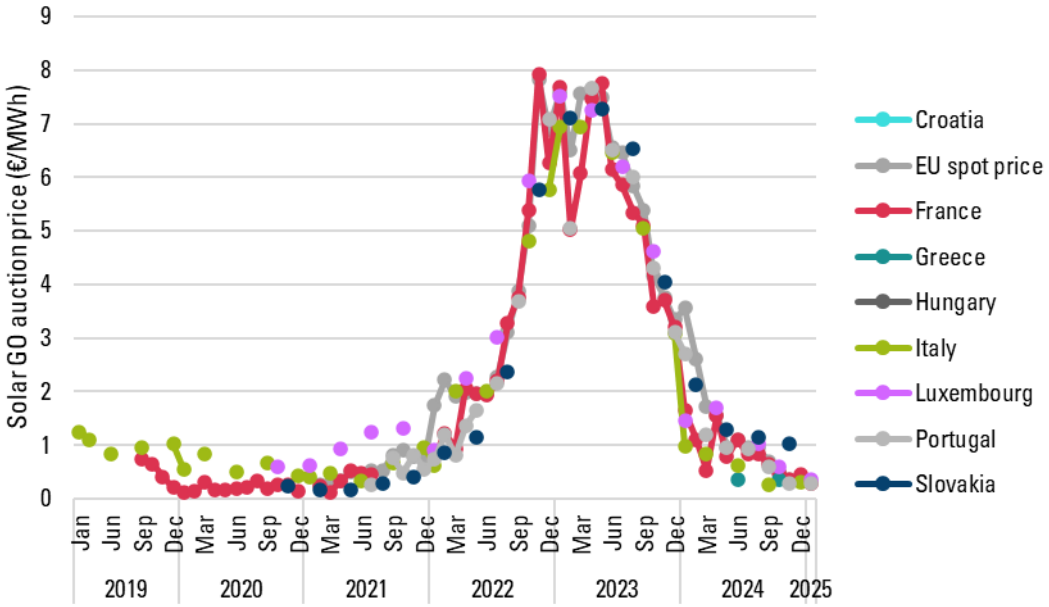


Figure 2-11: Auction results for solar GOs across Europe

Based on auction websites[51] and S&P Platts

Price formation

As GO prices usually are not specifically indicated for bundled GOs in respective energy procurement contracts, and overall bilateral trades overweigh among the direct trading options for unbundled GOs, price formation remains highly non-transparent. This is enhanced by the lack of visibility of GO market prices hindering efficient price discovery.

As the GO attributes can highly differ with regard to location of production, technology and subsidy regimes, it is difficult for market participants to compare prices. As feedback received from stakeholders confirms, various factors are counted in for the price formation. External factors leading to volatility in supply and demand furthermore add unpredictability to price formation.

[51] Overview of auction websites: https://www.aib-net.org/facts/market-information/auctioning-gos-aib-members

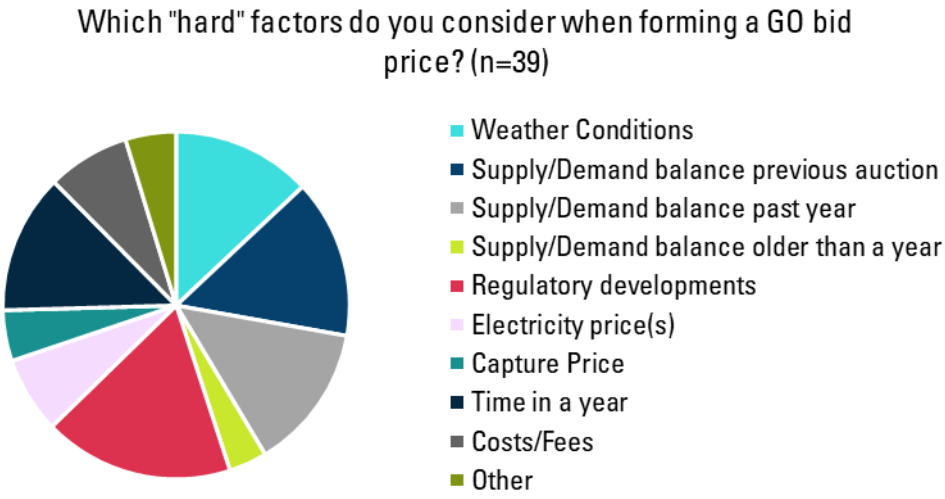


Figure 2-12: Survey feedback: hard factors considered in formation of GO price bid

Based on survey

Traded GO volumes, issuance and cancellation

AIB statistics on past GO volumes for different dimensions (e.g. time, country, technology, type of transaction) of high granularity from 2001 are publicly available and can be attributed with a high reliability as this information is provided directly by the issuing bodies. Minor deviations in the values were identified for the years 2019 and 2020, which are covered by the old AIB statistics set of 2021 and the new statistical dataset covering the period of January 2019 to August 2024. However, background information e.g. on lacking data, is made transparent.

The AIB statistics include information on issued volumes, cancellations, tradings, imports and exports as well as expiries. Especially with import and export volumes as well as data on ex-domain cancellations, inter-country trading patterns can become apparent with these datasets. Technology-specific granularity further enhances the understanding of supply and demand developments.

Information on currently traded volumes is less transparent. With regards to auctions, available GO volumes per technology are usually published a few days prior to the auctions so that bids and orders can be made.[52] OTC-trades which account for the majority of transactions, however, are less transparent. The limited visibility thus restricts the reliability on information and can enhance misconceptions on current market activity.

Product attributes

Guarantees of origin reliably provide information on the underlying product with a high level of detail. The information covered is required by the RED II and especially the EECS standard defined by the AIB[53]. According to RED II provisions and standards, the information provided by GOs must be verified by issuing bodies and is subject to audits ensuring high quality of the information. Still examples of wrongly issued GOs appear across the market, e.g. the Italian issuance of GOs for syngas-based electricity.

[52] https://www.aib-net.org/facts/market-information/auctioning-gos-aib-members
[53] https://www.aib-net.org/eecs

Regulatory framework

The regulatory landscape for GOs, based on the RED II and its national implementations, is considered transparent. While harmonisation is not fully reached and access to national legislative documents can be subject to language barriers, these national frameworks for market operations in the AIB region are publicly available through the domain protocols[54]. Provided from official sources, the high reliability of this information ensures all participants understand the rules governing the market, promoting fair competition and compliance.

Stakeholder feedback: dependence on third parties due to access barriers to information

Overall, also survey results confirm that the GO market is rather non-transparent. About 60% of the survey participants answered that they are dependent on third parties to be able to participate to the GO market. Those include to the largest extent market makers such as brokers (which build their business models around services navigating the non-transparencies of a market). Thus, it can be concluded that the **market power largely lies with market makers**. Naturally, most markets require some middle-men to enable operation and overall efficiency (see discussion next chapter), yet dependence on market makers may limit the effectiveness especially on consumer information and guiding capacity of the associated choices.

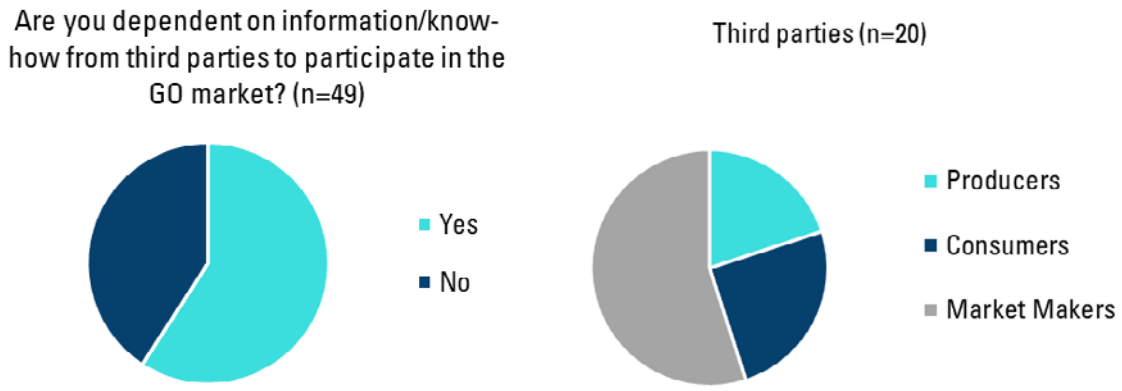


Figure 2-13: Survey results on transparency of GO market

Based on survey

Figure 2-14 attempts to describe the various stakeholder groups in the market and respective roles. The most important fact is that producers and consumers are buffered by market makers. As previously stated, this is not necessarily uncommon for markets, but also dilutes the flow of information between consumers and producers.

[54] https://www.aib-net.org/facts/aib-member-countries-regions/domain-protocols

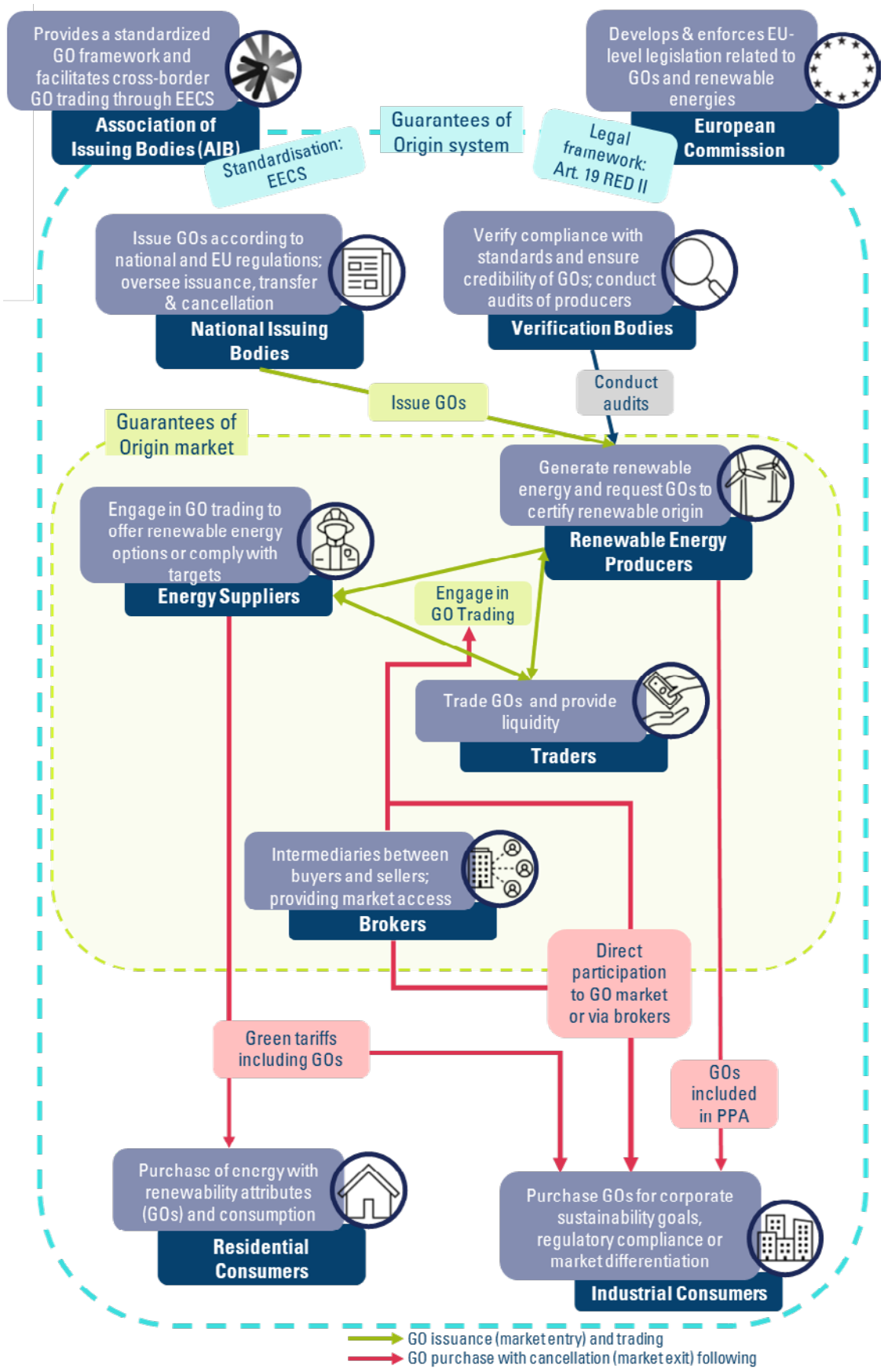


Figure 2-14: GO market participants and their role

Conclusion on the transparency of the GO market and summary of identified imbalances

From the above analysis, it can be concluded that while the regulatory framework and provided standards on the GO information itself are well-defined and highly transparent, other information categories lack transparency with regard to availability of or access to information. While information on historic GO volumes issued, traded, cancelled and expired is well-documented by issuing bodies themselves through the registries, price information is not publicly accessible. In particular, originating from the GO market formation itself (i.e. OTC trading dominating) and many different factors considered, price formation is highly non-transparent. In addition, depending on the granularity stipulated in the demand for GOs, GO prices can differ depending on technology, regionality, additionality etc. and price forecasts are associated with high uncertainty. Stakeholders confirm large reliance on third parties, which by the majority are mentioned to be market makers. These may benefit from the non-transparencies by offering associated services, which in turn provides them with the more market power.

Table 2-12: Summary table for Transparency dimension

#	Imbalance identified (qualitative description)	Quantification (if possible)	Associated indicator(s)	Potential influencing factor	Severity
1	**Restricted access to price information**	N.A.	Qualitative assessment of access to price information	Type of GO trading (OTC, auctions, …)	**Medium**
2	**Limited reliability of price information due to monopolistic competition**	N.A.	Qualitative assessment of reliability of price information	GO market (Monopolistic competition)	**Medium**
3	**None to low transparency on price formation**	N.A.	Qualitative assessment of access to price formation information	OTC-trades predominate, monopolistic competition	**Medium**
4	**Limited access to currently traded GO volumes**	N.A.	Qualitative assessment of access to traded volumes	Connection to AIB Hub; restrictions in eligibility for registry account	**Medium**
5	**Market power lies with market makers**	N.A.	Dependence on third parties for market information	GO transactions	**Medium**

2.2.5. Efficiency

The fundamental promise of markets is to "naturally" optimise resources and thus justify their use as a policy instrument. Moreover, efficiency of a market is a prerequisite to enable broad participation. These two factors are a prerequisite to eventually make the market effective. We here define efficiency strictly within the market boundaries, considering the market to be efficient if transactions on the GO market are facilitated at reasonable resources. The respective indicators include:

1. Administrative efficiency
2. Economic efficiency

Both analyses are based on direct stakeholder input. It should be noted that the perception of administrative and economic efficiency highly depends on the respective national implementation of the GO system and available IT infrastructure (connection to AIB Hub).

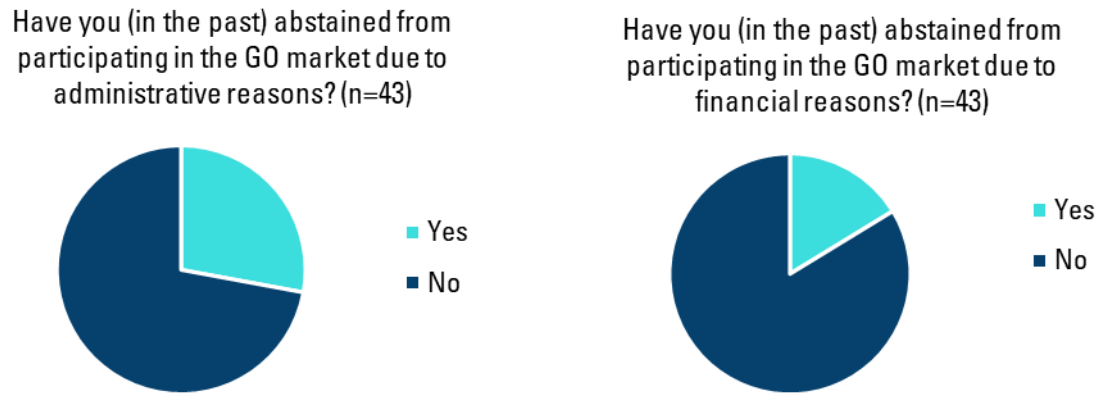


Figure 2-15: Survey feedback on abstinence from GO market due to administrative or financial reasons

Based on survey

Based on stakeholder feedback via a survey, the majority of respondents stated that they have not abstained from participating in the GO market because to administrative reasons. About one fourth of respondents claimed that they have abstained from participating in the GO market due to administrative reasons. While a potential bias should be taken into consideration, issues brought forward among this group included required manual interactions, frequently changing databases, and high fees. Particularly processes like monthly manual booking of GOs were seen as inefficient. For example, one stakeholder claimed that their request on hourly timestamping could not be realised by any registry. Auction management quality varies widely according to these survey respondents, with France viewed favourably while other countries are criticised for rather poor management.

However, while administrative hurdles are significant for some stakeholders, financial reasons are not the primary deterrent to participation (see Figure 2-15, indicating the market itself has inherent economic efficiency. Economically, the GO market appears reasonably efficient, evidenced by the presence of numerous active traders (e.g. STX, ECOHZ, Axpo, A Energi etc.). This is further corroborated by the survey indicating that a significant proportion of stakeholders participate actively in the market (see Figure 2-16). The results indicate that traders and electricity producers are especially active in the GO market.

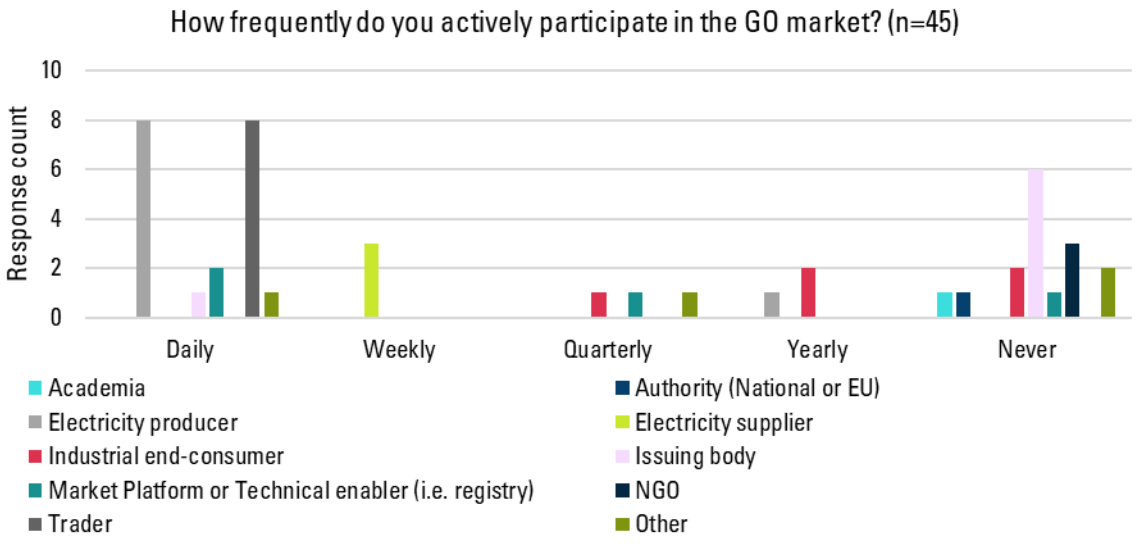


Figure 2-16: Survey results on frequency of active market participation per stakeholder group

Based on survey

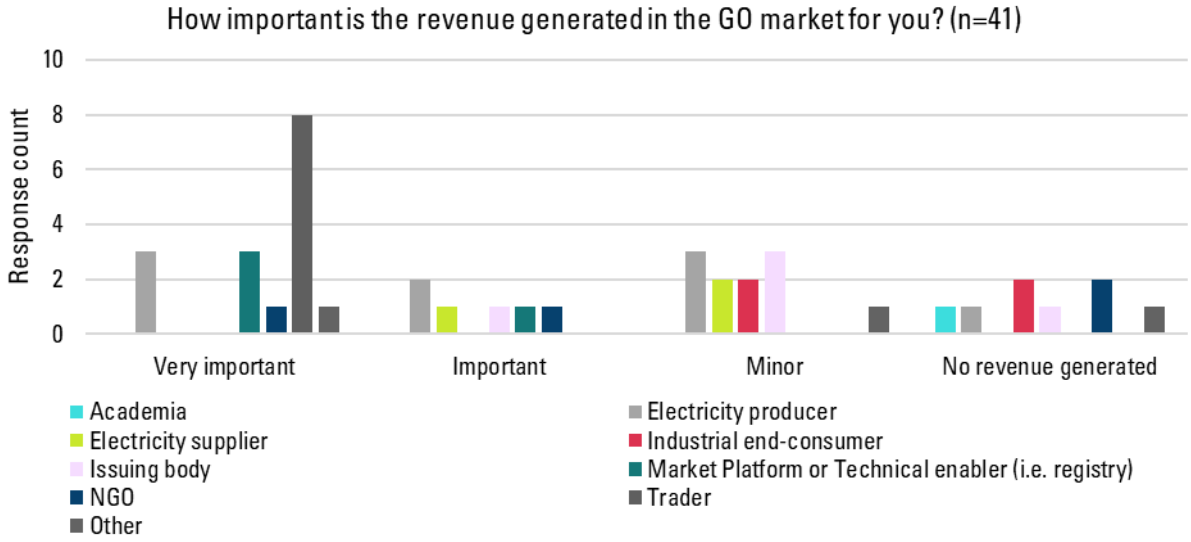


Figure 2-17: Survey results on importance of revenue generated in the GO market per stakeholder group

Based on survey

Traders play a crucial role in enhancing administrative efficiency, leveraging their expertise to navigate the complex processes. However, they can also skim a substantial portion of related revenue (see Figure 2-17 and the discussion on financial streams in chapter 2.4). Therefore, the potential for overall cost reduction hinges on fostering greater competition among traders to further drive down fees and improve overall market access. Furthermore, renewable energy producers can benefit from lower administrative costs, as the value of GOs deducted from the end-consumers' willingness-to-pay and administrative costs would increase. Thus, a more economically efficient GO market, facilitated by administrative streamlining,

is essential to enhancing the incentives for renewable energy build-out and reduce the dependence on traders.

Conclusion on the efficiency of the GO market and summary of identified imbalances

A minority of stakeholders has experienced market abstinence due to administrative burdens. Stakeholders see room for improvement in IT infrastructure, reducing complexity, in the implementation of more automated processes and the reduction of fees. Furthermore, auction management quality is claimed to differ across countries.

Not surprisingly, market makers depend strongly on the revenue generated in the GO market but can also help to navigate the disharmonies across MSs, however potentially shifting market power towards them, but also offering general smoothing and efficiency improvements.

Table 2-13: Summary table for Efficiency dimension

#	Imbalance identified (qualitative description)	Quantification (if possible)	Associated indicator(s)	Potential influencing factor	Severity
1	**Low administrative efficiency**	N.A.	Administrative efficiency	Poor IT infrastructure; manual processes required	**Medium**
2	**Suboptimal economic efficiency for consumers**	N.A.	Economic efficiency	High fees	**Low**
3	**Partially low auction management quality**	N.A.	Administrative efficiency	Registries, auction regimes	**Low-Medium**

2.2.6. Responsiveness

Responsiveness and evaluation of supply and demand require a more thorough discussion due to the importance for effectiveness, which is why the related discussion is covered in a dedicated chapter below.

2.3. Focus Dimension: Responsiveness

2.3.1. Analysis of the responsiveness of the GO market

Market responsiveness is a fundamental prerequisite for effectiveness. Markets release their guiding capability only if price changes are related to the realities of supply and demand and particularly changes therein. This is also true for the GO market.

Thus, the most important influencing factors on supply and demand should become apparent in quantitative indicators, such as historical price developments.

The indicators

1. "Monthly average of GO prices (Sep 2019-Dec 2024) per technology, spot and futures prices" and
2. "Quarterly volume weighted average of GO prices in Italian auctions (Jan 2014 – Dec 2024) per technology"

provide insights into fundamental characteristics of the GO market price discovery mechanisms. Aspects which were studied include, for example, general price levels against time, the price differences among

production technologies, the developments of futures compared to spot prices. Striking changes in prices are assessed in greater detail.

As a further basis for the subsequent analysis on responsiveness, the indicator

3. "Balance of GO issuance and cancellation (total, hydro and solar/wind GOs)"

is assessed. The changes in the balance identified provide further insights on the relationship between prices and changes in supply and demand.

Structural (and thus long-term), as well as short- to medium-term correlations of the GO price with changes in the supply and demand balance are assessed using the indicators

4. "Qualitative comparison of annual average of GO prices to changes in the issuance and cancellation balance (Jan 2016 – Aug 2024)" and
5. "Monthly correlation of the change in the GO transfer rate and GO price changes".

Analysis of general historic GO price developments

Figure 2-18 allows the following general observations regarding historic GO price developments, which will be further assessed against changes in supply and demand in the subsection on GO price responsiveness below:

1. The **price spread between the different production technologies** on the EU-market (considering Nordic Hydro, EU Solar, EU Wind and EU Biomass) is very narrow with a maximum price difference of 0.16 €/MWh in absolute values corresponding to 4% in relative terms and a maximum price difference of 31% corresponding to 0.10 €/MWh in absolute terms.
2. The **GO spot price levels** from September 2019 to December 2021 were constantly below 1 €/MWh with a minor price increase in May 2021 potentially influenced by the national RED II transpositions which became effective on 30 June 2021. From January 2022, the GO spot price abruptly rises to ~2 €/MWh and remains at this price level until June 2022. This price jump falls together with Russia's aggression against Ukraine which led to a general energy crisis and high electricity prices in Europe. From July 2022, an even larger, steep price increase can be observed peaking at 8 €/MWh in November 2022 (monthly average). Until May 2023, the monthly average GO spot price fluctuates around 7 €/MWh. From May 2023, the GO spot price decreases constantly to finally 1 €/MWh in May 2024 and further to below 1 €/MWh in November and December 2024.
3. **Futures show in general similar price movements while indicating expected changes in the supply and demand balance** and as such can show deviations from the spot prices. At the end of 2021, futures prices were twice as high as spot prices with ~2 €/MWh. During the price peaks in 2022/2023, Yr01-futures dropped to 5 €/MWh below the spot market price, while exceeding the spot market price by up to 2 €/MWh during the falling market price from mid-2023 onwards. Y02- and Y04-futures lie below the spot market price during the 2022/2023 price spike at about 4 €/MWh and peak at 5.5 €/MWh (Y04) and 7 €/MWh (Y02) respectively in September 2023.

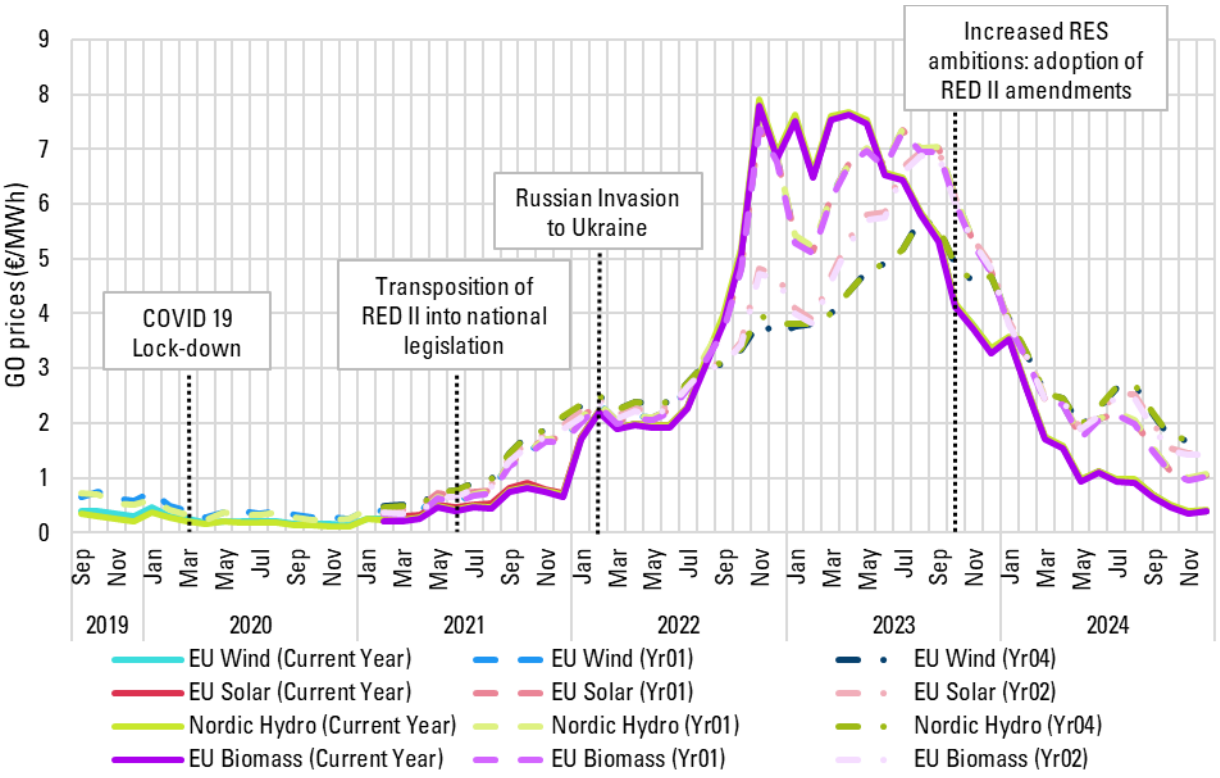


Figure 2-18: Indicator "Monthly average of GO prices (Sep 2019-Dec 2024) per technology, spot and futures prices" and indication of indirect influences on GO supply and demand

Based on S&P Platts

Based on Italian auction prices beyond 2019, as shown in Figure 2-19 below,

4. another **price peak in Q3 of 2018** is observed with Wind GO prices peaking at 2.70 €/MWh and Solar and Hydro GOs at 2.00 €/MWh. Prices show some deviations among the production technologies, especially during the high price peak in Q1 of 2024, with a difference of ~1.50 €/MWh between Hydro and Solar GOs.

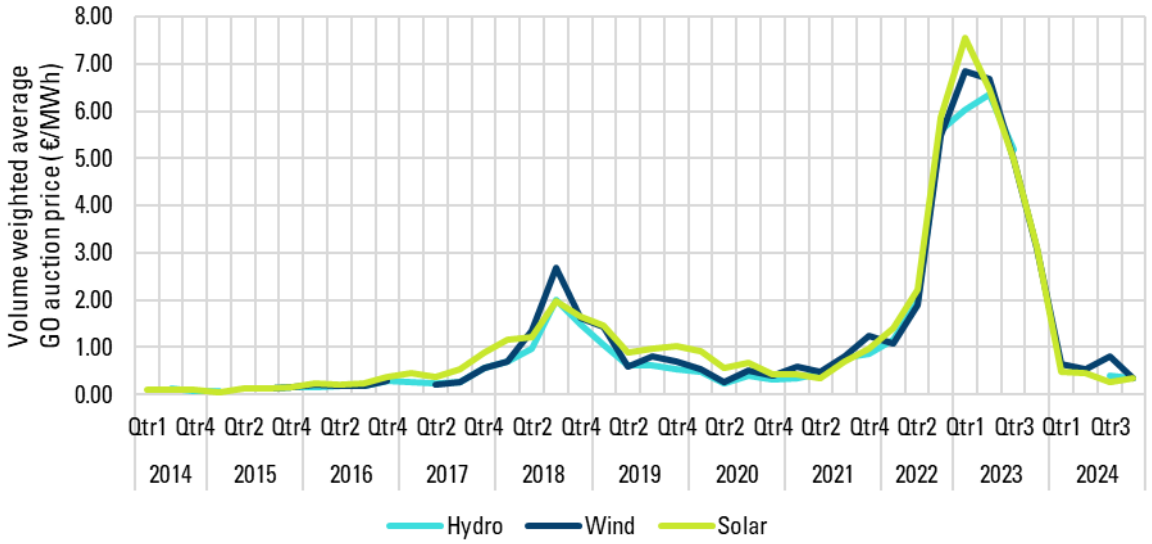


Figure 2-19: Indicator "Quarterly volume weighted average of GO prices in Italian auctions (Jan 2014 – Dec 2024) per technology"

Based on GSE auction results[55]

Analysis on the balance of GO issuance and cancellations

Before linking GO price developments to the developments of supply and demand of GOs, it is insightful to first describe the observations possible from the issuance-cancellation balance. The issuance of GOs is directly correlated with the supply of GOs to the market. Cancellations of GOs provide evidence for the consumption of renewable energy and are hence a good indicator for the demand for GOs in the respective year.[56]

The assessment of the balance of supply and demand per accounting year as shown in Figure 2-20 and Figure 2-21 below, shows the structural nature of the oversupply (as also already seen in chapter 2.2.1 and the market length assessment):

1. **Volumes of issued GOs are generally above the cancelled volumes** of in average 87 TWh/year. In some specific accounting years, demand does exceed supply for both wind/solar by 20 TWh and hydro power by 3 TWh in 2019 and by 25 TWh for hydro power in 2022. Due to non-restrictive handling of production and cancellation years (thus allowing to "stock up" on GOs in the limitations of the expiry rules), however, no real supply shortage is associated (see also overall market length).
2. The **drop in the issuance of hydro GOs** by 12 TWh in 2019 and 55 TWh in 2022 compared to the previous year **reflects the droughts** in these years respectively and the accordingly decreased electricity production from hydro.
3. From 2019 onwards, a **strong increase of GO issuance** of 188 TWh to 318 TWh in 2023 is observed reflecting the **accelerated build-out of RES** following the adoption of the Renewable Energy Directive II (RED II) in 2018. At the same time the RED II article 19(8) and the directive for the internal market for

[55] https://gme.mercatoelettrico.org/en-us/Home/Results/Environment/GO/Results/GSEGOAuctions#IntestazioneGrafico
[56] Please note: The data used is transaction-based, i.e. the accounting years refer to the year of issuance and cancellation of the GOs irrespective of the year of production of the GO. GOs generally expire after 12 months.

electricity[57] strengthened the enforcement of the electricity suppliers' use of GOs. Accordingly, it could be expected that the cancellations and thus demand for these GOs increased due to an increasing demand from RES suppliers.

4. **For 2020,** an overall **drop in the cancellations** of GOs is visible, likely originating from the overall decreased energy consumption during and because of the **Covid-19 pandemic**.

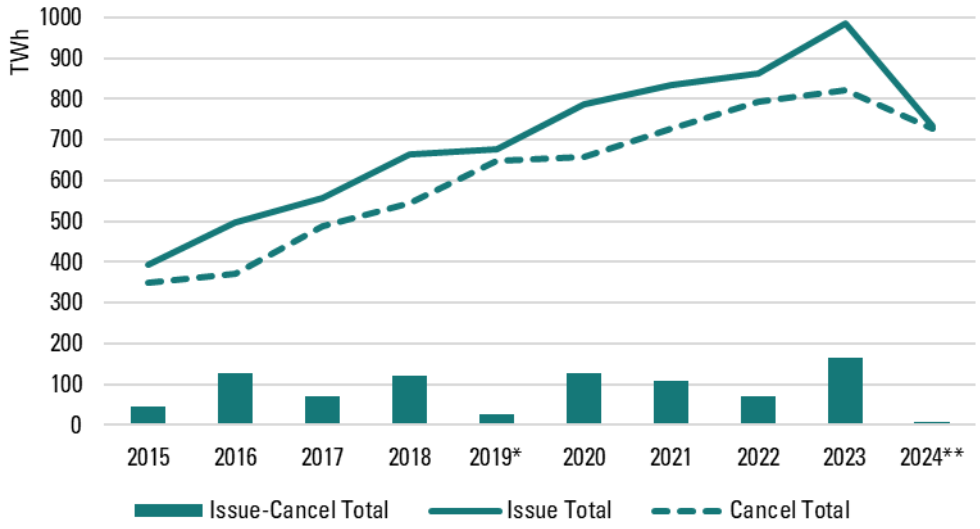


Figure 2-20: Balance of supply and demand for GOs in the AIB domain

LBST based on AIB 2021 and 2024 statistics

*The data until and including 2018 are based on AIB statistics 2021, while data from 2019 is based on AIB statistics 2024. For the overlapping year 2019 and 2020, the datasets however do not align which could have increased the apparent drop in GO cancellations.

**It should be noted that the data for 2024 is available only until and including August

[57] (EU) 2019/944

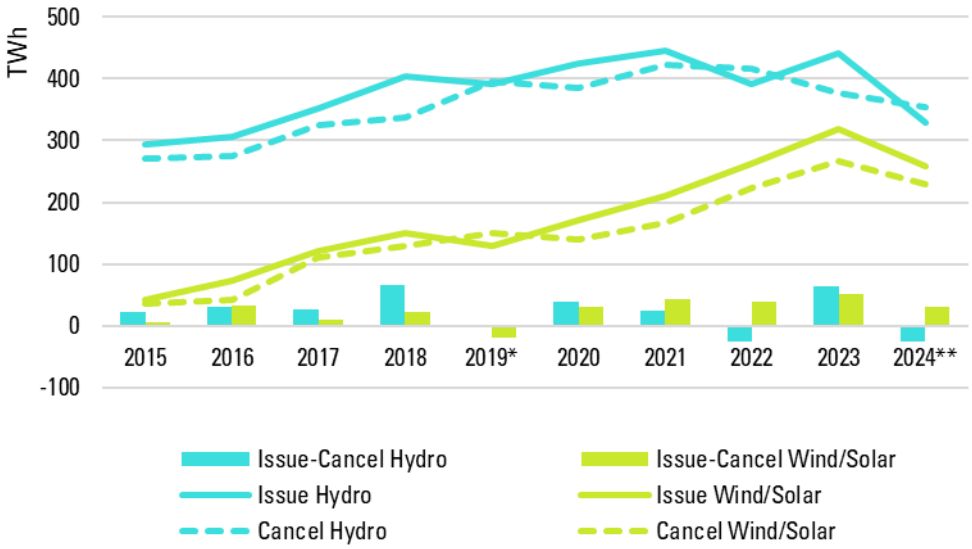


Figure 2-21: Balance of supply and demand for Hydro and Wind/Solar GOs in the AIB domain

LBST based on AIB 2021 and 2024 statistics

*The data until and including 2018 are based on AIB statistics 2021, while data from 2019 is based on AIB statistics 2024. For the overlapping year 2019 and 2020, the datasets however do not align which could have increased the apparent drop in GO cancellations.

** It should be noted that the data for 2024 are available only until and including August

Correlation of price and GO issuance and cancellation balance "responsiveness"

In the following, the responsiveness of the GO market is assessed by analysing the two indicators "Qualitative comparison of annual changes in GO issuance and cancellation balance and changes in the GO price" and "Monthly correlation of the change in the GO transfer rate and GO price changes".

Due to annual disclosure periods for the RES consumption the overall supply-demand balance of the GO market can best be compared on an annual level. As a result, **changing annual price levels provide** a picture of the more general balance of the market and can give indications on the impact of more **medium- to long-term factors**.

While structural changes in the GO market and the associated price response become more visible in the annual balance of supply and demand, an analysis of market fluctuations on a **monthly level** provide insights into the **short-term price response**. There, the responsiveness to more sudden changes and changing information on supply and demand factors is visible. Instead of using the cancellations directly, it is more insightful to use GO transfer activity. This is more accurately capturing market activity in procurement and hence to avoids misleading interpretation of cancellations, which are strongly guided by disclosure deadlines and reporting cycles and show high fluctuations throughout one year.

Responsiveness of the GO price on an annual basis

First, we compare annual changes in GO issuance and cancellation balance vs. changes in the GO price. Hypothetically (using pure market theory) decreasing oversupply (issue-cancellation balance is negative) should cause bullish price behaviour and increasing prices in the next year (and vice versa for the increasing values). Using AIB statistics the changes of the issue-cancellation balance (Δ(I-C)) from year to

year are calculated and provided in TWh. Positive values indicate that the volume of issued GOs increased more than the cancellations, thus enhancing oversupply and vice versa.[58]

As shown in Figure 2-22 and summarised in Table 2-14 in the years 2017 and 2020 to 2022, the price changes are indeed aligned with the market theoretical expectations of bullish (price increase) and bearish (price decline) price reactions. Although 2016, 2018, 2019 and 2023 show opposite price reactions to the respective changes of the issue-cancellation balance, at least 2018 and 2023 must be taken as exceptions due to dominating other effects. In 2018 the adoption of the RED II must be considered and for the year 2023, it might be misleading to simply consider the average increase in the GO price: the GO price in the year 2023 is highly volatile (see section 2.2.2) as the price spike from end of 2022 continues in 2023 while from Q2 2023 a general continuous but slower price fall is observed.

The GO price is thus responsive to structural changes in the supply-demand balance, but further factors must significantly influence the market as well. Their respective impact on the GO market is detailed in section 2.3.4.

[58] Notice that the AIB statistics provide data only until August 2024, thus limiting the validity of the analysis for 2024.

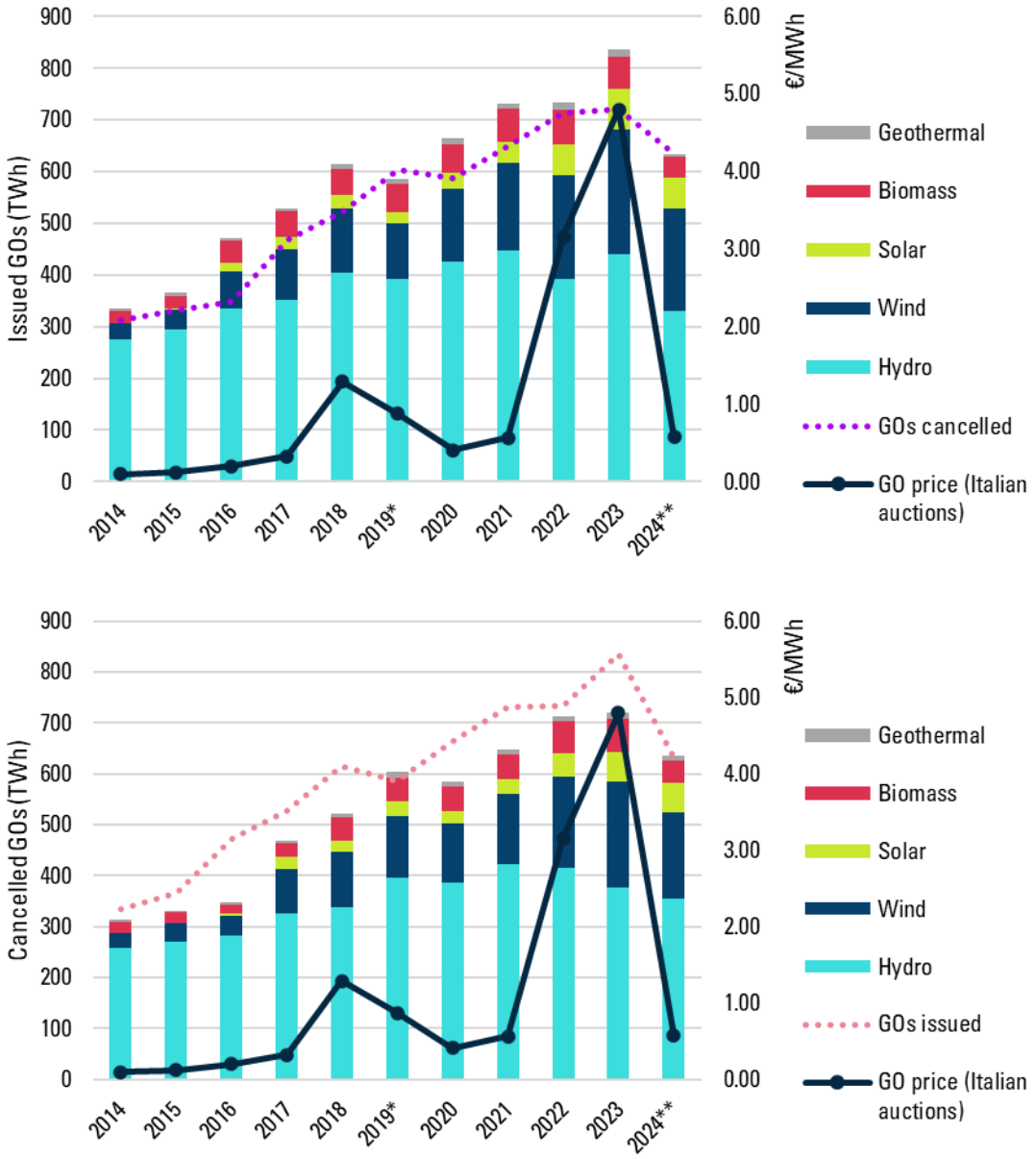


Figure 2-22: Indicator "Qualitative comparison of annual average of GO prices to volume of issued and cancelled GOs per production technology (Jan 2015 – Aug 2024)".

Based on GSE auction results, AIB 2021 statistics and AIB 2024 statistics

*The AIB statistical data of 2021 and 2024 overlap for the years 2019, 2020 and partially 2021. However, the values of the 2021 dataset are more optimistic. Throughout the analysis, for the overlapping years the values of the statistical dataset of 2024 are used.

**The AIB data for issued volumes is available only until and including August 2024.

Table 2-14: Summary of GO price (P) reactions on changes of the balance of issued (I) and cancelled (C) GOs and indication of influencing factors

Year	ΔI	ΔC	Δ (I-C)	I-C	Expected effect on GO price	ΔP	Potential bullish influencing factors	Potential bearish influencing factors
Unit	*TWh*	*TWh*	*TWh*	*TWh*		*€/MWh*		
2016	+103	+21	+82	127	Bearish	+0.13		
2017	+58	+116	-57	69	Bullish	+0.24	**Supply:** Dry year	
2018	+109	+58	+51	121	Bearish	+1.04	Adoption of RED II	
2019	+11	+105	-94	27	Bullish	-0.57	**Supply:** Dry year **Demand:** State aid schemes for reduced electricity levies (from 2019)	**Supply:** Increased RES build-out
2020	+111	+10	+101	128	Bearish	-0.46	**Demand:** EU taxonomy (from 2020)	**Supply:** Increased RES build-out **Demand:** Covid-19 pandemic and decreased electricity consumption
2021	+48	+67	-19	109	Bullish	+0.15	**Supply:** • Brexit (stop of REGO recognition in EU) • Low wind speeds across EU • Norway discusses to leave the GO market **Demand:** • State aid schemes for indirect ETS costs (market-based reporting, from 2021) • Implementation of RED II in national legislation	**Supply:** Increased RES build-out
2022	+27	+66	-39	70	Bullish	+3.36	**Supply:** Dry year **Other:** Russia's invasion to Ukraine, Energy crisis	**Supply:** Increased RES build-out
2023	+123	+29	+94	164	Bearish	+0.94	**Other:** Adoption of RED II amendments (e.g., higher sector-specific targets trigger demand for RES)	**Supply:** • Increased RES build-out • Nuclear GOs entering market **Demand:** Brexit (stop of GO-cancellations in UK)
2024*	-107	-45	-62	-54	Bullish*	-4.52		**Supply:** • Surplus rollover of Italian GO auctions • Increased RES build-out

ΔI: Annual change in issued GOs; ΔC: change in cancelled GOs; Δ(I-C): change in the balance of issued and cancelled GOs; I-C: balance of issued and cancelled GOs; ΔP: change in GO price

*2024 only includes data until and including August and is compared to 2023 data until August. Due to the intra-annual volatility, an interpretation of these values should be handled with care.

BOX 3: Learnings from the GO-Brexit – Supply shortage and the perception thereof can lead to immensely high prices

With the UK's Exit from the European Union in 2021, the Brexit also became valid for the European GO market: As of 1 January 2021, the EU no longer recognised UK Renewable Energy Guarantees of Origin (REGOs). From the disclosure period beginning 1 April 2023, EU GOs were no longer recognised in Great Britain Fuel Mix Disclosure (GB FMD), Feed-in Tariffs (FIT) annual levelisation or Contracts for Difference (CfD).[59] This led to changes in the overall supply and demand balance of the GO market but especially on the REGO market with strong impacts on the REGO price:

In 2020, 102 TWh of GOs were cancelled in the UK[60], while for the reporting period of 2019/2020 7.5 TWh of REGOs were exported to the EU[61]. Thus, the UK has been a net-importer of GOs. For the EU GO market, the impact on the GO price from the GO-Brexit remained small, as the drop in supply in 2021 was negligible compared to the overall supply and the lacking cancellations of GOs for the UK further increased the already existing oversupply. However, the stop of GO imports to the UK in April 2023 has potentially contributed to the GO price drop after the peak in 2022/2023.

The larger impact from the GO-Brexit was on the REGO price: Figure 2-23 shows, that with the first drop in GO cancellations to the UK, the REGO price increased from below 1 €/MWh in the beginning of 2021 to ~ 8.50 €/MWh in the beginning of 2022 caused by the decrease of the supply of GOs by 37 TWh and potentially leading to an undersupply in the UK. This effect is even stronger from April 2023, when GOs from the EU were no longer recognised in the UK further exhausting the oversupply. As a result, in October 2023, the REGO price reached a maximum of 24.40 €/MWh. As guarantees of origin are often tied to contractual agreements or serve as evidence for reporting obligations, the demand of GOs is not as elastic as the supply can be. This is the reason why undersupply as experienced in the REGO market is so critical to consumers and leads to these large price uptakes.

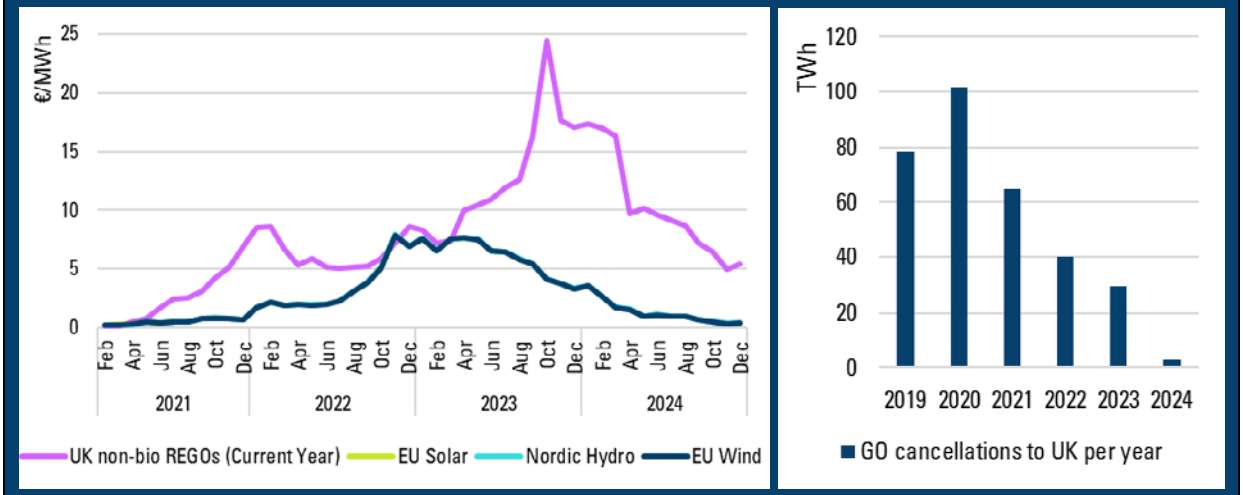


Figure 2-23: Price development of UK non-bio REGOs and GOs

[59] https://www.ofgem.gov.uk/environmental-and-social-schemes/renewable-energy-guarantees-origin-rego
[60] AIB statistics 2024
[61] https://www.ofgem.gov.uk/publications/renewable-energy-guarantees-origin-regos-retired-export-201920

The developments of the REGO market show, that **undersupply has an extensive impact on the price of guarantees of origin leading to high prices.** At the same time, a further increased effective oversupply through decreasing demand from the UK in the guarantees of origin market contributes to decreasing prices.

Responsiveness of the GO price on a monthly basis

Second, we check if and how the market reacts to immediate and short-term supply and demand changes using correlation analysis, to if at all direct correlations are visible. A mathematical model (Pearson correlation coefficient) is applied[62]. Absolute values above 0.3 indicate a moderate correlation and values above 0.5 a strong correlation with the sign referring to a positive (both variable increase/decrease) or a negative correlation (variable increase/decrease conversely). A correlation coefficient below 0.1 is considered as not significant.

Given the high fluctuation of cancelled GOs per month throughout one year – with cancellations peaking in March reflecting disclosure deadlines – changes in the transfer rate, i.e. transferred GOs / issued GOs, provide a clearer measurement of the actual supply-demand balance: Increases in the transfer rate thus indicate either growing demand or a declining supply which are expected to induce bullish effects on the monthly GO price. In contrast, a decreasing transfer rate implies decreasing demand or increasing supply of GOs which should lead to price falls in theory.

Looking at the r-value for the years 2022 to 2024 in Figure 2-24, a small positive correlation of changes in supply and demand of GOs and GO prices is indeed observable (r-value > 0.1). 2020 with r < 0.1 shows a negligible correlation, while 2021 shows a negative small correlation.

From a mathematical[63] and thus "ideal market" perspective **GO prices are poorly correlated with the short-term balance of supply and demand.** From the right figure, it becomes apparent that while the relative changes in the (quarterly) transfer rate show a pattern the relative change of the quarterly GO price average follows more randomly, resulting in an overall Pearson correlation coefficient of 0.27 on a quarterly basis. **Other market factors must therefore have a significant impact.** These include especially the simple anticipation and thus "information" on potential changes, which are not simply captured by the market balance. As seen for REGOs, structurally undersupplied markets are much more susceptible to the supply and demand balance and can lead to immense and quick price changes. This responsiveness to information is observed in the right graph of Figure 2-24: 2022 shows the largest relative price increases: the transfer rate remained unaffected, the information of a dry year and low hydro reservoirs still lead to relatively large price increases in Q1 and further in Q3 and Q4 (positive values of dP). During times of "normal" market equilibrium (before 2022 price peaks), prices were generally not largely affected by the transfer rate changes (see Figure 2-24 on the right for 2019-2021).

In 2021, the GO price showed relatively significant large increases in the first half of the year. Although the GO price is not directly linked to electricity prices, there still could be some influence of increasing

[62]Pearson correlation coefficient for the derivative of the monthly GO prices (P) and the derivative of the monthly quotient of transferred GOs and issued GOs, i.e. $dP_i = (P_i - P_{i-1}) / P_{i-1}$ and $dT_i = (T_i - T_{i-1}) / T_{i-1}$, where T = transfer/issue.

[63] It should be noted that the Pearson correlation coefficient represents a simplified approach for providing measurement of the responsiveness of the GO price with the underlying assumption that the values have a linear relationship. Furthermore, a cause-and-effect relationship cannot be simply interpreted from the resulting r-value. It rather gives an indication to what extent variables are associated with each other.

electricity prices on the GO price. In the beginning of 2021, the electricity prices in the Iberian, Italian and Dutch market started to increase.[64] Further even faster increase of the electricity price in 2022 could thus also be an influence on the drastic GO price increase observed in 2022 (see also BOX 4 below).

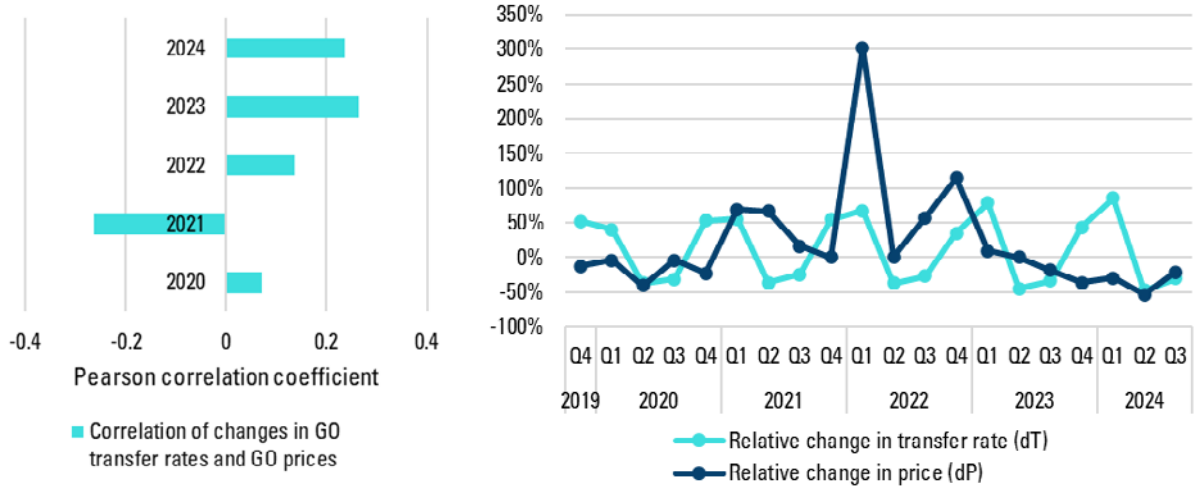


Figure 2-24: Correlation of monthly GO trading rate (traded/issued GOs) change (dT) and GO price change (dP)

A Pearson correlation factor of $0.1 < |r| < 0.3$ indicates small correlations

Based on own calculations, AIB statistics 2024 and S&P Platts

BOX 4: What caused the 2023 price peak? – Some physical factors and a lot of "market perception"

From Q4 of 2022, an extensive increase of the GO spot price could be observed peaking at up to 10 €/MWh in the beginning of December 2022. During this price spike and the oscillations in the months following, the monthly standard deviations of up to 1.30 €/MWh exceed previous price changes by an order of magnitude. Several potentially influencing factors must be considered to assess the cause for these developments.

[64] https://aleasoft.com/european-electricity-markets-reached-highest-prices-since-at-least-2019-may/

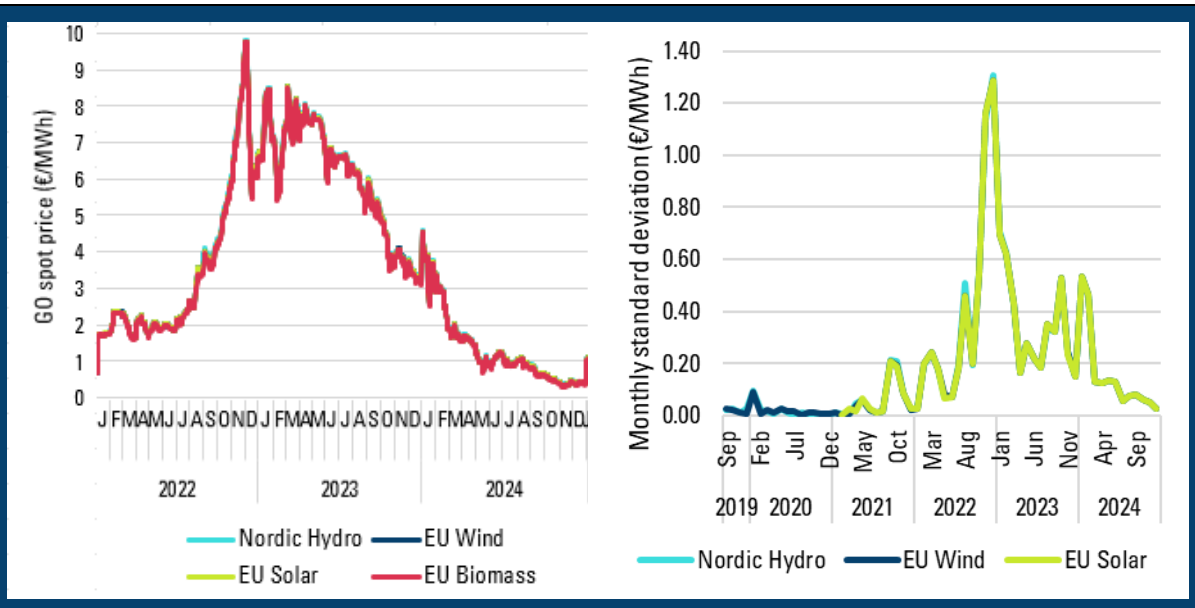


Figure 2-25: Daily GO spot price and monthly standard deviation

Based on own calculations and S&P Platts

1. Energy prices

With Russia's invasion to Ukraine, energy prices have increased with the industry electricity price peaking at 20 ct/kWh in the second half of 2022, and the electricity price for private households at 24 ct/kWh. Over the same period, GO prices have increased, yet at a higher relative rate than electricity prices to 3.8% and 3.0% of the electricity price respectively instead of below 1.0% in the past. In interviews, offtakers confirmed, that the willingness-to-pay for GOs is higher in times of uncertainty reflected also in the peaking of the energy prices. The peak of the quotient of GO price over electricity price however indicates that other influencing factors have amplified the price increase of GOs.

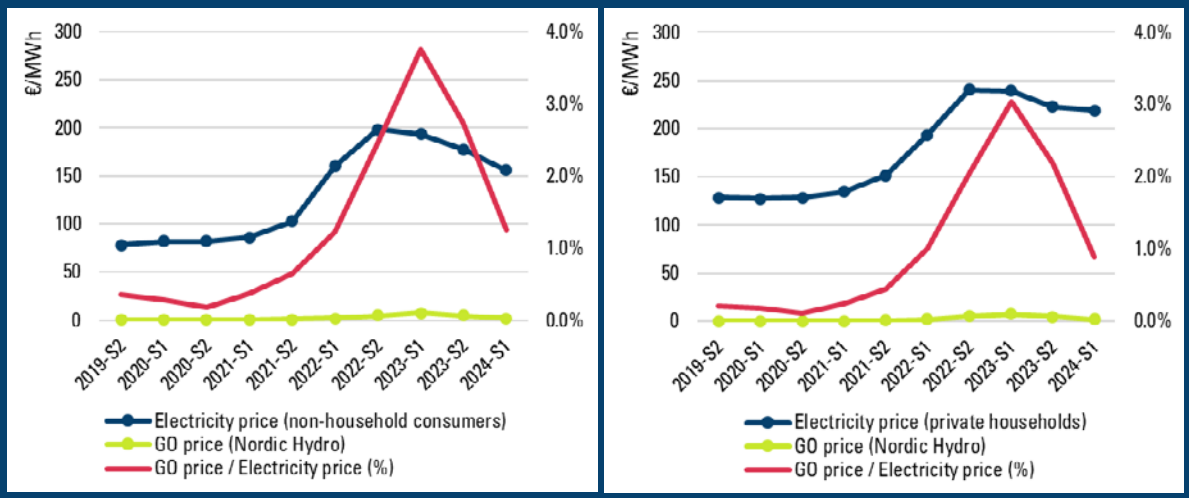


Figure 2-26: Comparison of GO price to electricity price for non-household consumers (left) and private households (right)

Based on own calculations, S&P Platts, Eurostat

2. 2022 drought

In 2022, the supply of hydro GOs was affected by dry weather conditions resulting in 55 TWh less hydro GOs issued compared to 2021. The resulting price increase from the decreased issuance of hydro GOs could have been amplified in light of the energy crisis indicating the fear for undersupply. Moreover, especially hydro producers had been forced to buy back from the market (due to contractually bound forward sold GO supply, e.g. within PPAs).

3. Potential speculative behaviour

During the price spike, speculative behaviour by traders could potentially have played a role but must be considered with caution. Daily spot prices show a radical step-wise increase in October and November 2022, with price increases of up to 50 ct/MWh within one day. Monthly GO transfer activities in Q4 of 2022 however, do not show significant increases compared to previous years. Thus, speculation as a factor for the price spikes remains uncertain.

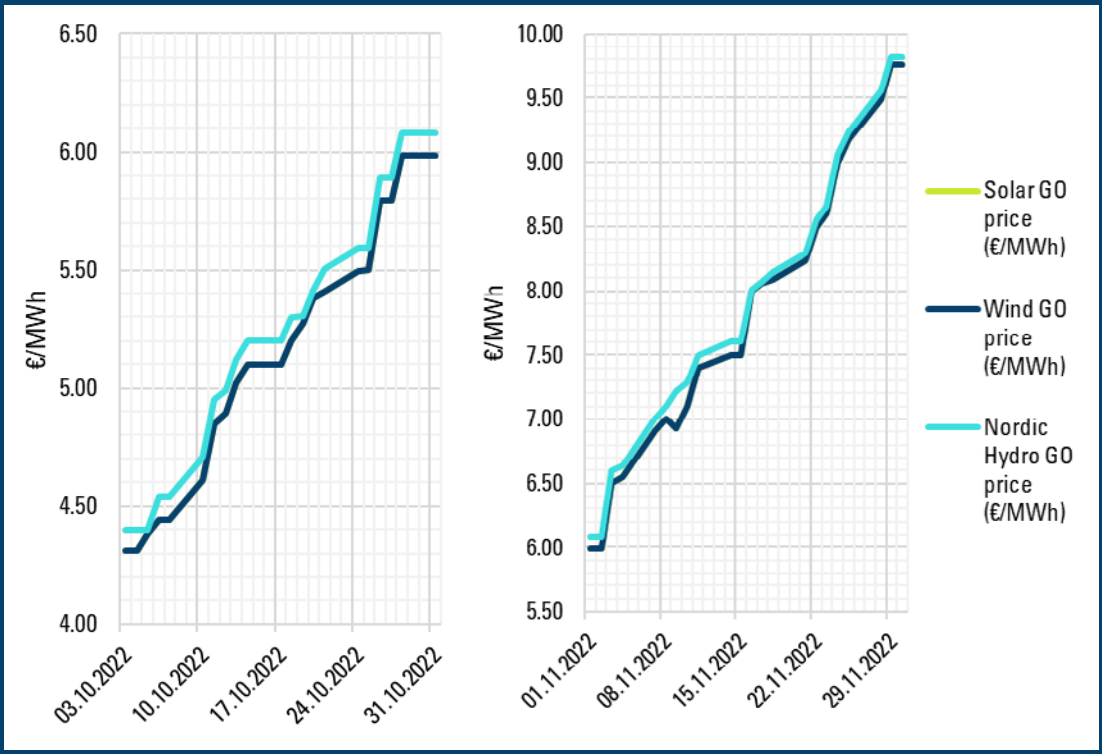


Figure 2-27: Daily spot prices of GOs during the price rallye (end of 2022)
Based on S&P Platts

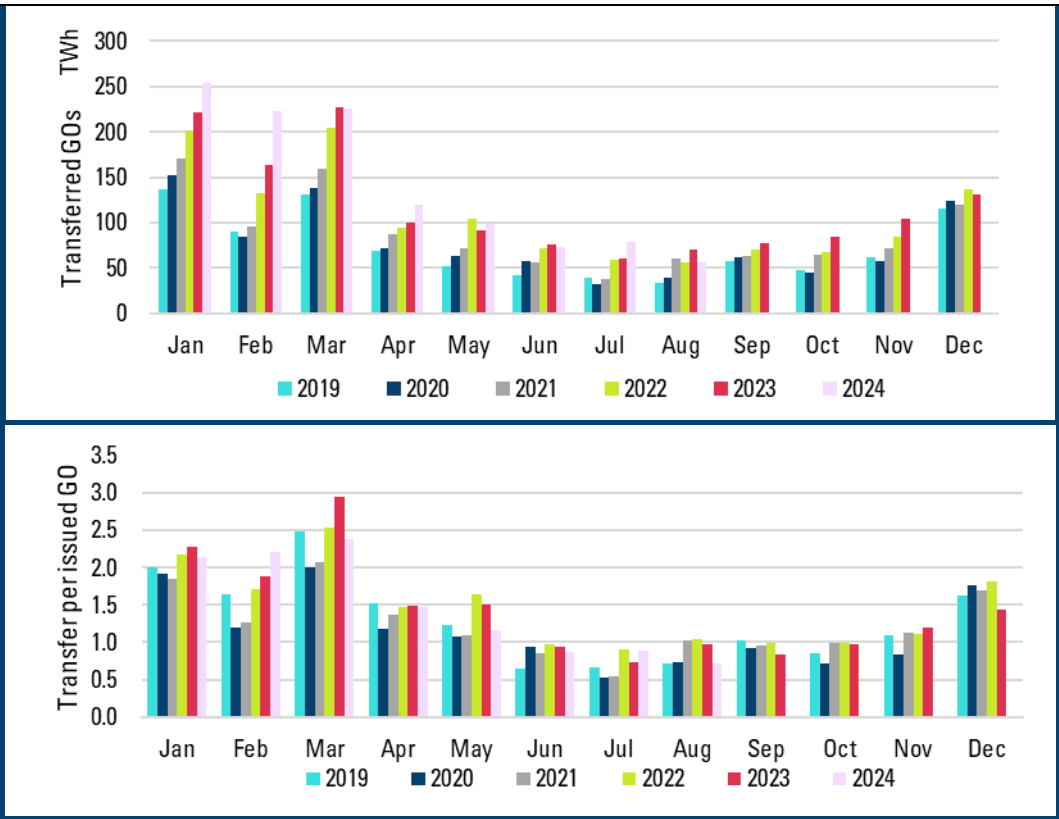


Figure 2-28: Comparison of monthly GO transfers per year (as measure of market activity)
Based on AIB statistics 2024

Overall, the GO price spike of Q4 2022 has been influenced by various factors. Among these, supply and demand effects only partly played a role, as also rated by stakeholders in a survey. The concurrency of geopolitical shocks and other factors leading to supply shortage, to a high probability has amplified the respective impact on the GO price.

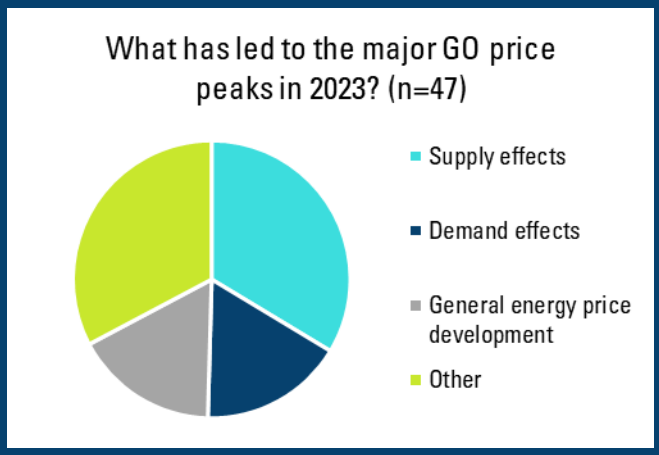


Figure 2-29: Survey results on the cause of the GO price peaks in 2023

The limited elasticity of the GO demand – driven by contractual obligations of electricity suppliers and reporting obligations on the demand side – becomes apparent in the GO cancellation curve which for November even shows the highest value of GO cancellations in 2022 with 36 TWh.

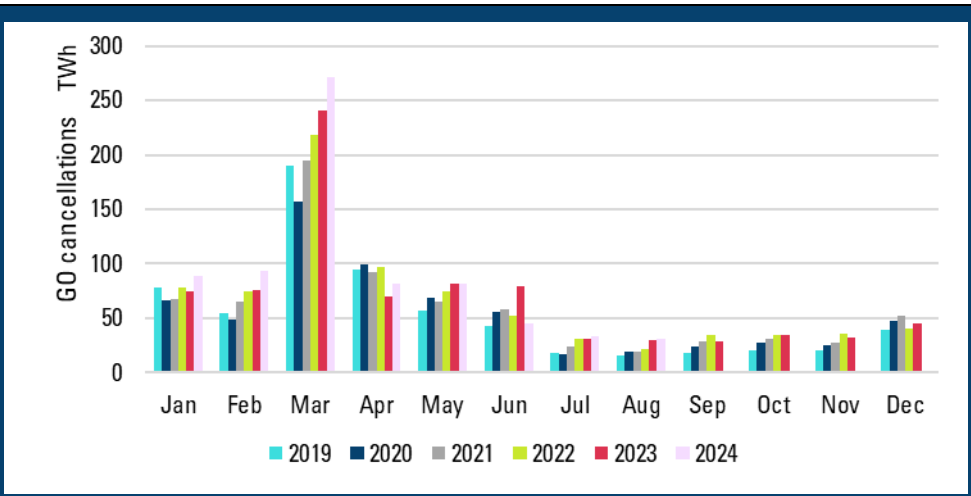


Figure 2-30: GO cancellations per month

Based on AIB statistics 2024

Conclusion on the responsiveness of the GO market

The GO market is considered responsive, if imbalances of supply and demand are reflected in prices. Supply shocks in fact do have an impact on GO prices, amplified by market psychology. In a generally oversupplied market however, the GO price is not significantly correlated to changes in supply and demand on short-term scales. Furthermore, increasing electricity prices could have an influence on the GO price.

2.3.2. Soft factors influencing price dynamics

As indicated above, price dynamics are anticipatory on information available. In order to understand this "soft factors", two key factors are discussed below: Hydro power as the essential anchor for pricing and futures as proofs for long-term anticipation of policy/demand developments.

Converging prices for different production technologies: hydro as "brent crude" anchor

The spot and future prices converge for the different production technologies (see previous Figure 2-18). Historically, hydro GOs have had the largest share of issues and cancellations with > 80% in 2014 and still > 50% in 2024 (see Figure 2-31 below). The feedback received by stakeholders via a survey confirms that in the past, GO prices were mainly dependent on the supply (and demand) of hydro GOs. Although the share of renewable electricity production from solar and wind strongly increased, and thus other influencing factors on the GO price gain importance, the hydro GO price to some extent is still considered an "anchoring price", used for overall market orientation. As discussed in BOX 4, the 2023 price peak showed that the willingness-to-pay was indeed increasing due to factors directly related to hydro power GOs: first the drought (justifying a "fear of undersupply") and then the factual buy back from GOs by hydro power producers due to forward sold GOs (confirmed in interviews).

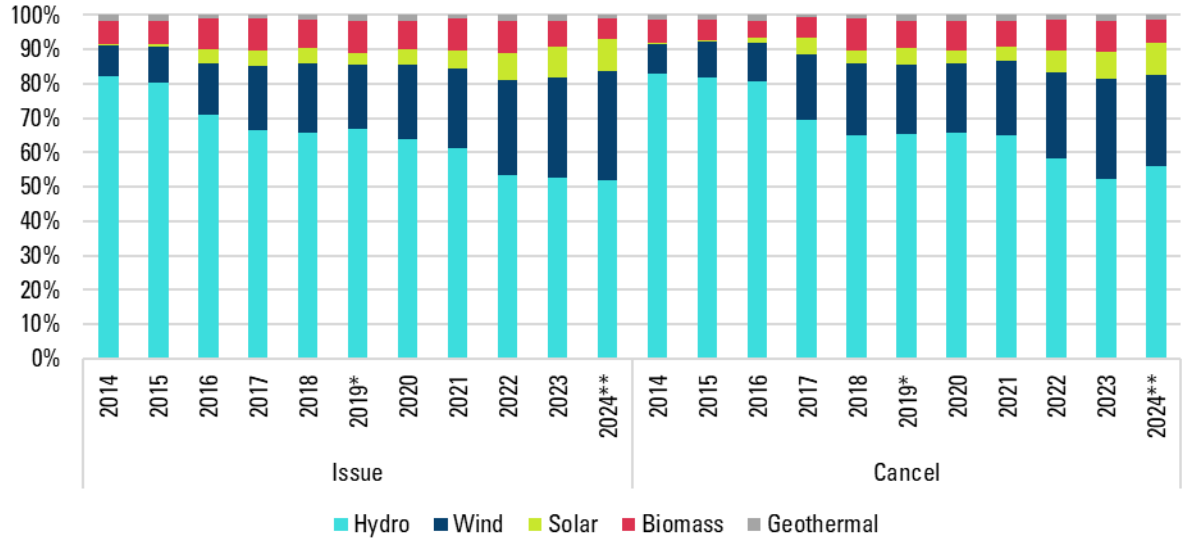


Figure 2-31: Share of technologies of issued and cancelled GOs

Based on own calculations, AIB statistics 2021 and AIB statistics 2024

*The AIB statistical data of 2021 and 2024 overlap for the years 2019, 2020 and partially 2021. However, the values of the 2021 dataset are more optimistic. Throughout the analysis, for the overlapping years the values of the statistical dataset of 2024 are used.

**The AIB data for issued volumes is available only until and including August 2024.

Overall, despite a trend in the demand towards solar and wind GOs, the converging prices indicate that demand does not differentiate the type of technology, and the role of hydro power remains dominating despite the decreasing overall shares in issued GOs. (see also BOX 6). On regional level, depending on consumer awareness and procurement strategies, a strong demand for local renewable electricity can lead to GO prices exceeding market prices and to show deviations in prices across technologies. Prominent example is the GO price for Dutch wind at 2.70 €/MWh in 2021, being five times higher than EU wind GOs with ~ 0.55 €/MWh, resulting from the strong local demand.[65]

Next year futures prices reflect expected developments of supply and demand balance of GOs

Futures were for the most time traded at higher prices than GO prices, anticipating the generally applying trend of increasing market participation and liquidity. Moreover, specific regulatory developments are publicly known for longer times, such as implementation of the CSRD from 2025 onwards, hence leading to futures being traded at higher prices today. Also, for example in 2021, the RED II implementation was anticipated to cause additional demand (RES target of 32% defined at the time), thus possibly seen in the steep increase of future prices after mid-2021. In addition, discussion of the Norwegian government for Norway – the by far largest exporter of GOs – to leave the GO market could also have had an influence on futures prices being above the spot market prices, reflecting the associated risk of undersupply.

More sudden changes can naturally not be anticipated by futures, including the Russian invasion in Ukraine or the effect of the dry year 2022. The unknowns for these "shocks" then lead to Y+1 futures to react steeply

[65] https://resource-platform.eu/wp-content/uploads/Guarantees-of-Origin-and-Corporate-Procurement-Options.pdf

and almost in parallel with the spot prices. The market remained positive that the crisis would not take longer than 2 years, considering that Y+2 and Y+4 futures were less responsive.

This confirms that demand developments are more generally incorporated into pricing, particularly visible in the futures prices.

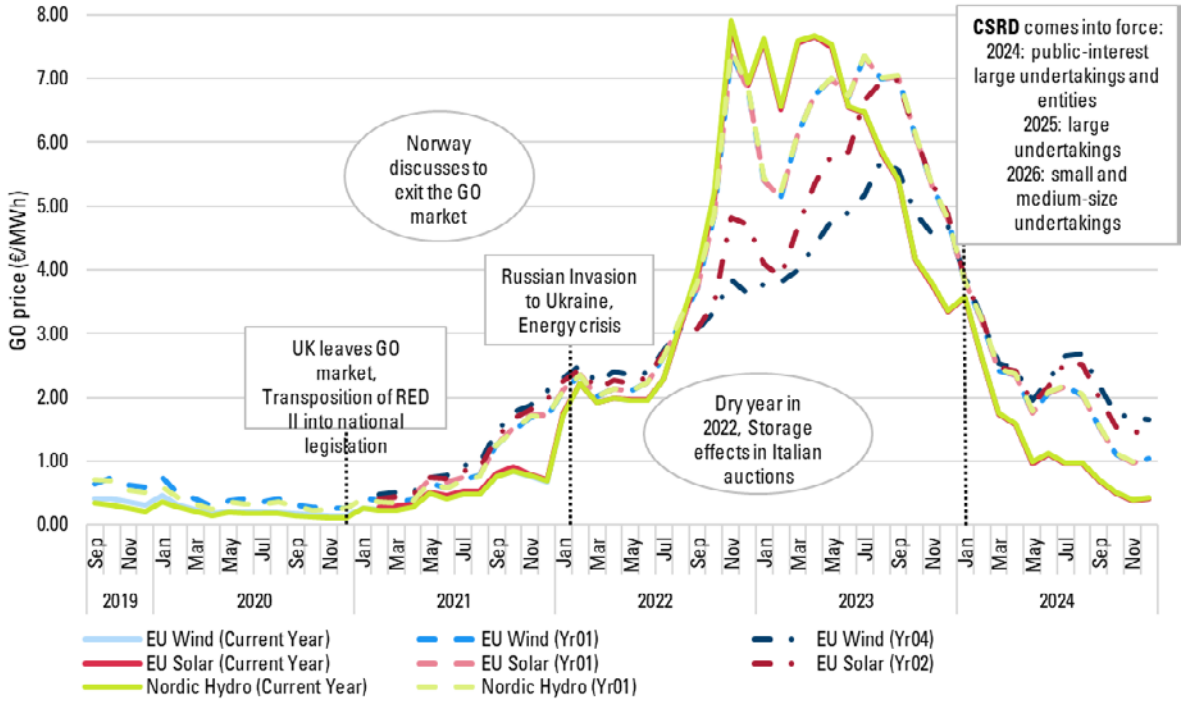


Figure 2-32: Futures and their response to developments (demand or general effects and in rectangular boxes, supply effects in ellipsoids)

Based on S&P Platts

2.3.3. Summary and conclusions on the responsiveness of the GO market and factors influencing the GO price

The GO market is considered to be responsive, if imbalances of supply and demand are reflected in prices. From our analysis we conclude, that while before the price spike in 2022, the general low GO price level reflected the persistent oversupply, the GO market is generally limited in its responsiveness to changes in the supply-demand balance: short-term price reactions are generally dominated by supply effects related to hydro GOs and due to its anchoring effect even wind and solar GOs follow the respective price developments. Medium- to long-term changes in supply – especially in the case of undersupply or just the perception of undersupply in an overall uncertain market – have led to large price reactions in 2022 and 2023. Long-term effects, such as regulatory changes are anticipated and visible in e.g. the futures prices. A summary of the imbalances with regard to responsiveness of the GO market including identified influencing factors is provided in Table 2-15.

Table 2-15: Summary of imbalances identified regarding the responsiveness of the GO market

#	Imbalance identified (qualitative description)	Quantification (if possible)	Associated indicator(s) (ID#)	Potential influencing factor	Severity
1	**GO price is anchored at hydro power GO price**	EU GO prices converging by at most 15 ct/MWh	GO price developments	Share of hydro in technologies; supply effects related to hydro (droughts)	**High**
2	**GO price more responsive to supply shocks or the related information hinting to undersupply**		Annual and monthly responsiveness of the GO market	Electricity prices, weather (drought), implementation of legislation, but most importantly the perception of a decreasing supply demand balance (Psychological market effects), Reporting obligations, contractual agreements	**Medium**
3	**Generally low responsiveness of the GO price in situations of oversupply**		Annual and monthly responsiveness of the GO market	Oversupply, RES-build-out, demand for quality-criteria (technology, regionality etc.)	**Low**

2.3.4. Key factors impacting supply and demand of GOs

Despite the limited correlation of supply and demand balance with price dynamics, supply and demand factors still influence the market. Below we therefore discuss the influence of all factors affecting supply or demand considered important by market participants (survey and interview feedback) and were at least quoted to influence ask and bid prices.

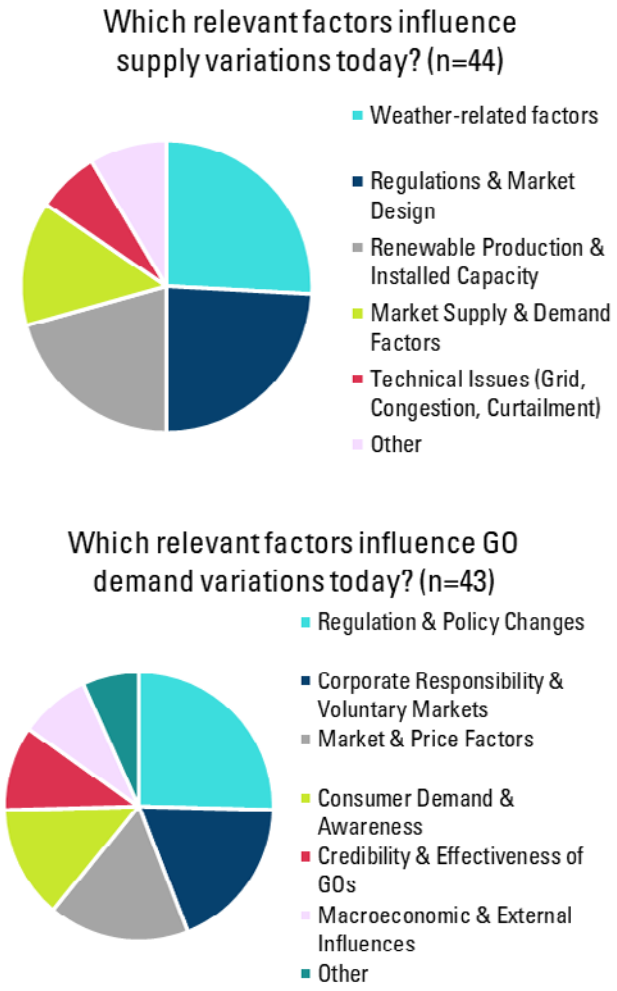


Figure 2-33: Relevant factors leading to GO supply and demand variations according to stakeholders
Based on survey

Key factors: Supply

Weather-dependency of electricity production leads to uncertainty in the supply of GOs with droughts having the highest impact as hydro GOs dominate in issuance

Overall, there are factors that remain unpredictable by nature and are hence accepted to bring uncertainty into a market dependent on these resources. Historically, with the largest share of issued GOs being for electricity from hydro, the supply of GOs has been largely affected by droughts (see also Figure 2-34). With an increasing share of GOs for electricity from solar and wind, the undersupply from droughts can be balanced out from other renewables. For example, in 2022, 55 TWh of hydro GOs less were issued than in 2021 due to low hydro reservoirs as a result of a dry year and at the same time, the issuance of wind and solar GOs increased by ~ 53 TWh, allowing to balance out the lack of hydro GOs.

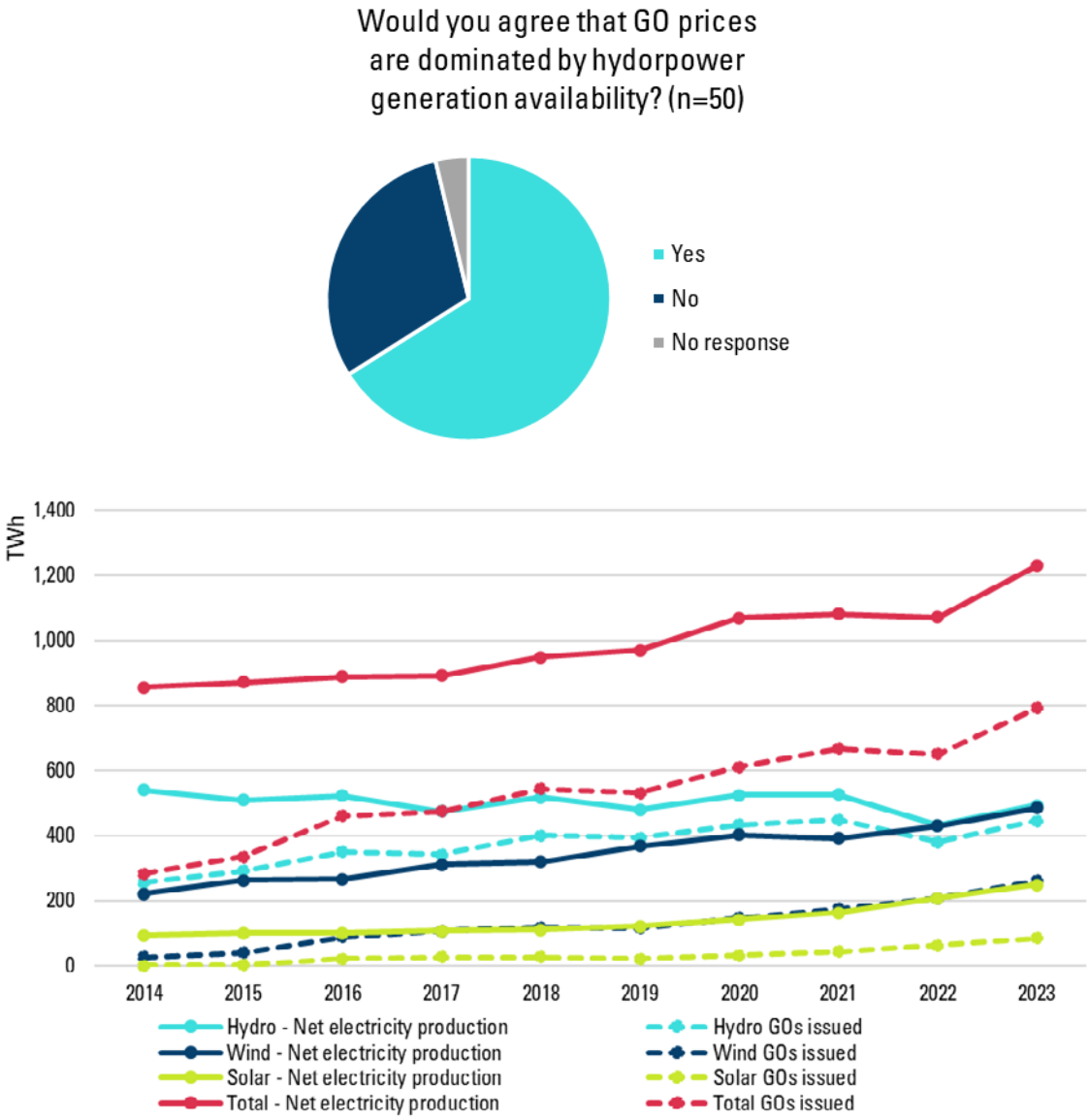


Figure 2-34: Net electricity production by renewable technology and sum of issued GOs

Based on Survey, Eurostat, AIB statistics 2021 and AIB statistics 2024

Note: The 2021 and the 2024 statistical dataset provided by AIB contain values for the years 2019 and 2020 which however do not align. In most cases, the values of the 2021 dataset are higher, which leads to the apparent drop in issued GOs in 2019

The build-out of solar and wind capacities contributes to the long-term increase of GO issuance

With the ongoing build-out of renewable electricity sources, the volumes of issued GOs are increasing, as apparent by the dotted red line in Figure 2-34. In addition (and confirmed by Figure 2-4) also the issuance rate of solar- and wind-based electricity is increasing continuously, covering large parts of the produced renewable electricity. In particular, cleaning the issuance rates for solar- and wind-based electricity produced in AIB countries without restrictions of GO issuance on supported electricity, the GO issuance rate based on production date has continuously increased form 57% in 2019 to 76% in 2022 with a small drop to 71% of GOs issued for electricity eligible for GO issuance in 2023. Although facing administrative burdens for small-scale installations (see section 2.2.1), the GO issuance grew stronger year-over-year

compared to the eligible electricity production in 2021. This likely falls together with the national implementation of the RED II and gives an indication on the growing acceptance of the GO system from the producer side. Overall, with the build-out of renewable electricity sources, also the volume of GOs eligible for issuance increases.

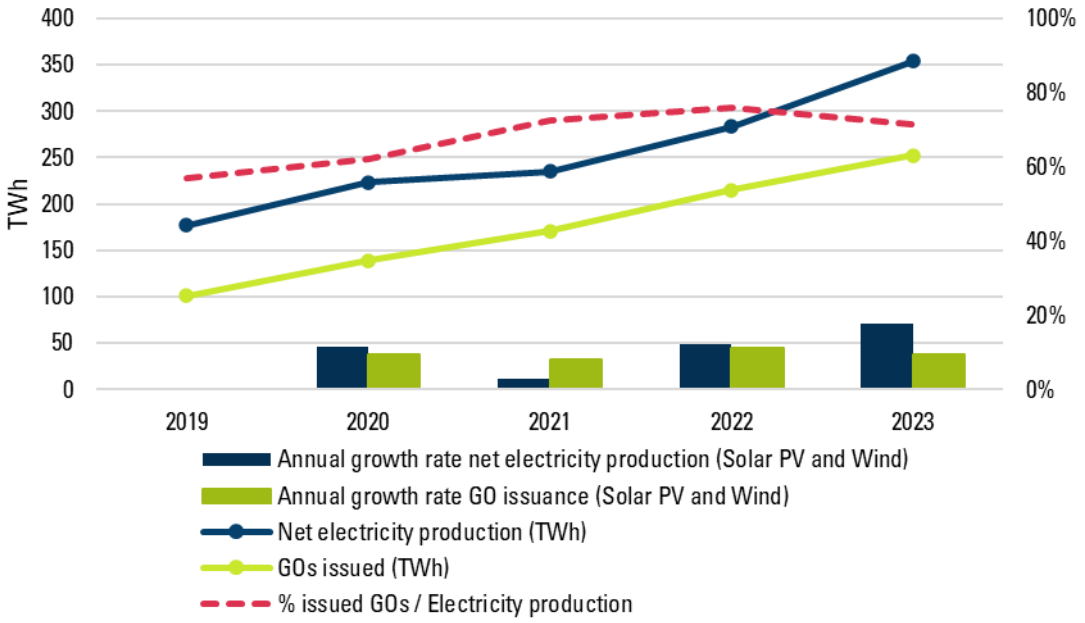


Figure 2-35: Comparison of GO issuance and growth of electricity production from renewables for AIB countries which allow GO issuance for supported electricity generation taking into account the start of AIB membership, availability of GO issuance data and status of eligibility of supported electricity for GO issuance (incl. AT since 2022, BE, CY, CZ, DK, EE, FI, FR since 2019, GR since 2023, HR since 2019, IT, LH since 2021, LU, NL, NO, PT since 2020, SE, SL since 2018, SK since 2023).

LBST based on AIB statistics 2024 (production-based data) and Eurostat

The eligibility of issuance for subsidised electricity is restricted in some Member States which especially limits the supply of GOs in Germany

Some Member States have implemented rules on how to treat subsidised electricity with regards to GO issuance (see discussion in section 2.2.2). There are different options, including:

- Non-eligibility of subsidised electricity for GO issuance
- Auctions for subsidised GO volumes
- Subsidised GOs are auctioned or traded only nationally
- Subsidised GOs are directly cancelled
- Earmarking of subsidised GOs

The restriction on non-eligibility for GO issuance has a considerable impact on the supply of GOs. This is especially the case for Germany where due to the "Doppelvermarktungsverbot" (Double marketing ban) GOs are issued for only ~10% of the renewable electricity produced making Germany by far the largest net-importer of GOs (see also Figure 2-5).

Auctions lead to monthly supply variations of in average 5%

Auctions help bundle and standardise GOs, fostering liquidity and simplifying trading in fragmented markets. GO auctions supply between 5 to 15% of the total yearly issued volumes to the market. As depending on country, these auctions show different frequencies (from monthly to quarterly) the monthly supply of GOs from auctions shows irregular variations of in average roughly 4 TWh year-on-year (see Figure 2-37), corresponding to about 5% of GOs issued by AIB countries. With auctions, large volumes are pushed into the market at once. In March 2024, 16 TWh of GOs were auctioned.

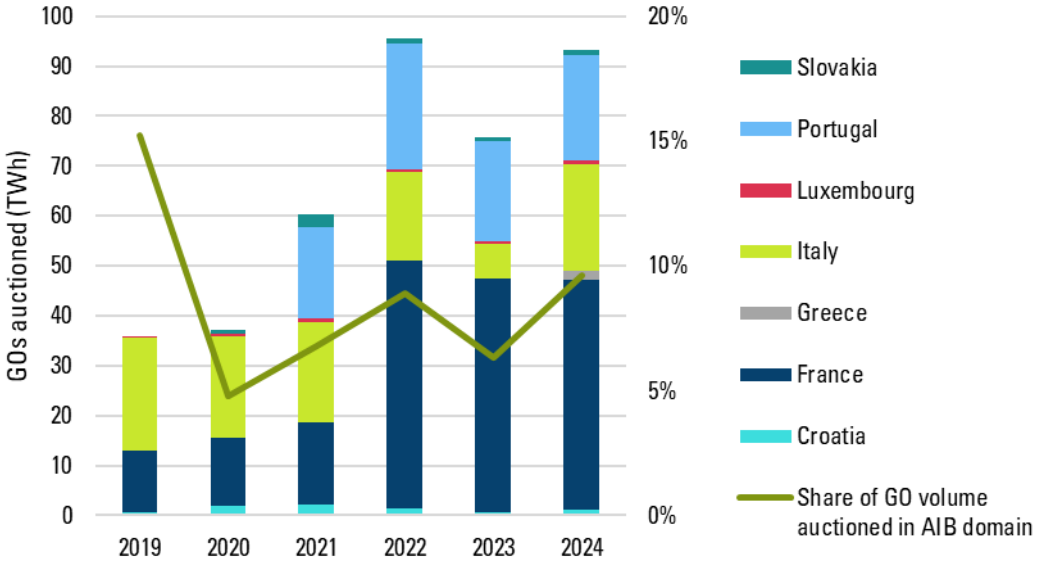


Figure 2-36: Annually GO volumes auctioned per country and share of auction volumes in AIB domain

Based on auction websites[66] and AIB statistics 2024

Note: AIB statistics includes only data until August 2024

[66] https://www.aib-net.org/facts/market-information/auctioning-gos-aib-members

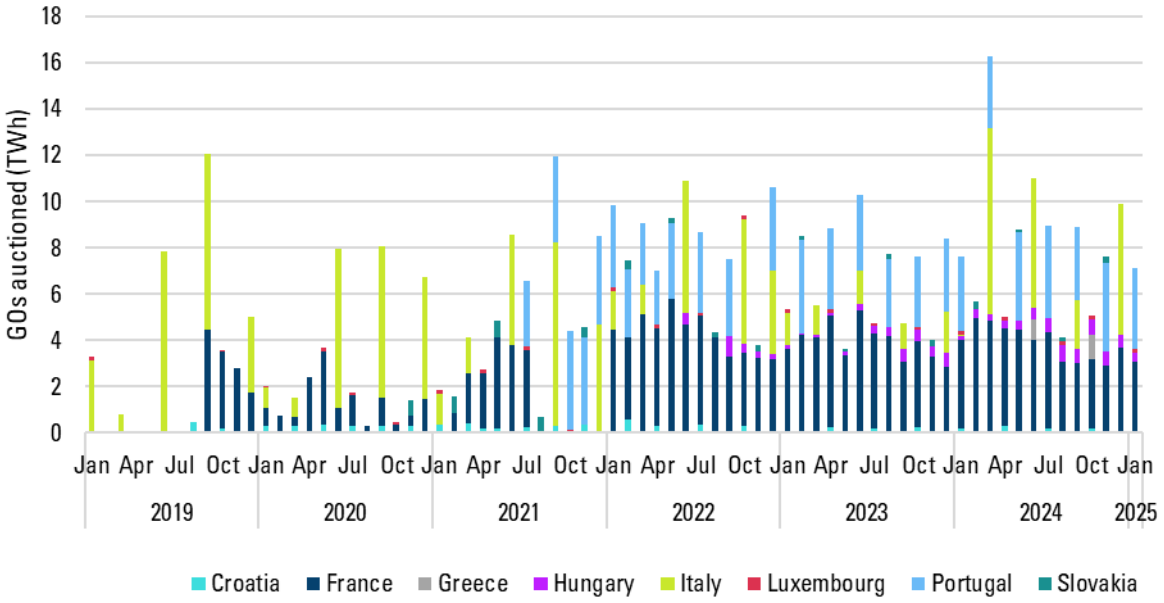


Figure 2-37: Monthly auctioned GO volumes per country

Based on auction websites[67] and AIB statistics 2024

Note: AIB statistics includes only data until August 2024

Strictness of implementation of temporal matching requirement

As identified in section 2.2.2, the temporal matching requirement, i.e. the allowed timeframe of electricity production until the cancellation is implemented with relatively large variability across Europe. While France has the strict provision of monthly matching, a few countries allow the cancellation of GOs after even 18 months (leading to uncertainty on supply per year). The majority of AIB members have implemented the validity of GOs of 12 months from the month of production of the corresponding MWh electricity. Depending on the applied rule, this has implications for the supply and demand balance of GOs.

Monthly matching

As objective, transparent and non-discriminatory criteria for the use of GOs are allowed as per Art. 19(12 of the RED II, France requires suppliers to cancel GOs for disclosure of the month matching the month of production. Still GOs can be issued up to five months after electricity production and are valid for 12 months. The disclosure period in France remains on an annual basis meaning that cancellation can be done within 12 months under the requirement that the respective GOs are cancelled for the month of production that the GO relates to. The monthly matching requirement makes the GO price more sensitive to supply variations, as decreased supply, e.g. from dry weather conditions, cannot be balanced out by GOs from months with good weather conditions which have resulted in oversupply. In general, this can lead to a

[67] https://www.aib-net.org/facts/market-information/auctioning-gos-aib-members

higher volatility[68] of GO prices, as it became apparent during the 2022/2023 price peak, where for France the standard deviation was 2.26 €/MWh[69], while the EU average was 2.18 €/MWh.

Annual matching

Annual matching allows for greater flexibility to balance supply and demand over a longer period. Thus, green electricity consumption can be more easily certified with any production technology, irrespective of their feed-in profiles: the illustrative example quoted frequently is the use of solar PVs to run a production process at night. Although GOs include the respective tracking information the associated messages of producing carbon-free do not reflect the physical reality. Note that this holds true for monthly matching as well, only allowing to balance seasonal effects. The advantage of annual matching compared to more granular matching requirements is the enhanced price stability due to procurement strategies buffering short-term effects on supply and demand. At the same time, speculation over long time periods is enabled.

Vintage swapping and storage effects

Another possible effect from loose temporal matching requirements became visible in the 2023 and 2024 Italian auctions. As a reaction to the persistent high prices in 2023, GOs for auction were withheld completely for the auctions of September and December 2023 as well as January 2024 while auctioned volumes the months before were also limited. Amplified by the prolonged cancellation period of 18 months in Italy, 14 TWh of GOs were offered at once in the auction of March 2024 containing unsold vintages of September 2022. This contributed to the already expected oversupply of 2024 and led to low GO prices back on pre-2022 level. Furthermore, during the high prices, minimal unsold volumes which were close to expiry were offered at only a fraction of the market prices, at 0.15 €/MWh.

[68] Note that a higher volatility can indicate a larger price responsiveness. Temporal matching can be be considered a measure to improve price responsiveness.
[69] Own calculations, based on EEX auction results

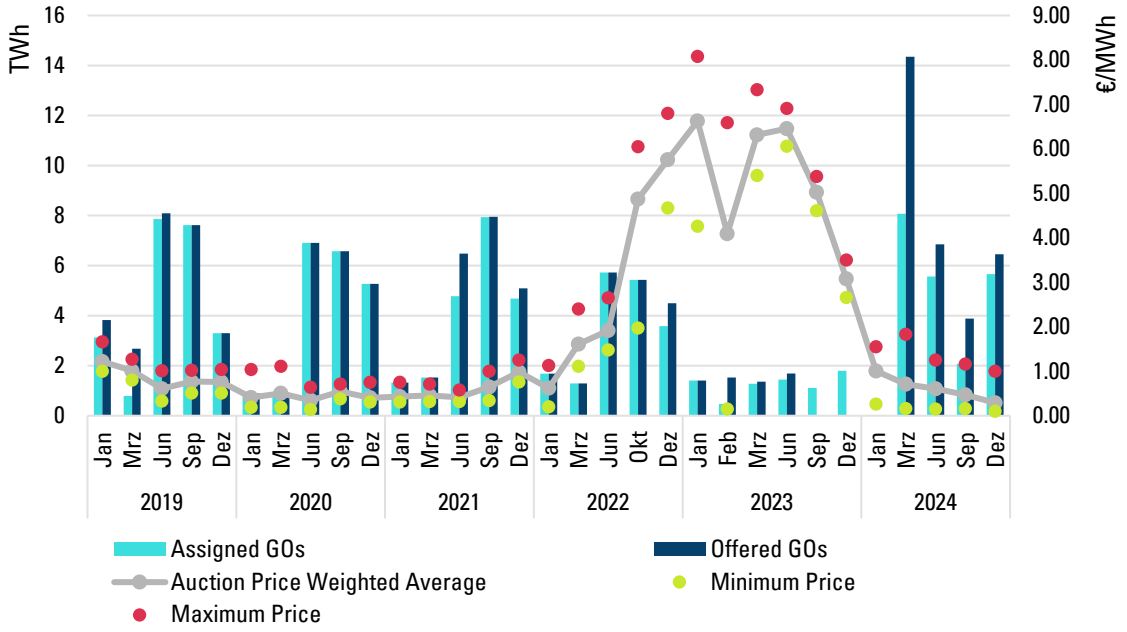


Figure 2-38: Italian GO auctions indicating storage effects during the price peak in 2023

Based on GSE auction results

Export restrictions for subsidised GOs

As discussed in section 2.2.2, there are export restrictions in place for supported GOs in Spain and Austria, removing these volumes from the supply to the European market. These nationally traded GOs are often associated with lower prices.

Key factors on either supply or demand

New countries entering AIB

From year to year, more and more countries have become AIB members and connected their national registries to the AIB Hub. This has increased the overall supply of GOs as well as the demand for GOs in the AIB domain. Depending on several factors such as renewable electricity resources, implementation of the RED II provisions into national legislation, countries enter the AIB domain as net-importer or net-exporter of GOs and thus positively or negatively influence the balance of supply and demand. The specific case of Serbia is analysed in detail in section Deep dive: New national participants.

The role of nuclear GOs

In 2022, the issuance of nuclear GOs almost doubled from 33 TWh in 2021 to 60 TWh. In this year, Finland and Slovenia started issuing nuclear GOs and contributed with considerable amounts, as shown in Figure 2-39[70]. During the high price periods of the year 2023, cancellations of nuclear GOs increased by 36 TWh to

[70] It should be noted, that since 2021, GOs from Switzerland are not recognised for disclosure in the EU.

84 TWh avoiding the high prices of renewable GOs. According to the EU Taxonomy, this required companies rebranding their portfolios from "renewable" to "carbon-neutral".[71]

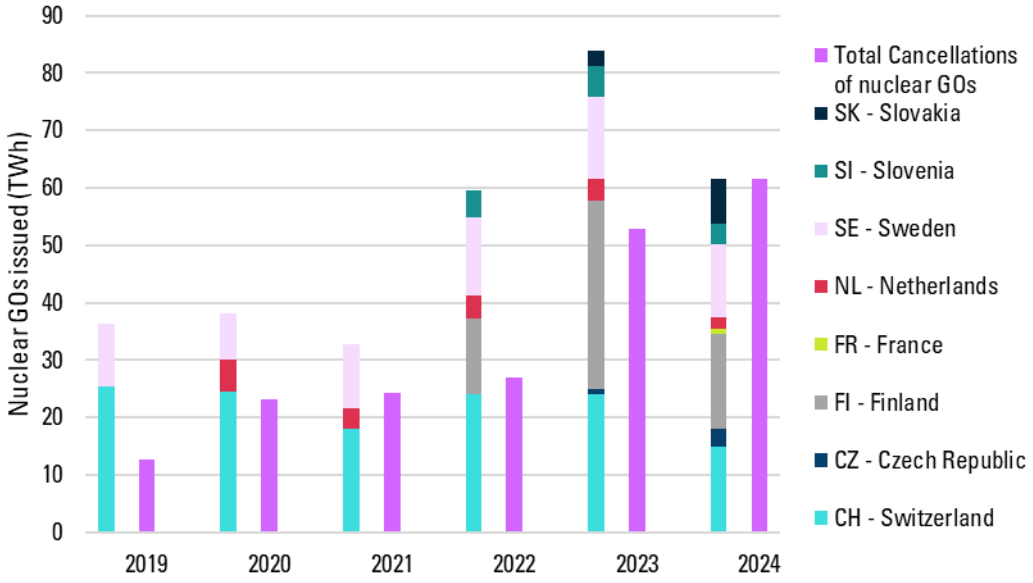


Figure 2-39: Annual issuance of nuclear GOs per country (left bars) and total cancellation of nuclear GOs (right bars)
Based on AIB statistics 2024
Note: 2024 includes only data until and including August 2024

Thus, overall, nuclear GOs - if accepted in companies' portfolios - can further increase the supply of GOs. Considering different ongoing discussions, the sustainability of nuclear GOs is perceived differently among Member States and limitations in the demand are likely to remain.

Key factors: Demand

The demand for GOs is generated from different motivations. As reflected in the survey, this comes to the largest share from regulatory obligations on reporting. Secondly, the demand is influenced by the intrinsic motivation of private consumers choosing green tariffs and thirdly by companies which mainly see marketing opportunities in the use of GOs.

[71] https://cloud.google.com/blog/topics/sustainability/google-achieves-four-consecutive-years-of-100-percent-renewable-energy?hl=en and https://blog.google/outreach-initiatives/sustainability/getting-closer-to-a-carbon-free-future-our-largest-offshore-wind-projects-to-date/

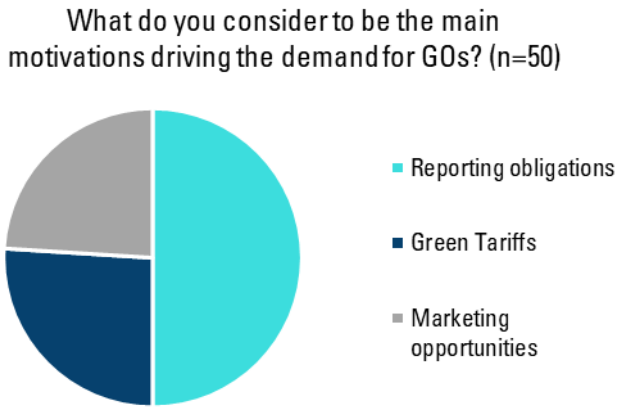


Figure 2-40: Survey feedback on main motivations driving the demand for GOs (n=50)

Based on survey

GOs as a trusted instrument to proof renewability and being used for disclosure purposes are often bundled in contractual agreements, e.g. 217 TWh via renewable PPAs, and thus the elasticity in the cancellations is relatively small. This leads to the expectation that the cancellations will not largely be affected by price changes. During the price peaks of 2022/2023, however, as also confirmed in interviews, the procurement strategies where adapted and consumers aiming to regularly stock-up did "skip" some of their regular buying activity. Market players not having had appropriately hedged their risks, where forced to buy at very high prices on the "spot market". Also, contractually bound offtake within i.e. PPAs is rather rigid and may have put some parties under pressure to buy despite very high prices. (Note that PPAs are, however, individual contracts and in generally include some flexibility on RES volumes, both for supplier and offtaker).

Even though reporting is "voluntary" in most cases, their combination with (sub-)sectoral renewable targets can make the demand comparatively inelastic, increasing the risk for a market that has reached structural undersupply. "How should a consumer report, if there is no issued certificate left?"

More generally, demand elasticity is guided by the respective contractual situations, with more flexibility with industrial consumers that might indeed actively refrain temporarily from procuring "green", while private households are somewhat buffered from immediate market effects.

Green tariffs

Private consumers are not directly participating in the GO market. Instead, the demand for GOs is indirectly driven by the demand for green tariffs. Energy suppliers must follow procurement strategies which hedge risks in order to be able to fulfil their contracts. The willingness-to-pay of average household consumers in Europe is highly dependent on trust in the respective energy supplier, thus not only the GO system but also related to brand history and application of "correct" labels. Interviews confirmed that green tariffs must orient on the average conventional tariffs. Only very specific "expert labels" might reach a small group of customers, with an even higher WTP. A deepened discussion will follow in a second part of the study, dealing with options to establish a Union-wide green label in Europe.

Procurement strategies

Procurement strategies for GOs have become an increasingly important factor influencing the demand for these. Companies are adopting various approaches to secure GOs as part of their sustainability efforts. These give rise to demand elasticity, and demand diversification and specification, e.g. with regard to technologies: [72]

- **Direct Purchasing:** Many corporations are opting to purchase GOs directly from suppliers or through online trading platforms. This strategy allows companies to have more control over the type and source of renewable energy they are supporting.
- **Supply contracts for unbundled GOs:** Companies committing to medium- to long-term contracts for the future supply of GOs provide a strong demand signal for the GO market while securing long-term renewable energy claims.
- **Power Purchase Agreements (PPAs):** A significant portion of GOs (217 TWh in 2024) is included in Power Purchase Agreements (see BOX 5). The tracking and information properties of GOs remain highly relevant for the functioning of the PPA market, even as the two markets maintain a distinct price dynamic. This approach does not only allow buyers to claim the use of renewable energy but also helps in hedging financial risks associated with energy procurement.
- **Bundled Energy Contracts:** Some power suppliers are bundling GOs with their electricity contracts, ensuring that customers automatically receive renewable energy. This strategy is particularly common in countries like Sweden and Germany, making it easier for consumers to choose renewable options.[73] This strategy is comparable to PPAs with the difference that the contract is agreed between consumer and electricity provider. This provides the opportunity for consumers to continuously negotiate the contract to mitigate risks associated with traditional corporate PPAs.

Driven by reputational impact[74], companies are becoming more strategic in their GO procurement, considering quality factors such as[75]:

- **Regionality**: There's an increasing demand for locally generated renewable electricity, which can drive up the value of GOs from specific regions.
- **Technology preferences**: Buyers may choose GOs from specific renewable sources like wind, solar, or hydropower to align with their sustainability goals.
- **Additionality**: Some companies are seeking GOs that demonstrate the creation of new renewable energy capacity, potentially influencing future market trends.

These diverse procurement strategies are contributing to the growing demand for GOs with limited demand elasticity, reaching cancellations of 723.2 TWh in 2023, up from 707 TWh in 2022. It is commonly assumed that with growing professionalisation in the GO market, procurement strategies for large corporations will further be refined allowing increasing diversification and price differentiation based on quality characteristics. As we will discuss in the context of GO market effectiveness, however, this may hold true

[72] https://resource-platform.eu/wp-content/uploads/Guarantees-of-Origin-and-Corporate-Procurement-Options.pdf
[73] https://www.statkraft.com/newsroom/explained/guarantees-of-origin-ensuring-100-per-cent-renewable-power-in-europe/
[74] https://resource-platform.eu/wp-content/uploads/Guarantees-of-Origin-and-Corporate-Procurement-Options.pdf
[75] https://www.kas.de/documents/252038/16166715/Guarantees+of+Origin+for+Green+Energy.pdf/e40eb8d2-6e83-5411-aa9c-ab1b888f4e2f?version=1.0&t=1663249143008

for very large energy consumers, but not necessarily SMEs, e.g. not easily signing PPAs[76] and more generally develop an electricity procurement strategy.

GOs demonstrating the use of renewable energy disclosed under reporting obligations

Regulations such as the Renewable Energy Directive, have been crucial to promote the use of renewable energy by obligating various sectors. Although not directly assigned to promote the use of renewable energies, guarantees of origin have been introduced by Art. 19 of the RED II for the purpose of "demonstrating to final consumers the share or quantity of energy from renewable sources in an energy supplier's energy mix and in the energy supplied to consumers under contracts marketed with reference to the consumption of energy from renewable sources". As such, GOs serve as evidence for the use of renewable energy and support sustainability claims.

The EU has set out several legislations which require different stakeholder groups to report their energy consumption mix.

EU Taxonomy

The Taxonomy Regulation 2020/852/EU entered into force on July 12, 2020, to establish a classification system to define environmentally sustainable economic activities. It was implemented as part of the European Green Deal initiative and aims at creating market transparency to redirect capital flows towards sustainable investments. One of its six environmental objectives includes climate change mitigation. Under the Corporate Sustainability Reporting Directive (CSRD) companies can demonstrate their alignment with the EU Taxonomy to incentivise the allocation of investments.

Corporate Sustainability Reporting Directive (CSRD) and European Sustainability Reporting Standards (ESRS)

The Corporate Sustainability Reporting Directive (CSRD) introduces disclosure obligations related to environmental, governance and social issues for up to 50,000 companies in the EU. From 2025 companies obligated under the NFRD are required with the reporting of the financial year (FY) 2024. Other large companies are required from 2026 for the FY 2025 and listed SMEs from 20227 for the FY 2026 with the option to postpose the reporting by two years. Non-EU parental companies will be obligated from 2029.[77]

The European Sustainability Reporting Standards, defined under the Commission Delegated Regulation (EU) 2023/2772 supplementing the CSRD, most importantly establish the market-based method as the only option for the disclosure on the energy consumption mix. Along with PPAs and also the residual mix, GOs are eligible to demonstrate the use of renewable energy. To report Scope 2 emissions, both the location-based and market-based method are required, while for the reporting of targets related to climate change mitigation can be based on either of the methods.[78]

Data centres regulation

In the course of the recast of the Energy Efficiency Directive, the Information & Communication Technology (ICT) sector has been identified to have an increasing importance with regard to reducing the EU's energy

[76] https://perspectives.se.com/blog-stream/decarbonizing-supply-chains-through-aggregated-ppas
[77] Veyt webinar: Have GO prices hit rock bottom?
[78] https://eur-lex.europa.eu/eli/reg_del/2023/2772/oj/eng

consumption. In the following, the Commission has adopted the delegated regulation on the first phase for establishing an EU-wide scheme to rate the sustainability of EU data centres.[79]

Under its provisions, operators of data centres with an installed IT power demand of at least 500 kW are required to report their renewable energy consumption. Through specific categories defined to calculate the renewable energy consumption, GOs are specifically mentioned as eligible evidence of renewable energy consumption providing transparency and reliability of the information reported. The information reported including the GO usage contributes further to establishing a common Union scheme for rating the sustainability of data centres.[80]

RFNBO production according to the RED II framework

The RED II amendments have strengthened the targets related to renewable energy supply for various sectors including specific sub-targets for renewable fuels of non-biological origin (RFNBO) for 2030. Market operators are further incentivised to choose RFNBOs by double accountability towards the obligated targets. For the production of RFNBOs, producers must demonstrate that the electricity used to produce the fuel – if not procured via a direct connection – complies with the criteria of additionality, temporal correlation and geographical correlation. Here, power purchase agreements are obligatory to demonstrate compliance and MSs have to ensure the cancellation of the associated GOs according to recital 15 of the RFNBO DAs.

BOX 5: Renewable PPAs are an important driver for GO demand

Renewable Power purchase agreements are an increasingly relevant tool that allows on the one hand project developers to secure bankability and on the other hand offtakers to hedge their risks in renewable energy procurement[81]. Importantly, PPAs are a tool requiring strong credit worthiness on offtaker side to secure the bankability required for the producers, this makes PPAs especially suited for very large corporations and utilities bringing creditworthiness and then selling "subsets" to smaller customers. According to the PPA Deal tracker operated by RE-Source in 2024[82] over 12 GW of annual production capacity were announced. This is six times the capacities announced in 2018 around implementation of REDII and reaching 50 GW of capacity cumulatively contracted since 2013. The actual energy produced under the existing contracts reached 217 TWh in 2024[83]. The largest share are solar capacities, but due to the lower capacity factors the most contracted electricity is from wind power plants.

For the GO market PPAs are an important driver for demand since under all contractual designs with off-site electricity production GOs are used to track and proof the renewable nature of the procured energy[84]. On-site electricity production and respective self-consumption (behind the meter) is usually not tracked via GOs. According to Art. 2(14) also end-consumers procuring electricity via a direct line

[79] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ%3AL_202401364
[80] https://energy.ec.europa.eu/news/commission-adopts-eu-wide-scheme-rating-sustainability-data-centres-2024-03-15_en
[81] https://advisory.eib.org/publications/attachments/commercial-power-purchase-agreements.pdf
[82] https://resource-platform.eu/buyers-toolkit2/ppa-deal-tracker/
[83] https://www.spglobal.com/commodity-insights/en/news-research/latest-news/electric-power/080124-infographic-european-renewable-power-purchase-agreements
[84] https://resource-platform.eu/wp-content/uploads/files/statements/RE-Source-introduction-to-corporate-sourcing.pdf

fall under the category of "renewables self-consumer". However, as also confirmed in interviews, it is safe to assume that close to 100% of the 217 TWh produced under PPAs in 2024[85] is also issued as guarantees of origin. PPAs are thus essentially combining the electricity market dynamics with GO market dynamics.

PPAs intrinsically provide investment support to project developers by securing a large share of the produced energy at a base price and in turn support the build-out of renewable energy capacities. Especially in Spain and Germany covering the largest shares of the contracted volumes[86], renewable energy build-out under PPAs reach over 40% in Spain (3.1 GW of 7.3 GW[87]$_{2024\ basis}$) and > 20% in Germany (3.7 GW of 17 GW[88]$_{2023\text{-}basis}$) respectively. The largest share of renewable capacity build-out in Europe remains dependent on public support instruments.

Regarding GO market dynamics, Spanish solar PPAs play a special role in the GO market. Spain limits the export to the owners of the power plants in order to have control on renewable build-out subsidies[89]. As a consequence, the GOs issued under Spanish PPAs have a more limited value in the portfolios (and leading to misconceptions on the "standard product").

PPAs are also signed for existing hydropower stations[9091] usually having not incentivised new investments, but rather securing offtake individually. Cumulated data are not available but are certainly on the order of[92].

[85] https://www.spglobal.com/commodity-insights/en/news-research/latest-news/electric-power/080124-infographic-european-renewable-power-purchase-agreements
[86] https://resource-platform.eu/news/europe-breaks-records-with-10-3gw-corporate-renewable-energy-deals-in-2023/
[87] https://www.pv-magazine.com/2025/03/26/solar-becomes-spains-top-power-source-in-2024/
[88] https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/EN/2024/20240105_EEGZubau.html
[89] https://www.dlapiperintelligence.com/corporateppa/countries/index.html?t=incentives-and-benefits&s=04-national-support-scheme&c=ES
[90] https://www.borealisgroup.com/news/borealis-and-vattenfall-si gn-their-first-long-term-hydropower-ppa-to-source-renewable-power-in-sweden
[91] https://www.hydro.com/en/global/energy/energy-in-hydro/hydros-power-portfolio/
[92] https://www.renewableenergyworld.com/energy-business/energy-finance/statkraft-and-inovyn-sign-two-new-ppas-for-electricity-from-hydropower/?related=post_cards

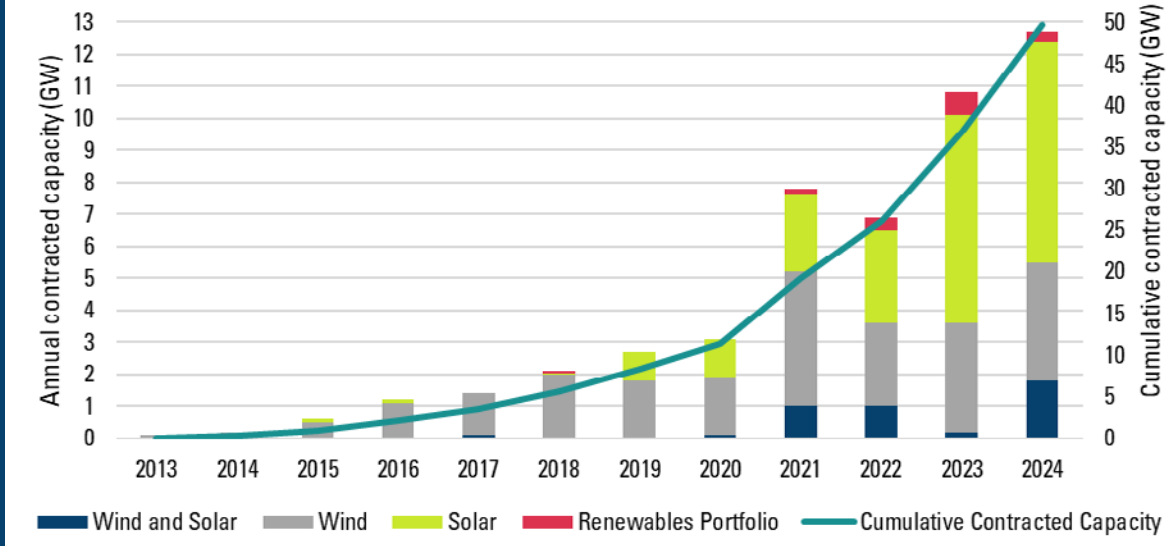


Figure 2-41: Annual and Cumulative Contracted PPA Capacity (GW).
Based on RE-Source, PPA deal tracker[93].

GO volumes issued under PPAs are usually not available for the merchant market, except for some overcapacities not covered under the contracts and hence reduce liquidity. To date however, the GO merchant market always exceeded the energy generated under PPAs by at least a factor of 3, thus not reaching critical volumes. As also discussed in chapter 3, a further growing PPA demand will likely not reach this critical level toward 2030.

Comparing trends in prices between GOs and PPAs, no major correlation is observed (Figure 2-42). While the overall electricity price peak in 2023 was also observable for PPAs contracted, the prices stabilized in 2024. In contrast GO prices continuously fell further.

[93] https://resource-platform.eu/buyers-toolkit2/ppa-deal-tracker/

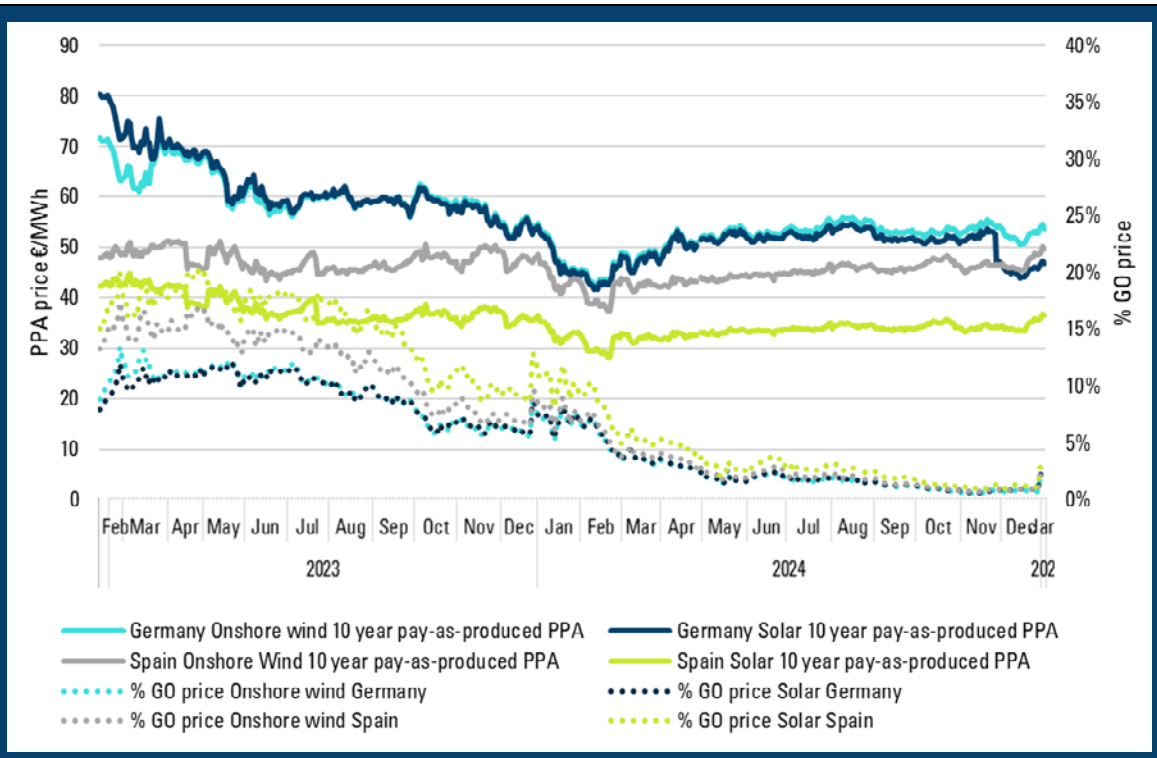


Figure 2-42: PPA prices and Share of GO price in PPA price.
Based on S&P Platts

Thus, PPAs remain dominated by the electricity market and not GO market, not excluding that the tracking and information property of GOs (the system) are highly relevant for a functioning PPA market.

GOs serving as evidence for eligibility for state aid schemes

Regulatory decisions driving GO demand also include state aid schemes. Most prominently two of the schemes require consumers to increase their renewable energy consumption to become a beneficiary: The state aid scheme for reduced electricity levies and for indirect ETS costs. For both, several countries approved GOs as eligible evidence proving compliance with obligations.[94] Since the associated demands are however all occurring at different points in time, it can only be concluded that the overall trend to increasing cancellations is also influenced by these factors.

State aid scheme for reduced electricity levies

In accordance with Art. 4.11 Guidelines on State aid for climate, environmental protection and energy 2022 (2022/C 80/1) several Member States have been approved for state aid schemes to protect energy-intensive sectors at risk to move outside of the European Union by reduced electricity levies for energy-intensive sectors. This affects 79 sectors (NACE) such as mining, chemicals, metals, food and beverages. Beneficiaries must comply with the obligation to conduct an energy audit and must be monitored by the Member State to do one of the following:

[94] Veyt webinar: Have GO prices hit rock bottom?

- Implementation of recommendations of the audit report
- Reduction of carbon footprint by covering at least 30% of their electricity consumption from carbon-free sources
- Investment of at least 50% of the state aid into projects that lead to substantial reductions of the installation's greenhouse gas emissions

State aid schemes of at least 13 Member States have been approved by the Commission. Six of these have implemented the electricity sourcing requirement as one of the options for beneficiaries, including Germany, Italy, Spain, Croatia with a threshold of even 60% of renewables, Slovakia and Romania. Germany, Spain and Croatia in addition exclude the option of carbon-free electricity sources. Unbundled GOs are eligible evidence in all six Member States to prove compliance with these obligations, while PPAs are excluded in Romania.

State aid schemes for indirect ETS costs

In accordance with Art. 10(6) of Directive (EU) 2018/410 and State aid rules, Member States can adopt "financial measures in favour of sectors and subsectors which are exposed to a genuine risk of carbon leakage due to significant indirect cost that are actually incurred from greenhouse gas emission costs passed on in electricity prices". Since 2020, State aid schemes for indirect ETS costs have been approved for 17 Member States and Norway. The table below provides a list of these indicating where unbundled GOs and PPAs are approved as evidence for renewable and carbon-free electricity consumption:

Table 2-16: Approved EU/EEA state aid schemes for indirect ETS costs

Country	Market- or Location-Based Method	Eligible Sources	Unbundled GOs	PPAs	Reporting Period
Czechia	Market	Carbon-free	✓	✓	2022–2030
Finland	Market	Carbon-free	✓	✓	2021–2025
France	Hybrid	Carbon-free	✓	✓	2022–2030
Germany	Market	Renewable	✓	✓	2023–2030
Greece	Market	Renewable	✓	✓	2021–2032
Italy	Market	Carbon-free	✓	✓	2021–2030
Luxembourg	Market	Renewable	✓	✓	2025–2030
Netherlands	Market	Carbon-free		✓	2024–2025
Norway	Location	Renewable			2021–2030
Poland	Market	Renewable	✓	✓	2021–2030
Portugal	Market	Carbon-free	✓	✓	2021–2030
Romania	Market	Carbon-free	✓	✓	2025–2030
Slovakia	Market	Carbon-free	✓	✓	2021–2030
Slovenia	Market	Carbon-free	✓	✓	2022–2024
Spain	Market	Carbon-free	✓		2025–2030
Wallonia (Belgium)	Market	Renewable		✓	2021–2030

BOX 6: The Netherlands – Can consumer awareness create real value?

The Dutch GO market experienced an early debate on so-called '*sjoemelstroom*', leading to wide public awareness of the downturns of European-wide trading of GOs. Together with a generally wide-spread interest in green tariffs (more than 60% of Dutch households procure "green"), this early on led to high demand in GOs issued from local wind farms. In turn up to 8 €/MWh were paid for Dutch wind GOs, while European average was below 1 €/MWh.

Since 2019 the GO market in the Netherlands has the additional advantage of large transparency on the demand side with a full consumption disclosure[95]. Even in a much more liquid market for all kinds of technology specific GOs across Europe, Dutch GOs consequently noted at higher prices compared to European average (2.7 €/MWh, while European GOs noted below 0.5 €/MWh). This effect can indeed be explained by the factually undersupplied market (in 2021 34 TWh of GOs were issued in the Netherlands, while almost 61 TWh were cancelled), dominated by very rigid "base demand" from publicly controlled companies such as the Dutch rail company committing to procure 100% renewable electricity.

It remains difficult to judge, if the full consumption disclosure had an effect on additional demand (since in the first year of implementation no additional demand can be observed (53 TWh in 2019 vs. 54 TWh in 2020). However, the change into 2021 did significantly increase demand to 61 TWh, which in turn could either be a delayed effect, or may overlapped by general growth and rebound effects after the COVID crises.

On the one hand the Dutch example shows how undersupply can indeed create value to specific GOs, while it must be noted that any company falling under reporting obligations has the flexibility to "fill up" missing GOs from a European market ("open system"), translating to large supply elasticity. Interestingly, the market however did not increase import GOs from outside the Netherlands, showing that domestic availability grew fast enough to supply the increasing demand.

On the other hand, simply applying the same model to a European/AIB market, would in fact see much less supply elasticity ("closed system") and hence increase the risk for structural undersupply that must then be buffered via demand elasticity. Possibly leading to detrimental effects, since consumers will effectively be forced to NOT claim as much green electricity as they intended to.

For a more detailed discussion, please refer to the chapter on development options.

Sources: Becour[96], RWTH Aachen/MDPI[97], RE-Source[98], Guardian[99], RECS[100]

[95] https://recs.org/download/?file=Full-Consumption-Disclosure-in-the-Netherlands_FINAL.pdf&file_type=documents
[96] https://becour.com/articles/guarantees-of-origin-in-the-netherlands/
[97] https://www.mdpi.com/2071-1050/9/1/16#B57-sustainability-09-00016; https://www.fcn.eonerc.rwth-aachen.de/global/show_document.asp?id=aaaaaaaacaonfsg
[98] https://resource-platform.eu/wp-content/uploads/Guarantees-of-Origin-and-Corporate-Procurement-Options.pdf
[99] https://www.theguardian.com/world/2017/jan/10/dutch-trains-100-percent-wind-powered-ns
[100] https://recs.org/download/?file=Full-Consumption-Disclosure-in-the-Netherlands_FINAL.pdf&file_type=documents

2.4. Financial streams

National issuing bodies charge account holders for participating in GO trading[101], however fees and the structure of the fees vary significantly between countries. In some countries, fees are set by the issuing body, whilst others are government regulated. According to AIB, AIB costs are included in the tariffs, unless stated otherwise. Some countries, e.g. Slovenia or Austria, directly depend their costs charged on the AIB fees they have to pay. Some countries further have different fees in place for electricity and gas, whilst most countries have only one cost structure.

Due to the largely different structure of the costs across AIB countries, comparison is difficult. As an example, Austria simply divides the AIB fee by its users and demands only an annual account charge from all parties (€ 83,900 in 2024 for electricity) and no fees for individual transactions or plant registration. Other countries have only a small annual account charge for traders and suppliers in place but require plant registration fees (dependent upon plant size), as well as transaction fees depending on the number and type of transfer made. Another interesting case is Ireland, where there are no charges on certification basis, but the fees are totalled and charged back using a socialised charging mechanism (via the Transmission Use of System Charges). In Spain, there are no fees at all charged.

In its overview of the tariffs charged by AIB members[102], AIB differentiates between different categories of fees, which are used to compare costs across. These categories are account opening, production plant registration, annual account charges, monthly account charges, transaction charges and sundries. Based on this distinction, seven different cost structure models have been identified, differentiating between account charges (annual & monthly), transaction charges and plant registration (see table below for details). The table shows that a majority of AIB countries charges either within all categories or for the account and transactions. However, in several countries only transactions are charged, and three countries do not charge at all.

Table 2-17: Types of Cost Structures of issuing costs across AIB members

Model	Countries	Number of Countries	Share of Countries
Account Charges only	Austria	1	3.4%
Plant Registration only	Cyprus	1	3.4%
Transaction Charges only	Estonia, Italy, Latvia, Serbia	4	13.8%
Account Charges & Transaction Charges	Czech Republic, France, Hungary, Lithuania, Montenegro, Netherlands, Slovakia, Slovenia*, Sweden, Switzerland	10	34.5%
Account Charges; Plant Registration & Transaction Charges	Croatia, Denmark, Finland, Germany, Iceland, Luxembourg, Norway, Portugal	8	27.6%

[101] https://www.aib-net.org/facts/aib-member-countries-regions/tariffs-charged-aib-members
[102] https://www.aib-net.org/facts/aib-member-countries-regions/tariffs-charged-aib-members

No Charge	Belgium, Georgia Greece, Spain	4	13.8%
Charged back via Transmission Use of System Charges	Ireland	1	3.4%

*Slovenia has a slightly different model of dividing fixed costs by membership and variable costs based on transactions. Since this approach is similar to the other models and thus included here.

The variance of the cost structure makes comparison challenging, as costs vary further between countries, depending on factors such as production plant size, type of party (e.g. trader/supplier), annual turnover, amount of certificates issued, type of transaction (issuance, transfer, cancellation), etc.

To make a useful comparison of the costs for producers, the annual fees across countries will be compared in two cases, case one being a small wind power plant, generating 2,000 MWh per year, while the second case represents a large hydro power plant, generating 150,000 MWh annually.

Applying the calculation to all countries, it becomes clear that pricing mechanisms which heavily rely on account charges irrespective of the size of the production plant are a disadvantage to small producers. This is most visible in Austria, which is the only country that only charges an annual fee for all parties. In this calculation, this means that costs per issued GO were at € 41.95 in case 1, whilst they were at € 0.56 per GO in case 2. Both values are the highest of each case. Other countries with significant differences between the two cases are Denmark (Case 1: € 2.51/GO; Case 2: €0.04) and Finland (Case 1: € 1.61/GO; Case 2: €0.03). The table below shows the median and the mean value for both cases, both based on the total value and broken down on the cost per issued GO. The data is further differentiated between all countries and those, that generally charge fees and have data available. In this latter case, Belgium, Greece and Spain are excluded because they generally don't charge, and Ireland and Slovenia are excluded for data unavailability. The differences between both cases are rather minor, however. The data shows multiple trends: As mentioned, costs per issued GO are generally higher in case 1, as fixed costs have a higher impact for small producers with a smaller amount of GOs issued. Furthermore, the differences between median and mean values are quite stark, as some countries, particularly Austria, Denmark and Finland, push the average up. The median values are thus more meaningful. Whilst the data shows a slight 'discrimination' of small producers (case 1) compared to large producers (case 2), it can be concluded that the administrative costs for producers associated with issuing GOs are sufficiently small.

Table 2-18: Issuing costs for two exemplified examples in AIB area

Cost Summary	Based on all AIB Countries	Based on countries, that generally charge fees and have data available
Case 1 - Total - Median	€ 100.00	€ 287.10
Case 2 - Total - Median	€ 3,785.20	€ 4,443.50
Case 1 - Total - Mean	€ 1,389.70	€ 1,610.00
Case 2 - Total - Mean	€ 5,261.81	€ 6,176.91
Case 1 - Cost per GO Issued - Median	**€/MWh 0.05**	**€/MWh 0.14**
Case 2 - Cost per GO Issued - Median	**€/MWh 1.89**	**€/MWh 2.22**
Case 1 - Cost per GO Issued - Mean	€/MWh 0.01	€/MWh 0.01
Case 2 - Cost per GO Issued - Mean	€/MWh 0.04	€/MWh 0.04

A similar approach was followed for the various different fees applicable in the market, see table on transfer costs and cancellation fees.

Table 2-19: Transfer costs for two exemplified examples in AIB area

Cost Summary	Based on all AIB Countries	Based on countries, that generally charge fees and have data available
Case 1 - Total - Median	€ 375.69	€ 544.00
Case 2 - Total - Median	€ 4,129.21	€ 4,667.80
Case 1 - Total - Mean	€ 1,982.20	€ 2,382.84
Case 2 - Total - Mean	€ 5,397.10	€ 6,101.06
Case 1 - Cost per GO Transfer - Median	**€/MWh 0.21**	**€/MWh 0.27**
Case 2 - Cost per GO Transfer - Median	**€/MWh 2.07**	**€/MWh 2.34**
Case 1 - Cost per GO Transfer - Mean	€/MWh 0.01	€/MWh 0.02
Case 2 - Cost per GO Transfer - Mean	€/MWh 0.04	€/MWh 0.04

Table 2-20: Cancellation fees for two exemplified examples in AIB area

Cost Summary	Based on all AIB Countries	Based on countries, that generally charge fees and have data available
Case 1 - Total - Median	€ 353.44	€ 544.00
Case 2 - Total - Median	€ 4,124.68	€ 4,662.68
Case 1 - Total - Mean	€ 901.42	€ 1,327.23
Case 2 - Total - Mean	€ 5,039.87	€ 5,697.25
Case 1 - Cost per GO Cancelled - Median	**€/MWh 0.18**	**€/MWh 0.27**
Case 2 - Cost per GO Cancelled - Median	**€/MWh 2.06**	**€/MWh 2.33**
Case 1 - Cost per GO Cancelled - Mean	€/MWh 0.01	€/MWh 0.01
Case 2 - Cost per GO Cancelled - Mean	€/MWh 0.03	€/MWh 0.04

It must be noted that utilities in some countries require the payment for cancellations fees particularly for imported GOs, which can then reach 2 €/MWh and add to the other costs.

In conclusion fees reach significant values for small scale production, but remain rather low for the majority of registries and utility scale production. Even during times of low GO prices (e.g. <1 €/MWh at end of 2024) fees remain on the order of about 20%.

This is further confirmed by stakeholder feedback, where the following cost breakdown was obtained (Figure 2-43) based on a very rough scale of 1-10 points (and acknowledging that costs vary a lot across the market, and overall limitations with regards to interpretation of terms “value”, “administrative costs” etc.)):

Stakeholders indicated that 23% the GO price is due to fees (note that cancellation fees are considered outside the estimation, since they are to be paid directly by the end-consumer). Administrative costs are considered a relatively small contribution of 12%. The value obtained for “uncertainty and speculation” corresponds to the typical volatility applicable before the price peak (of about 0.1-0.2 €/MWh, cf. chapter 2.2.3). It must be assumed that most of the volatility is averaged by the traders and market makers, offering price smoothing and risk hedging. The actual value corresponds to about 40% of the GO price. In the case of today’s prices (between 0.40 €/MWh to 1.5 MWh for futures) corresponding to only ~0.40 €/MWh actually reaching the producers of electricity. Comparing this to LCOE’s currently applicable in Europe of about 30-

70 €/MWh[103] it becomes clear that compared to the revenues generated by the actual electricity market (industry price in Europe at ~150 €/MWh [104] and considering 30% of this to be electricity generation), revenues generated by GOs remain marginal at best, contributing <1% to reaching the business cases.

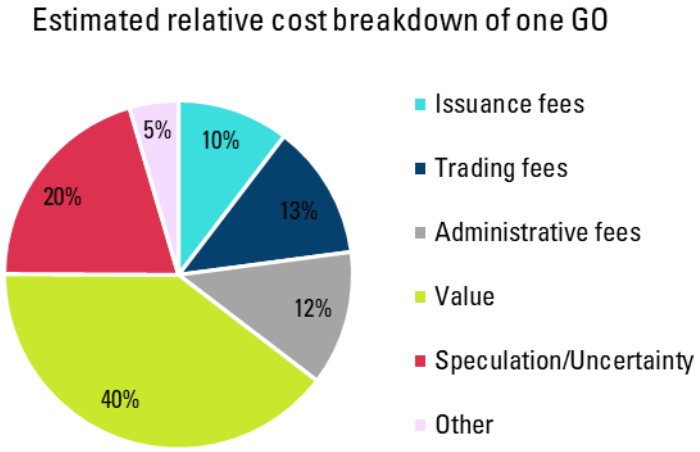


Figure 2-43: Indicative Cost Breakdown as provided by stakeholders via survey (allowing to provide shares as integers of ten)

LBST based on Survey

As confirmed via interviews the GO market is not a market with large speculative trading shares, thus in first approximation the amount of cancelled GOs, corresponds roughly to the amount of generated revenues from the market. Thus, applying today's 860 TWh/2024 x today's GO price of 0.40 €/MWh at the end of 2024 and applying 40% (being the value left after subtraction of all costs and fees from Figure 2-43), an overall volume of about (only) € 140 million is reached for producers across Europe. (See Table 2-21 for a breakdown per 5 biggest GO issuing countries. Note that simplifications are applying.) Comparing this to the estimated investment needs and actual investments, this is much less than 1% for Germany alone investing about € 37.3 billion into renewables in 2023[105].

Table 2-21: Indicative Value creation broken down for largest 5 GO issuing countries

EEA Country	Value created per year [in Euro]	Rough share of hydro/wind/solar/nuclear in this country
France	~21 Mio	35/52/11/2
Italy	~18 Mio.	53/24/23/0
Netherlands	~12 Mio	0/72/21/7
Norway	~25 Mio	91/9/0/0
Sweden	~16 Mio.	47/34/0/19

[103] https://www.ise.fraunhofer.de/de/veroeffentlichungen/studien/studie-stromgestehungskosten-erneuerbare-energien.html
[104] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_price_statistics
[105] https://www.bmwk.de/Redaktion/EN/Downloads/Energy/kurzdokumentation-wirtschaftl-impulse-ee-2024-eng.pdf?__blob=publicationFile&v=2

2.5. Summary and conclusions on the analysis along the 6 market dimensions

In summary, the GO market has reached healthy liquidity, but is structurally oversupplied. The price peak in 2022/2023 (despite structural oversupply) has induced some uncertainty among stakeholders and prices remain highly volatile. Ongoing developments contribute to improving harmonisation across the AIB region, the major limitations however arise from administrative issues associated with different implementation of registries (technical and operational barriers). And while the GO system is especially dependent on completeness to avoid double-counting of renewable electricity consumption, the varying understanding of the purpose of GOs creates issues in reporting (location-based vs. market-based reporting). This can diminish trust in the system and hence effectiveness.

Stakeholders confirm generally large reliance on third parties for both information as well as participation on the market increasing the risk for revenues ending in the hands of market makers rather than producers.

The GO market is attested with poor efficiency due to IT infrastructure issues, complexity and the need of manual processes and sometimes very high fees. Furthermore, auction management quality differs across countries.

While transparency generally has improved, price discovery in particular, remains highly non-transparent. GO prices can differ in aspects not easily visible to consumers, such as technology, regionality, additionality etc. and price forecasts are associated with high uncertainty; also due to "monopolistic competition". The GO market is in principle responsiveness to changes in supply and demand, but the effects on prices remain low due to the structural nature of oversupply. The perception of undersupply has caused significant price reactions in 2022/2023. Short-term price changes are mainly influenced by hydro GOs, with wind and solar GOs following suit. Long-term effects, like regulatory changes, are anticipated and reflected in futures prices.

2.6. Discussion and conclusions on effectiveness of GO system

The evaluation of effectiveness of the GO system is closely interrelated with the question of what is (and can be) expected from the GO system today. Therefore, and in order to evaluate the effectiveness of GOs, it is important to acknowledge that GOs conceptually foremost allow to reach two goals:

A **track the origin of electricity consumed and avoid double-counting of renewability attributes (, if used under a single accounting framework such as AIB),** (cf. Recital 55 of the initial legal act of 2018)

and

B **provide trusted information to be checked against criteria.** (cf. Recital 56 of the initial legal act of 2018)

Our analysis below discusses the level of trust in the GO system that is needed for these goals to be achieved, and how ongoing market developments affect the goals. In principle Goal A and B depend largely on governance and methodology applied (responsibilities, traceability, standards etc).

The GO system may serve additional goals. When the GO system was first set up (and still today) it was widely accepted that renewables do play a fundamental role in decarbonising the energy system. Thus, all

instruments contributing to the build-out of renewables are to be considered politically supported and aligned with the strategic goal of decarbonising the European continent. In the creation of the GO instrument book-and-claim was defined as the fundamental accounting mechanism which in consequence creates a market that is independent of the physical entity (electricity). In fact, this was fostered early in the stages of the GO instrument creation by introducing the market-based disclosure requirement on electricity bills in the late 2000s. However, since it is aimed at empowering consumers to make an active choice, the expectation was that this market creates a fair value to renewables by enabling the choice of "green over grey". By the associated demand for renewable electricity, the GO system in turn was expected to:

C **incentivize investments into renewable energy sources.** (cf. Recital 56 of the initial legal act of 2018)

Today society has advanced strongly to larger shares of renewables, yet the GO market may still allow to create a fair value for certain RES. This requires a more differentiated choice of different "shades of green", particularly because the market is structurally oversupplied. Goal C must therefore be differentiated to Goal D:

D **guide the market (on renewable build-out) and support overall system efficiency.** (which will also be required, if the RES in Europe are transitioning into the default electricity source)

Goal C requires a market in balance (see discussions in chapter 2) and appropriately informed consumers. The latter being particularly important for Goal D, since (apart from reporting obligations) increased value creation and premia can only be created from the demand for RES with additional criteria such as the age of installations, regions, etc. This in turn requires empower consumers that make a conscious choice between these qualities. In oversupplied markets, the price signals from GOs could in principle therefore still guide the market on the most economical and efficient way to build-out renewables of specific qualities, yet the level of information required at the consumer is intrinsically more complex.

Below we discuss and conclude how **effective** the GO system is in achieving the 4 goals (A-D) .

2.6.1. **Goal A**: Effectiveness for (renewable) energy tracking

On average more than 90% of the hydropower, more than 50% of wind and 30% solar power produced in Europe is issued as and thus tracked by GOs (see chapter 2.2.1). Due to subsidy schemes and small-scale power plants (e.g. rooftop PV) the share for wind and solar cannot easily reach the same level as hydropower. Yet it can be stated that for the largest part of renewable energy produced in Europe GOs are issued, and hence consumption can be tracked on the basis of one of the generally accepted standards (namely EECS), as provided by the AIB.

The AIB as central market enabler has guided the industry towards a broadly well-functioning system, for example by refining the calculations methods for residual mixes to be applied if energy is not reported via GOs and other measures. Due to differences in applied reporting practices (i.e. overproportionally procuring GOs from the Norwegian market that in turn makes Norwegian companies apply locational

approaches in their reports[106]), RE tracking does not (yet) fully exclude incorrect claims based on the procurement of GOs. In particular, the state of harmonisation (section 2.2.2), and enforcement options upon misconduct[107] are still limited by national differences.

Overall, today the GO system is effective in tracking of renewable energies but requires further harmonisation to further reduce risks of misconduct.

2.6.2. **Goal B**: Effectiveness as trusted instrument for reporting against criteria

In a survey conducted among over 60 participants from wide stakeholder backgrounds, the effectiveness of the GO instrument as trusted reporting instrument was generally seen positive, with the peak at 9 out of 10 (Figure 2-44).

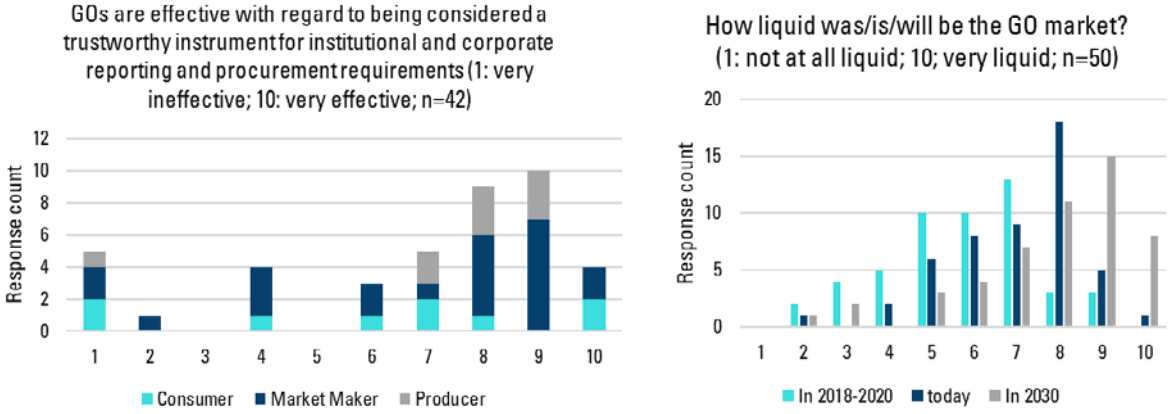


Figure 2-44: Survey perspective on effectiveness with regards to reporting and procurement as well as liquidity trend.
Based on survey

This is aligned with the overall view concerning market liquidity (see chapter 2.2.1) and market participation of stakeholders from all AIB member states (see BOX 1 in 2.2.1).

GOs are accepted as the appropriate instrument to track the origin of electricity consumed, despite the remaining disharmonies across Europe (Section 2.2.2) as well as continuous adjustments in the standards. Interviews confirmed that GOs are the most pragmatic and cost-effective way to underpin claims (particularly the industrial stakeholders obliged to report), leading to the widespread use and hence trust in the GO system.

Although the system is considered voluntary, the reference to GOs in various legislations creates a sense of GOs being backed by EU institutions in relevant consumers groups (i.e. industry), that goes beyond the simple acceptance of GOs as one instrument among others. It is important to emphasise that in practice, however, the AIB has to date not been recognised as an official body on European level. In addition, not all issuing bodies are also authorised to guide disclosure and cancellation of GOs in the national market.

[106] https://onlinelibrary.wiley.com/doi/epdf/10.1111/jiec.13553
[107] https://www.aib-net.org/eecs/eecsr-rules

Moreover, the market-based reporting approach, and more explicitly by the use of GOs, is not consequently applied throughout European legislation.

While the EECS standard as applied by the AIB members creates a good level-playing field, in practice certain national specificities lead to domain protocols excluding the cancellation of certain countries' GOs. This is sometimes also realised via unproportionally higher cancellation fees. While the EECS standard supports the fact that the system has enough flexibility to adapt to national specificities, the related "reactive" measures can lead to confusion and eventually non-participation.

Overall, today the GO concept and system itself is trusted to provide the information required and the informed (mostly professional) market participants acknowledge the sufficiently applicable level-playing field established over the past years.

2.6.3. **Goal C**: Effectiveness for incentivizing renewable build-out

A commonly assumed effect of the GO market revenues is to create a basis for business models and therefore allowing the market itself to create the value required to bridge the cost gap of renewable energy production (and distribution) with that of conventional fossil energies.

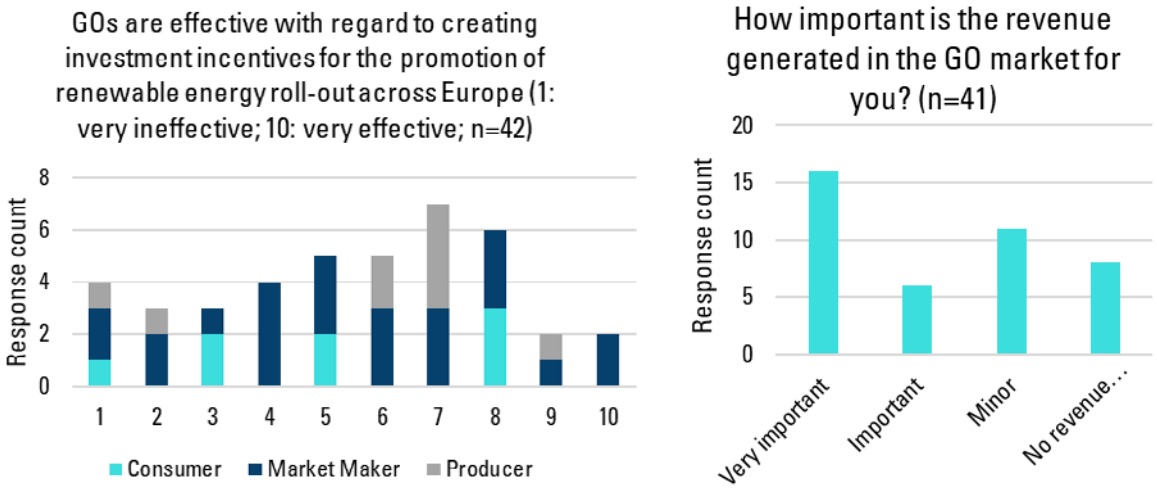


Figure 2-45: Investment incentives and importance of revenue to electricity producers

Based on survey

Survey (Figure 2-45) and interviews confirmed that the revenues generated from issuing GOs are for renewable energy developers "neither making nor breaking" the business cases. This can be understood to be mostly routed in the structural oversupply (see chapter 2.2.1): an oversupplied market requires consumers to differentiate "shades of green" and associated higher willingness-to-pay for a product. This, however, is hindered due to the large anchoring effect of hydro power. Hence, despite the fact that the market does create revenues attributable to the "green value", GOs are anchored at prices from sources with usually fully depreciated CAPEX (hydropower) and thus do not reach LCOEs for other renewables i.e. wind and solar (see chapter 2.4).

Also, the stability of the market has suffered from the price peak experienced in 2022 and 2023 (chapter 2.2.3). While this effect in principle was positive for renewable energy producers it also created large volatility (Figure 2-9) and stakeholders seem to confirm decreased confidence on the market stability compared to pre-crisis (compare survey results in Figure 2-10). Due to this fact also a stable minimum price for GOs (or certain type of GOs) may not be sufficient to solely incentivize investments.

The general mismatch of planning horizons and market uncertainty make project developers consider revenues from GOs as a welcome additional revenue stream, but no fundamental part of their (re-)financing structure. Bankability is only reached via offtake contracts, such as PPAs. Hence the GO market does not provide signals to the build-out of renewables "as such".

However, the GO system (in contrast to the GO market only) may provide incentives for renewable build-out on various other levels. Taking the example of renewable PPAs, GOs do provide an essential part of the contractual arrangements and thus indeed allowing ambitious offtakers to sign renewable PPAs. In turn, build-out of renewable energies is directly supported. On a secondary level - and under the assumption of broad acceptance - the GO system as accounting tool may serve to avoid both, double and zero-counting of (renewable) energy in the European Union and neighbouring countries. The benefit would be fully informed decision making by policy makers and thus indirectly allowing to also induce positive effects on renewable build-out across Europe, e.g. by steering subsidies.

Overall, today structural oversupply allows GOs to at best contribute additional revenue streams after an investment decision into renewable energy production was reached, but the market stability and created value is not sufficient to induce the investment decision. However, the GO system also creates indirect effects that support renewable energies build-out, including especially PPAs.

2.6.4. **Goal D**: Guide the market (on renewable build-out) and support overall system efficiency

The market's effectiveness regarding its guiding capability within an oversupplied market depends strongly on appropriately informed consumers (on the true nature of the product bought) and if the related information aligns with the expectations among participation on the GO market. This also causes the stakeholder feedback on the effectiveness of the GO system to strongly vary across the stakeholder groups and the respective perspectives on it.

Below we discuss the difference between effectiveness on informing industrial consumers and private households.

Industrial consumers

Today many industrial consumers still differentiate electricity procurement (Operations Departments) and sustainability aspects (Communications departments), leading to confusion with regards to the various interrelations and incongruences. Overall, the misunderstandings cannot be simply put under responsibility of the GO system, since GOs do in principle contain all relevant information on various qualities of renewable energies, see goals A and B and in principle. Large corporations have the capacities to procure renewable energy through an informed decision by experts and aligning the respective market behaviour with an energy procurement strategy. The interviews also confirmed an overall trend to professionalisation in the market.

However, in a factually oversupplied market (see 2.2.1) the nuances and hence a deeper understanding of the various renewable energy qualities is much more important. A simple decision of "I prefer green over grey" does not create a signal for further build-out of renewables anymore. This effect is strengthened due to the industrial consumers' focus on GHG emission reduction as the major goal (also driven by sectoral targets and confusion with regards to renewable and fossil-free qualities). Therefore, the largest share of cancelled GOs serves to support GHG emission reduction reporting, which by definition allows to claim any electricity consumed and matched with GOs to be zero-emission (independent of the GO source).

Overall, industrial consumers for the largest part are driven by reporting obligations and sectoral targets rather than real marketing opportunities (see Figure 2-46).

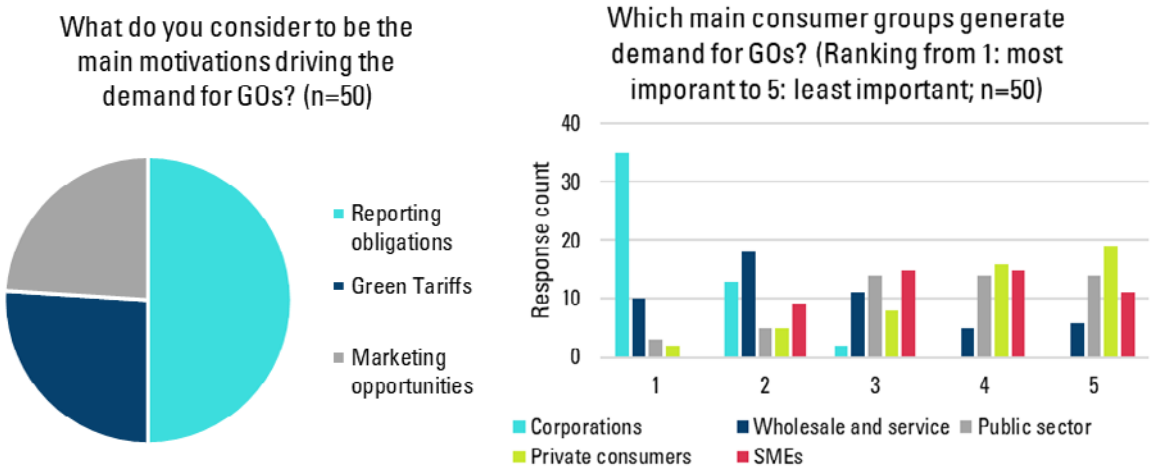


Figure 2-46: Survey perspective on importance of reporting obligations and corporate consumer dominance.
Based on survey

Demand on the basis of "fully informed decisions" remains therefore very limited for industrial consumers. While, for example, GOs work as fundamental tool within the contractual arrangements of renewable PPAs, the industrial consumer does not make a choice pro particular GO type, but rather pro particular PPA (which combines electricity and sustainability procurement). Consequently, the GO is not necessarily the tool guiding the consumer decision.

As previously mentioned, it is undoubted in Europe that renewables are an essential part of contributing to decarbonisation, yet build-out of renewables and the role of other fossil-free energy sources is an ongoing debate in society[108]. In fact, GOs are embedded in the renewable energy directive and thus primarily aim to build-out renewables and by that mean to enable decarbonisation (cf. Recital 2 of the RED II). This conflicts with the reporting realities for most industrial consumers focusing on GHG emission reduction only. Only those consumers closer to retail markets have interest in avoiding more controversial energy sources to avoid "green washing" accusations in the general public[109].

Academic authors also emphasize the fact that the market creates various slightly differing products that are seemingly substitutes, but in reality are not.[110] This allows to subtly change claims or messages based

[108] https://www.derstandard.de/story/2000144187814/atomkraft-ja-oder-nein-nicht-immer-sind-sich-klimaaktivisten-einig
[109] Confirmed by interviews
[110] https://www.mdpi.com/1996-1073/17/1/104

on procured GOs: in times of high price pressure (i.e. the price peak in 2023) some large consumers GOs did react – not by reducing overall demand – but "downgrading" the communicated targets in their reporting from renewable energy procurement to "carbon-free"[111], allowing to (newly) include e.g. nuclear GOs in their portfolios.

While reporting obligations for corporations create the largest "demand", which does not require an active choice on consumer side, it is also clear that industrial consumers only have limited interest and opportunities to use active choice pro specific GOs to create additional value to their brands. Hence, the willingness-to-pay for certain subgroups of GOs is kept at a rather low level. The example of the Netherlands however shows that e.g. regional GOs can in fact create higher value, which is largely based on free choice.

Overall, the GO system and associated disclosure and reporting requirements today do not allow to create pressure or guidance from the end-consumer into the market to differentiate renewable energies. Due to demand being largely reporting-driven and thus technocratic, the focus lies on GHG emission reduction and is not based on informed decision-making, which however is aligned with large parts of the industry expectations for the GO system.

Private household consumers

In contrast, and as emphasized by end-consumer representatives, green tariffs are pretty much always signed under the assumption of contributing to the renewable energy build-out (enhanced production) or more generally the energy transition[112]. This must be understood as an in most cases active choice of "green over grey" since billing information almost consistently across Europe require the disclosure of electricity sources (Figure 2-47).

[111] https://cloud.google.com/blog/topics/sustainability/google-achieves-four-consecutive-years-of-100-percent-renewable-energy?hl=en and https://blog.google/outreach-initiatives/sustainability/getting-closer-to-a-carbon-free-future-our-largest-offshore-wind-projects-to-date/

[112] https://www.beuc.eu/sites/default/files/publications/beuc-x-2016-002_jmu_trustworthy_green_electricity_tariffs.pdf; https://www.ofgem.gov.uk/sites/default/files/docs/2013/12/perceptions_of_green_tariffs_0.pdf
(confirmed to still be an up-to-date evaluation of consumer challenges in green electricity tariffs.)

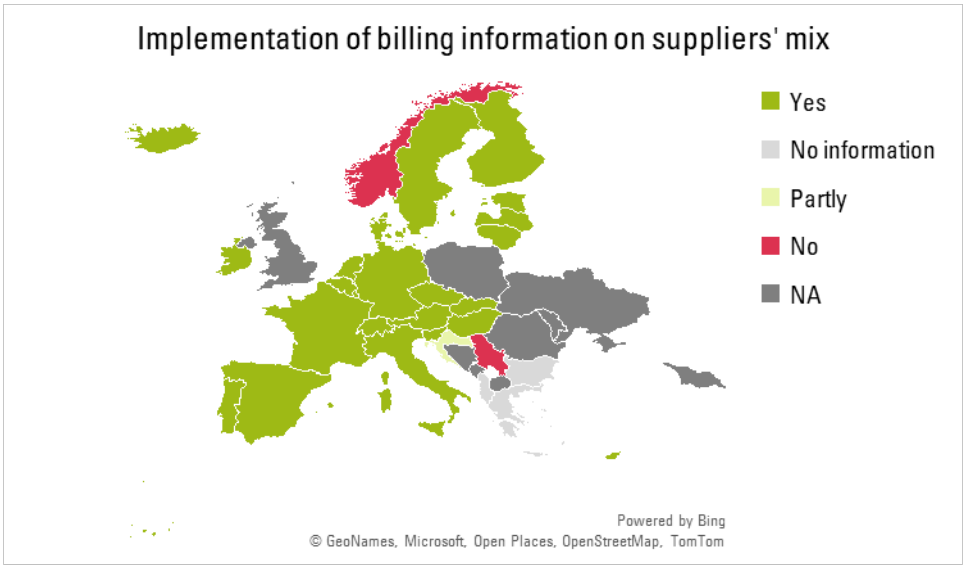


Figure 2-47: Implementation of billing information on suppliers mix for electricity

Based on AIB national datasheets on GOs and disclosure[113]

The largest mismatch of information applies therefore between the limitations of the structurally oversupplied GO system (and hence the need for choosing "shades of green") versus the expectations of end-consumers. Quantified analysis is limited by the availability of literature and general understanding of numbers behind these expectations.

Interviews confirmed that green tariffs are limited to an upper bound that orients itself on the average conventional electricity tariffs. Exemplifying the figure allows to speculate that this number could lie at maximum 10% higher than the conventional tariff (0.33 €/kWh M-Strom fix and 0.36 €/kWh M-Ökostrom regional from the Munich energy provider), due to large competition in the market however green tariffs in Germany overall are only marginally higher than grey tariffs[114].

The prices for the green tariffs are much higher than associated costs for GOs, justified by the suppliers with balancing risks etc[115]. and hence not allowing to pass on the gradual changes of willingness-to-pay for various differentiated green tariffs (e.g. wind only) into the oversupplied GO market. This in turn creates demand robustness, increasing stability, but also reduces the guidance effect of end-consumer demand.

Approaching the issue from the other direction, means to assess from which maximum price change consumers start switching into conventional tariffs. It is well-known that end-consumers are very sensitive to price and a correlation of switching rates to price changes can be found in many European countries[116]. The data are very limited with regards to reactivity specifically for consumers of green tariffs. Interviews confirmed that a complex interplay of trust in specific supplier(s), used labels and overall societal state of discussion (see example BOX 6 on the Netherlands) contribute to this. Mistrust in any of the points can

[113] https://www.aib-net.org/facts/national-datasheets-gos-and-disclosure

[114] https://data.bundesnetzagentur.de/Bundesnetzagentur/SharedDocs/Mediathek/Monitoringberichte/MonitoringberichtEnergie2024.pdf

[115] And confirmed in interviews

[116] https://www.ceer.eu/publication/acer-ceer-2024-market-monitoring-report-energy-retail-and-consumer-protection/

lead to supplier switching. As a consequence, switching itself is not an appropriate indicator for willingness-to-pay, since suppliers across Europe are in fierce competition and it remains realistic that consumers simply switch into another green tariff.

Interestingly, and independent from the ongoing discussions on "green washing", consumers in Europe and especially in Germany increasingly signed green tariffs for electricity consumption[117] (today reaching >30% in Germany, starting at around 25% in 2018 and below 10 % in 2010). Arguably, this number of persons exceeds a group of end-consumers that could be considered experts for the energy market. In consequence it is safe to assume that most consumers keep choosing "green tariffs" on the basis of general trust in the system, possibly not knowing the details about "shades of green". This discussion needs careful evaluation of the role of labels as important translators of information, which will be addressed in the second part of this study, also including further literature[118].

It remains difficult to assess if consumer willingness-to-pay would increase if the GO system was completely "bullet-proof". Especially under consideration of larger and larger shares of renewable energies consumed just via the grid-mixes, and already existing various support schemes usually paid via tax funds, it can be doubted if respective adjustments in the market will have a significant effect. Furthermore, it remains difficult to anticipate if this (end-)consumer choice is visible enough to navigate the market within the complexities of the various "qualities of renewable energy", particularly if price signals from e.g. hydropower to wind power remain within the same order of magnitude.

Overall, today the impact of private household consumers on the GO price remains very limited and provides hardly any guiding function to the GO market.

117 https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/24_2023_cc_analyse_eines_unternehmensentwertungsrechts_fuer_strom-herkunftsnachweise_in_deutschland.pdf

118 https://energy.ec.europa.eu/system/files/2021-12/consumer_engagement_and_green_offers_-_final_report.pdf

2.7. Status quo and Outlook on the Gas GO market

In 2018 (almost 20 years after first introduction of GOs for electricity) the RED II obliged member states to set up GO systems also for gases such as biomethane, synthetic gases, and hydrogen as well as heating and cooling (H/C) from renewable energies.

In contrast to the GOs for the electricity market, the gas and H/C GO markets are still in an emerging phase; availability of historical data is very limited and not comprehensive to allow conclusions on market balance or imbalance. The focus in this chapter will therefore lie on an overview based on the current state of development, as well as a short discussion of discussion of the potential and challenges of market development. The forward-looking analysis will prioritize a) the implementation of the Gas Directive with its requirement of a gas fuel mix disclosure, and b) the impact of Art. 31a of the RED II amendment on the traceability of gas GOs by establishing the Union Database (UDB). For heating and cooling, the establishment of GO systems will for the first time provide a legally secure basis for the marketing of green district heating products. However, as there is no relevant market established at the time of writing of this report, the H/C market will be omitted within the scope of this assessment.

First, we will describe the status quo for biogas and hydrogen markets, **second,** we describe the ongoing activities on the GO market and related certification options, **third,** we discuss the interdependencies of GO and compliance markets (especially for hydrogen), and **finally,** provide an outlook on growth potentials.

2.7.1. Status quo biogas and hydrogen market

In the following, the status quo of the gas market is outlined, differentiating between biogas and the hydrogen market.

Biogas/Biomethane

Biomethane production in the Europe totalled at 49 TWh/a in 2023, which marks a year over year (YoY) increase of 17% and 7 TWh and is the biggest YoY increase since 2011[119, 120]. EU MSs produced 41 TWh/a in 2023, increasing by 21% from 2022[121,122]. Available production capacities installed for biomethane already reached 64 TWh/a in the European region in 2023[123], which apparently is not fully utilized to date. European biomethane production could thus exceed 60 TWh in 2024[124]. EU consumption of natural gas today is at 840 TWh/a[125,126] for households and reaches almost 3900 TWh across all sectors[127].

[119] https://www.europeanbiogas.eu/22-bcm-of-biogases-were-produced-in-europe-in-2023according-to-a-new-report-released-today/, for simplification we will assume 49 TWh production volume for the whole of Europe not further differentiating the exact different member states of AIB and others (ERGaR).
[120] https://www.europeanbiogas.eu/wp-content/uploads/2024/07/GIE_EBA_Biomethane-Map-2024.pdf
[121] https://biokierto.fi/wp-content/uploads/2024/01/Biogas-and-biomethane-in-Europe_Mieke-Decorte.pdf
[122] https://www.europeanbiogas.eu/22-bcm-of-biogases-were-produced-in-europe-in-2023according-to-a-new-report-released-today/
[123] https://www.europeanbiogas.eu/22-bcm-of-biogases-were-produced-in-europe-in-2023according-to-a-new-report-released-today/
[124] https://veyt.com/articles/veyt-2024-biomethane-overview-and-2025-outlook/
[125] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview#Final_energy_consumption
[126] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_consumption_in_households
[127] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Natural_gas_supply_statistics

Using the available statistics for GOs by ERGaR (not covering the full AIB area) at least 55-82 % of the 49 TWh produced volumes of biomethane were issued as GOs in 2023[128,129]. However, these GOs are traded only on a very limited basis across European borders: Most are imported into Germany (e.g. just under 2 TWh in 2024 from Denmark to Germany, while the rest of Europe received just above 2 TWh from Denmark[130]. The total amount of biomethane produced during this period was 126 TWh since 2021. Assuming that the issuing rates were comparable to 2023 (at 55-82%) only about 2-3 % of the issued GOs were traded cross-border. Nonetheless, a small trend in increasing cross-border biomethane trade activity is visible through 2023 compared to the previous years[131].

Hydrogen and RFNBOs

While the renewable hydrogen market is overall considered an integral part of the EU net-zero strategy[132], the associated challenges with the necessary market ramp-up of hydrogen are considered substantial[133]. The focus lies in particular on renewable fuels of non-biological origin (RFNBO). The revised RED II provides detailed quotas for the use of RFNBO, including green hydrogen and its derivatives. An industrial sub-quota for hydrogen with RFNBO quality has been defined: The RFNBO share of industrial hydrogen consumption should be 42% by 2030 and 60% by 2035. On EU level, the annual hydrogen demand is expected to rise from 264 TWh today to around 396 TWh by 2030[134]. The EU target is even higher, with 667 TWh (10 Mt local production, 10 Mt import) until 2030, requiring 350 GW of electrolyser capacity in the EU and importing countries[135]. Further, investment needs for infrastructure are estimated to be in the range of EUR 335-471 billion[136]. A tradeable market for green hydrogen, according to EEX, is expected shortly before 2030. In contrast, by the end of 2023, only 0.4% of the total EU hydrogen production capacity (512 operational hydrogen production facilities capable of producing 11.23 Mt of hydrogen annually) was based on water electrolysis, equalling 45 tonnes or 1.5 GWh, and a further 9.2% (approximately 1033 tonnes or 34 GWh) based on hydrogen produced as a (green) by-product (e.g. via chlor-alkali electrolysis).[137] Hydrix, a market-based price index for green hydrogen for Germany[138] estimates the current price for green hydrogen at 7.8 EUR/kg to 9.5 EUR/kg (since 01/2025); 2,5 times the cost compared to grey hydrogen (around 3 to 4 EUR/kg).

2.7.2. Renewable gas market certification

The renewable gas market includes both biogas as covered in RED II Art. 2 (1): [139] 'energy from renewable sources' or 'renewable energy' means energy from renewable non-fossil sources, namely wind, solar […]

[128] https://renewablegascertificates.org/renewable-gas-certificates/
[129] https://www.dena.de/biogasregister/
[130] https://energinet.dk/Gas/Biogas/Oprindelsesgarantier-gas/Certifikater-i-tal/
[131] CoO Scheme Statistics - ERGaR
[132] The EU's goal is to annually produce and consume 10 million tonnes of renewable hydrogen domestically and to import the same quantity from third countries from 2030 onwards. European Commission, 2020: https://energy.ec.europa.eu/system/files/2020-07/hydrogen_strategy_0.pdf
[133] https://files.h2-global.de/Market-Ramp-Up-Renewable-Hydrogen-Derivatives-H2Global.pdf
[134] Tarvydas (2022): https://publications.jrc.ec.europa.eu/repository/handle/JRC131299
[135] Wijk et al. (2022): http://files.h2-global.de/H2Global_How-to-deliver-on-the-EU-Hydrogen-Accelerator.pdf
[136] European Commission COM(2023) 156 final: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52023DC0156
[137] Clean Hydrogen JU (2024): https://observatory.clean-hydrogen.europa.eu/sites/default/files/2024-11/The%20European%20hydrogen%20market%20landscape_November%202024.pdf
[138] Hydrix is based on voluntary submissions; https://www.eex-transparency.com/de/wasserstoff/deutschland
[139] RED III: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02018L2001-20240716

and biogas;" and renewable fuels of non-biological origin (RFNBO) such as hydrogen produced from renewable energy via electrolysis and derivatives, as defined in RED II Art 2. (36).

There are different types of gas certification schemes and standards available in the European certification landscape. Largely, three different types can be differentiated by area of application.

First area is the **compliance market** that is allowing end users to fulfill fuel obligations on Member State level (as defined in RED II Art 25 ff). The recognition of renewable gases for achieving EU targets under RED II requires sustainability verification through an EU-recognized certification system **based on mass balance**. For biogas, certification schemes such as ISCC EU and RedCert EU issue certification**,** for RFNBOs, CertifHy VS, ISCC, and RedCert are the recognized certification schemes[140].

The second area is the **Guarantee of Origin market**. In the gas sector, this certificate market primarily aims at creating transparency towards the end customers about the source of the gas. This market for Guarantees of origin for energy from renewable sources, including RFNBO such as hydrogen is based on RED II Art. 19. Under RED II, MSs have now been obliged to set up GO systems for gases such as biomethane, synthetic gases, and hydrogen as well as heating and cooling from renewable energies. Some MS have already established national certification schemes, while others are currently setting up such systems. However, with the phasing in of the Union Database and the requirement in article 31a of RED II, that once transferred, GOs shall not be tradeable outside the Union Database. Thus, the flows in the market of GO and certified RES gas (under mass balancing rules) will be synchronised.

Third, there is a **private market with voluntary energy attribute tracking systems** run by different market initiatives, many aiming to comply with the GO market requirements or pursuing complementary approaches. The biomethane market is also served by private market initiatives, particularly at the interface of biomethane and biofuels, including ISCC, REDCert and others.

For hydrogen, only one privately owned scheme, the CertifHy Non-Governmental Certification (NGC) Scheme is operational since 2018 as a book-and-claim system to certify volumes of low-carbon and renewable hydrogen for voluntary disclosure in Europe. CertifHy is active only in those countries that do not have a national gas GO scheme in place (yet), such as Germany. Within the boundaries of non-governmental certification, the CertifHy NGC Scheme complies with the EECS Rules[141]. CertifHy is since 19 December 2024 a recognised voluntary scheme for RFNBO and should therefore comply with those specific requirements[142]

State of GO implementation

Some Member States have already established their own national gas GO schemes, while others are in the process of doing so. As for renewable energy GOs, the European Energy Certificate System (EECS) developed by the Association of Issuing Bodies (AIB) serves as an integrated European framework for the issuance, transfer, and cancellation of energy certificates. Below is an overview of national schemes with EECS registries that offer gas certification and are actively connected to the AIB Hub[143].

[140] https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/voluntary-schemes_en
[141] https://www.certifhy.eu/ngc-certification/
[142] https://www.certifhy.eu/news/certifhy-achieves-official-recognition-by-the-european-commission-to-issue-rfnbo-certification/
[143] https://www.aib-net.org/facts/eecs-registries, accessed: 13.03.25

Source: AIB

Table 2-22: Implementation of gas issuing bodies across AIB members (as per AIB website on 13.03.2025) and assigned by governments (in *italics*).

Domain	Member	Energy Carriers
Austria	E-Control	Electricity + Gas
Belgium - Brussels	BRUGEL	Electricity + Gas
Belgium – Flanders	*VREG*	
Belgium – Wallonia	*SPW*	
Croatia	*HROTE*	
Czech Republic	OTE	Electricity + Gas
Denmark	*Energinet*	
Estonia	*Elering*	
Finland	Gasgrid Finland	Gas
France	*EEX*	
Germany	*UBA*	
Greece	*Dapeep*	
Hungary	*MEKH*	
Italy	GSE	Electricity + Gas
Latvia	Conexus Baltic Grid	Gas
Lithuania	*Amber Grid*	
Luxembourg	*ILR*	
Netherlands	*VertiCer*	
Portugal	*REN*	
Slovenia	*AGEN-RS*	
Slovakia	*SPP*	
Spain	Enagas GTS	Gas
Switzerland	*Pronovo*	

Also, the European Renewable Gas Registry (ERGaR), established in 2016, promotes cross-border trade of renewable gas certificates. Founded by national renewable gas registries and industry representatives, ERGaR serves as European hub for stakeholders in the biomethane certification supply chain. Its membership includes 44 entities from 14 European registries, including national registries, gas operators, traders, consultants, and trade associations[144].

[144] https://www.ergar.org/

At the core of ERGaR's operations is its CoO (Certificate of Origin) scheme, launched in 2021, to facilitate the cross-border transfer of CoOs between national biomethane registries. The scheme offers harmonised rules for issuing CoOs and a protocol for ownership transfer across countries. It covers hydrocarbon gases, hydrogen, biomethane, and other renewable gases injected into the natural gas network. However, the CoOs are defined in line with Article 19 of Directive EU 2018/2001 for the issuance of renewable gas Guarantees of Origin (GOs). ERGaR is closely monitoring the revision of the CEN-EN 16325 standard for gas GOs and is dedicated to ensuring full compliance with the updated requirements[145].

According to ERGaR, their scheme facilitated the transfer of more than 2 TWh biomethane certificates between the participants. A look at the quarterly numbers of CoO transfers via the ERGaR scheme indicates that there has been an increase in trading activity since Q2 2023[146].

Hydrogen GO trading volumes

All green hydrogen produced to date, if certified, has not been traded as RFNBO but only with either GOs or NGCs, since RFNBO certification has only been possible since Dec 2024, and at writing of this report, first RFNBO certifications are forthcoming. Assuming that all 45 tonnes (1.5 GWh)[147] of renewable hydrogen potentially produced in 2023 via water electrolysis were produced and certified with GOs and considering that 1 GO is issued for 1 MWh, theoretically, 1500 GOs could have been issued in 2023. As a limited number of EU Member States are already active in the gas GO market, and even less already offer EU-wide GO trading, no aggregated official statistics on issuance, and trading of certificates have been available at writing of this report. According to CertifHy, the interest in GOs/NGCs, so far, has been mostly associated with smaller projects, that produce green or blue hydrogen but do not fulfil RFNBO requirements. Larger projects, many of which are currently in the pre-FID phase, are preparing for RFNBO certification to take advantage of the offtake obligations in the compliance market. The Low-carbon Hydrogen Delegated Act (LCH DA) 2024/1789[148] details the Commissions current plans on low-carbon hydrogen, which strongly build on and complement the rules already in place for renewable hydrogen and RFNBO, are consistent regarding the methodology for a life cycle assessment of the total greenhouse gas emissions of these fuels. It can thus be expected that low-carbon hydrogen production will be certified under a similar framework as RFNBO, rather than purely with GOs.

State of biogas GO implementation

AIB surveys indicate that the implementation at the national level is still limited, with no rapid developments in gas GO disclosure recently[149]. Still the market is active as can be concluded from the existing price curves shown in Figure 2-48. In comparison to the electricity market the gas GO market is more fragmented and has large national focus.

[145] https://www.ergar.org/ergar-schemes/ergar-coo-scheme/
[146] https://www.ergar.org/ergar-schemes/coo-scheme-statistics/
[147] Clean Hydrogen JU (2024): https://observatory.clean-hydrogen.europa.eu/sites/default/files/2024-11/The%20European%20hydrogen%20market%20landscape_November%202024.pdf

[148] Low-carbon Hydrogen Delegated Act (LCH DA) 2024/1789: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=OJ:L_202401789

[149] https://www.aib-net.org/facts/national-datasheets-gos-and-disclosure

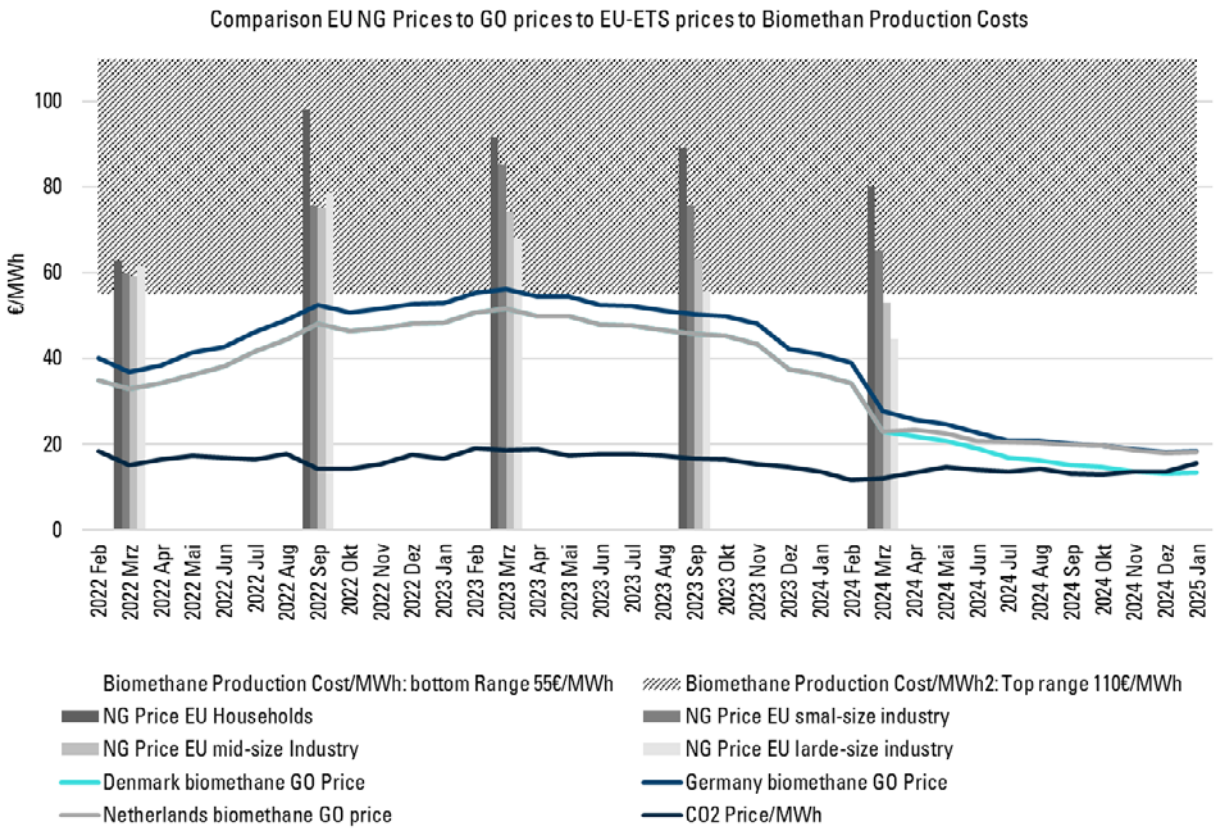


Figure 2-48: Biomethane GO prices in Europe and NG prices for various sectors across EU-27.
Based on S&P Platts and Eurostat[150][151]

Comparison of the GO prices with NG tariffs in the years around the energy crisis show that GO prices more or less followed the gas market. Comparison with the of CO_2 applicable under ETS further supports the fact that buying biomethane GOs over the past years was a more expensive option to decarbonise gas supply compared to ETS trading. In 2024, this changed when the Biomethane GOs' price went down and reached the order of magnitude of CO_2 pricing applicable to fully combusted NG.

Comparison of the levelized costs of biomethane production to the currently paid prices for biomethane further reveals that the currently paid prices for Biomethane GOs are not sufficient to cover the costs under all circumstances (influencing factors include choice of feedstock, plant size and technology). Taking the NG tariffs of 2024 of around 60 €/MWh + 18 €/MWh generated with the issued biomethane GO, the upper bound of biomethane production costs at 110 €/MWh cannot be reached. In turn not allowing to make investment decisions only on the basis of the biomethane market, but certainly contributing significantly to the revenue generated.

2.7.3. Interdependencies between gas GO and compliance markets

Proofs of Sustainability (PoS) are following a mass-balance approach where the PoS is traded with the renewable gas, a concept originating from liquid biofuels. All parties trading the PoS except the final

[150] https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_202/default/table?lang=en
[151] https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_203__custom_15948722/default/table?lang=en

customer must be certified according to the rules of a voluntary schemes. With introduction of the Union Database (UDB), a tracking database for PoS that has become mandatory by 21 November 2024 for gaseous fuels, the PoS is kept in the account of the owner of the certificate and can be transferred to another account after a transaction. At the final phase certificates can be redeemed against gas consumption.

To ensure, that no double claiming can occur, interfaces between both systems are regulated in the revised REDII and Delegated Act 2023/1184 (and the EC Q&A). Art. 31a of the revised RED II on the Union database allows for both GOs and PoS to be issued for the same consignment of gas. However, if GOs are issued for RFNBO produce, the two certificates must be "bundled" and never sold separately to different companies. When this part of the UDB becomes operational (expected by 21 May 2025[152]) the PoS and GO will be linked within its database, meaning that where PoS are issued for biomethane the GO will also move via the UDB and not within national registries. The GO must also be transferred to the UDB when the RFNBO and sustainability certificate are registered, and cancelled after the RFNBO is withdrawn from the Union's interconnected gas infrastructure. These GOs, once transferred, are not tradable outside the UDB. Given the early state of implementation, it is not fully clear, yet, how how each Member State establish a workable link between GOs systems and the Union Database[153].

Regarding the option to reconvert biogas and RFNBO into electricity, there is a difference between both types of gases. RED II Art. 2 (1) includes biogas as a source in the definition of 'energy from renewable sources' or 'renewable energy'. RFNBO, however, are not included as a source in this definition. Therefore, in principle, electricity GOs cannot be issued for electricity produced from RFNBOs. Whether this might become an issue, e.g. with the reconversion of RFNBO-grade renewable hydrogen in combined heat and power (CHP) plants, is not addressed yet.

2.7.4. Assessment of emerging market effectiveness

Biogas

Despite limitations on long-term growth, biomethane has the potential to take an important role when it comes to achieving the EU's clean energy objectives. The biomethane market offers further expansion and diversification of the EU gas supply and contribute to reducing the dependence on Russian fossil fuels[154] and the exposure of consumers to volatile gas prices[155]. Therefore, the EU targets a biomethane production of 350 TWh/a by 2030[156]. Current growth rates suggest that the target may not be reached, applying for example, the current annual growth rate of 21% from 2023 towards 2030, total European biomethane production would reach around 186 TWh/a.

The upcoming **Gas Directive (EU) 2024/1788** aims to stimulate the Guarantees of Origin (GO) market by requiring suppliers to include GOs on consumers' bills, enhancing transparency and facilitating consumer comparison. Member States must transpose the Directive into national law by August 5, 2026[157]. This may

[152] https://www.entsog.eu/sites/default/files/2024-04/Presentation%20UDB%20GO%20Prime%20Movers%20event.pdf
[153] https://www.aib-net.org/sites/default/files/assets/news-events/Other%20news/AIB-2023-EECSU-06%20final%20RED%20III%20-%20main%20changes%20for%20GOs%20.pdf
[154] https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biomethane_en
[155] 20230213_Guidehouse_EBA_Report.pdf p, 72
[156] https://energy.ec.europa.eu/topics/renewable-energy/bioenergy/biomethane_en
[157] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202401788

increase the demand for GOs drastically, if considering that 30% of EU households use gas for heating and the EU are still reliant on a sufficient gas supply[158].

In Germany despite relatively long history of biofuels and biogas and being considered the largest market in Europe[159][160][161] of total gas demand (about 11 TWh/a). If applying this (optimistic) rate to whole of Europe about 17 TWh of biomethane would need to be covered by GOs, if the billing obligation These may easily be provided by the market today (assuming full consumption of produced biomethane in private EU households today (49 TWh) and the issuing rate of 55-82%.

Towards 2030 it is instructive to consider Germany to remain the most important market for biomethane. Furthermore, Germany has implemented the "Building Energy Act" (GEG) which may further stimulate additional demand for biomethane and hence GOs for private households.

Starting in 2024, new buildings in new development areas must be heated with at least 65% renewable energy. In existing buildings located in municipalities with more than 100,000 inhabitants (as of 1 January 2024) and for areas where no heating plans exist, new heating systems that do not provide 65% of the heat from renewable energies may only be installed until 30 June 2026. In municipalities with 100,000 or fewer inhabitants, this regulation applies until 30 June 2028. Afterwards the newly installed heating systems must:

- By January 1, 2029, at least 15% of the heat must come from biomass or green/blue hydrogen, including its derivatives.
- By January 1, 2035, this increases to 30%.
- By January 1, 2040, at least 60% of the heat must come from these sources[162].

Dena has analysed how biomethane demand will develop in light of the Building Energy Act. Using the fundamental assumption of about 250 000 heating systems newly installed every year, they assessed the demand development for biomethane in three different scenarios [163].

Based on these scenarios, Dena estimates that biomethane demand in private households in Germany will increase from 1.8 TWh in 2022 to between 2.2-8 TWh in 2029. By 2035, demand could increase to between 8-27 TWh and reach between 13-45 TWh in 2040, depending on the scenarios. Due to the large uncertainty on roll-out of electricity-based heating the wide range of values applies, yet even in the relatively pessimistic scenarios (from biomethane perspective), towards 2029 large relative growth is.

Across sectors biomethane demand could reach approximately 20 TWh. Estimations on available biomethane production by (e.g. DBFZ) expect 50-90 TWh. Therefore, Germany will theoretically be able to cover its own private household demand for biomethane in 2030, even if the Building Energy Act induces further demand for biomethane and the need for GO trading across borders will remain limited.

Applying the growth rates mentioned above for Germany to the EU as a whole 21 TWh of biomethane could be covered the billing obligation 2029 and reaching 76 TWh in 2035.

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[158] https://www.consilium.europa.eu/de/infographics/where-does-the-eu-s-gas-come-from/#0
[159] https://gasforclimate2050.eu/wp-content/uploads/2023/12/GfC_MarketStateTrends_2023.pdf, p.11
[160] https://www.ergar.org/ergar-schemes/coo-scheme-statistics/
[161] https://www.dbfz.de/fileadmin/user_upload/Referenzen/Statements/Positionspapier_Biogas_Ukraine.pdf
[162] https://www.gesetze-im-internet.de/geg/__71.html
[163] https://www.dbfz.de/fileadmin/user_upload/Referenzen/DBFZ_Reports/DBFZ_Report_50.pdf

Assuming that the EU biomethane production target of 350 TWh is reached by 2030, at least 192-287 TWh of biomethane of those will be covered by GOs (assuming an issuing rate of 55-82%) in Europe, showing a largely oversupplied market (note: the higher prices observable for gas GOs are thus not a consequence of a market more balanced compared to the electricity market, but rather a sign of a completely different market willingness-to-pay). Large uncertainties apply however, on development of biomethane application and production in the other EU countries. Furthermore, coupling with the UDB and thus limiting the book and claim principle will further reduce the option to trade on the free market and hence limit price discovery optimization.

Hydrogen and Derivatives in the Industry

As of today, multiple challenges exist in the creation of a European hydrogen market, many of them independent of GO-related issues but linked to electrolyser CAPEX, electricity cost, and overall market and price uncertainties. Based on the current size of the green hydrogen market in the EU, it is important to note that any conclusions or **predictions regarding the future functionality and effectiveness of the hydrogen Guarantee of Origin (GO) market** are highly limited. At this time, it seems not possible to judge the future effectiveness of hydrogen GOs as **a trusted instrument for reporting.**

Some initials indications exist regarding the current perceptions of hydrogen GOs in the market. Many Member States are not yet able to offer a functioning scheme and the transition from private market schemes to national GO schemes appears to face difficulties in some jurisdictions, at times leaving industry clients without adequate means for proving the sustainable qualities of their product. As the certification market is still very fragmented, making any judgement from the consumer side is likely very challenging.

The market related to hydrogen and derivatives is expected to be driven mainly by the demand created via quota obligations for mandating offtake volumes. Since market focus is strongly on RFNBO and the GOs that can be issued for RFNBO produce are not tradeable outside of the UDB, the GO market for non-RFNBO compliant produce is likely to remain a niche market for small (existing) green hydrogen producers that are not able to fulfil all RFNBO requirements (additionality, temporal correlation, geographical correlation). Therefore, hydrogen GOs cannot be considered an effective tool for incentivizing hydrogen build-out.

The current main challenges specific to the hydrogen GO market that will influence future developments and the possible establishment of hydrogen GOs as a certification choice are 1) the slow implementation of national GO systems, and 2) the unclear future of GOs in relation to the planned integration of GOs with the mass balance system of RFNBO within the UDB. It remains to be seen, whether GOs will serve a relevant function to the market and offer a value that PoS cannot, even if independent trading is not possible for the majority of GOs.

Private market hydrogen certificates have, on occasion, been used as a tool for consumer information[164]. However, this seems a niche application, as unlike biogas, hydrogen will likely not be relevant in a domestic context (e.g. domestic heating) in the foreseeable future. It may be that this changes once the phasing out of gas heating systems becomes more imminent, possibly hydrogen or e-methane as derivative might become more relevant in this sector, but this is purely speculative.

[164] NGC certification of hydrogen for AirLiquide for Hydrogen Taxis for Paris Olympics 2024: https://www.airliquide.com/air-liquide-official-hydrogen-supporter-paris-2024

3. FUTURE (ELECTRICITY) GO MARKET DEVELOPMENT

Like any other electricity-related market, the GO market is affected by various influencing factors (see discussion in chapter 2) applying to both supply and demand. Anticipation of the impacts of the upcoming developments towards 2030 on supply and demand is provided in this chapter by using various proxies.

First, we look at the renewable energy generation capacities and growing availability of GOs supplied to the market;

Second, we judge on the impact of various developments by comparing the average additional annual demand towards 2030, with the average additional availability of GOs supplied to the market. Main focus lies on the structural oversupply observed to date (and if a tipping point may be reached), also considering the qualitative elasticity of the supply or demand. Further by considering the year-to-year changes, we approximate if short-term shortages may apply.

Third, we discuss if combined developments along 3 "pathways" cause a change in the structural balance of the market.

In a separate **deep dive**, taking the example of Serbia, we discuss how additional national participants may influence the market balance.

Finally, those development options currently debated are assessed qualitatively and mapped to serve as basis for future discussions on active evolution of the GO system.

3.1. Understanding renewable deployment in Europe and implications on the GO market

Since 2018 the share of renewable energy production in the EU27 has steadily increased by an average of 35 TWh per year, reaching a maximum build-out from 2022 to 2023 and generating over 150 TWh of additional renewable electricity year over year. A significant further rise of the RES share is expected and legally mandated by the EU. The revised REDII[165] has increased the EU's binding renewable energy target for 2030 to 42.5%, with the aim of increasing it to 45%. No binding target for 2040 is in place, but the EU will significantly have to raise its renewables capacity to reach its goal of climate neutrality by 2050. Yet, MSs' current commitment to the 2030 target may only reach a share of renewables from 38.6% to 39.3% by 2030[166], meaning that MSs must raise ambition to reach the EU's target.

[165] EU Directive 2023/2413
[166] European Commission, 2023

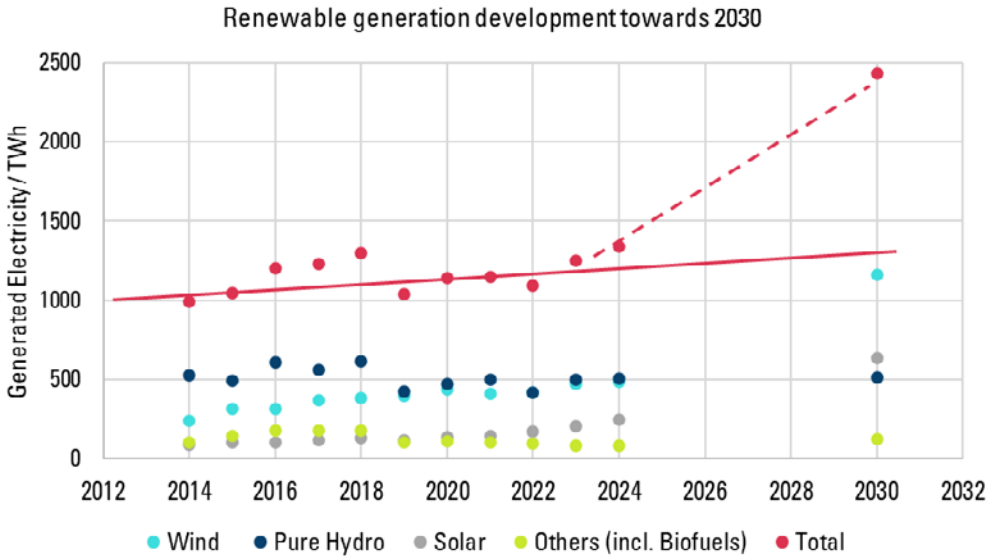

Figure 3-1 Renewable energy generation development towards 2030, based on ENTSOE Power Stats[167] and IA 2040[168].

According to the Impact Assessment for the 2040 climate targets[169] the European renewable market is targeting further increasing RES shares and ~2430 TWh/a may be produced in 2030. To reach this target, a growth by another 200 TWh/a generated renewable energy is required yearly, almost doubling the average growth rates since 2020. The largest increase will come from wind generated electricity, while hydro power can be expected to remain in the same order of magnitude. This can be further confirmed via the (independent) IEA scenarios, which confirm the overall renewable build-out to lie on the order of doubled capacities and therefore roughly also doubled generation: IEA expects Hydropower to not further expand towards 2030, remaining at about 250 GW production capacity, while overall renewable energy build-out doubles and reaches 1600 GW starting at about 894 GW (considering Europe as a continent); also confirmed by other sources expecting a decline down to around 35% of overall generated electricity[170].

If applying today's averaged issuing rates (per technology) to the expect renewable energy generation [see chapter 2.3], **around 1324 TWh/a of GOs may be issued in 2030**. From today's issued values of around 800-900 TWh this would correspond to **about 70 TWh/a of GOs additionally available**. Towards 2040 and depending on the scenario applied (S1 or S3) similar annual growth rates can be expected (ranging on average from below 70 TWh/a to above 140 TWh/a). Since the averaged issuing rates today are reduced by small-scale generation plants (generally much more unlikely to request issuance of GOs) and by subsidized plants not being eligible for issuance the rates may in fact lie higher for additional generation capacities towards 2030. (cf. chapter 2.3, where we have shown an average of 70-80% issuing rates for all capacities not underlying any restrictions). Hence about 70 TWh per year additionally available is to be considered as a rather conservative scenario. Moreover, as shown in chapter 2.2.1, the structural oversupply has led to an accumulated liquidity or "reserve" of the market since 2019 of about over 200 TWh,

[167] https://www.entsoe.eu/data/power-stats/

[168] https://eur-lex.europa.eu/resource.html?uri=cellar:6c154426-c5a6-11ee-95d9-01aa75ed71a1.0001.02/DOC_1&format=PDF

[169] https://eur-lex.europa.eu/resource.html?uri=cellar:6c154426-c5a6-11ee-95d9-01aa75ed71a1.0001.02/DOC_1&format=PDF

[170] https://auroraer.com/media/guarantees-of-origin-market-set-for-growth-trajectory-projected-to-reach-3-7-bn-e-by-2030/

which, if stretched over the five years towards 2030, could make additional 20-40 TWh/a available to the market.

Hence, the tipping point between structural oversupply and undersupply will only be reached if, towards 2030, more than 100 TWh of additional GO demand is created annually.

Considering that under specific conditions the relative variability of the renewable production can also lead to short-term undersupply (as observed in the 2023 price peak), it is also important to consider the trends for supply variability. In the past local weather effects (i.e. droughts) have had the largest impact, sometimes leading to ~55 TWh of hydro power less available [chapter 2.2.1]. This risk, however, reduces with the decreasing importance of hydro power generation, reducing supply variability from almost around 10 % today (2023 basis) to about 6 % of overall tradable volumes in 2030.

3.2. Relevant developments and respective impacts

This chapter aims to provide proxies and estimations on how these developments may affect supply or demand and will additionally shed light on the elasticities and uncertainties of the related numbers.

Several ongoing developments in European and national policy as well as non-policy driven factors may influence the balance of the GO market. Literature research particularly based on the analysis of market observers like Veyt[171], Montel[172] or Becour[173], as well as survey and interview feedback on "trends" were used to identify the most important developments until 2030 (summarized in Table 3-1 - Table 3-3).

Table 3-1: Developments related to European policy and regulation

(Potential) Development	Short Description	Impact qualitative
Corporate Sustainability Reporting Directive (CSRD)	About 50000 companies will need to report their renewable electricity consumption using market-based instruments (i.e. GOs)	Increases demand
Omnibus regulation	Has reduced the numbers of affected companies from the CSRD and delayed implementation (2nd and 3rd wave to 2028 and 2029 respectively, but before 2030)	Decreases demand
Green Claims Directive (GCD)	Upcoming regulation requiring adequate substantiation for green claims (e.g. via surrendering GOs)	Depends on exact interpretation of "voluntary claims", but may affect the demand from household consumers through labels applied

[171] https://veyt.com/articles/becou
[172] https://montel.energy/post-tag/guarantees-of-origin
[173] https://becour.com/articles/

Table 3-2: Developments related to national markets

(Potential) Development	Short Description	Impact qualitative
EU wide: Additional auctioning of subsidized RES capacities	This practice is successfully implemented in the countries of Croatia, France, Greece, Hungary, Italy, Luxembourg, Portugal, Slovakia	Increases supply of GOs
Germany: Abolishment of Doppelvermarktungsverbot	Germany has large renewable electricity capacities that currently are NOT issuing GOs	Increases supply of GOs
Norway: Leaving AIB	Norway considered leaving the AIB, which is a rather unlikely scenario due to "settled discussions"	Decreases supply of GOs (Norway is net exporter)

Table 3-3: Non-policy driven developments

(Potential) Development	Short Description	Impact qualitative
RE100 (15-years age - limit)	RE100 companies have announced to procure at least 85 % from installations not older than 15 years	Increases demand specifically for wind/solar GOs
RFNBO production demand of electricity	RFNBO production targets reach 10 Mio. Tonnes in 2030, requiring hourly GOs to proof temporal correlation	Increases demand (for hourly)
Renewable PPAs demand increase	PPAs become an increasingly popular instrument for renewable electricity procurement	Increases demand also decreases liquidity for merchant market
Own production (corporates) – CEN EN 16325 → differentiation of behind the meter GOs from market GOs[174]	Large corporations may aim to procure via direct line in order to diversify the procurement portfolio	Reducing demand

For each of the above-described developments, we chose a proxy to estimate the related GO quantity, define the related uncertainty and elasticity and finally conclude if the development may lead to a change in structural balance, or if temporary undersupply towards 2030 (e.g. due to sudden changes) may occur.

The two criteria are:

174 https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/24_2023_cc_analyse_eines_unternehmensentwertungsrechts_fuer_strom-herkunftsnachweise_in_deutschland.pdfhttps://www.umweltbundesamt.de/sites/default/files/medien/11850/publikati

Structural balance: is the quantity of GOs exceeding the additional supply of 500 TWh.

Temporal undersupply: Does the yearly increase excess the value of 100 TWh.

Table 3-4: Semiquantitative impacts of the various developments

	(Potential) Development	Proxy chosen	Quantified value maximum in 2030 (TWh/a)	Uncertainty/ Elasticity	Risk to reach tipping point (Structural oversupply at stake?)	Risk for temporal undersupply ? (based on yearly)
European Policy	**CSRD**	SMEs in Europe[175] and overall electricity demand industry sector[176]	170-225 TWh	Voluntary commitments to RE shares, forward-looking elasticity, but reporting relatively inelastic	No	no
	Omnibus	Share of companies not affected anymore	- 50 TWh	-	N/A	N/A
	Green Claims Directive	Share of European household with "green tariffs" reaches German average[177]	210 TWh	Fairly elastic: High price sensitivity of end-consumers, yet often fixed contractual situation of suppliers and end-consumers	Unlikely	Possible, if implemented without transition periods
National policy	**Additional capacities from subsidized RES**	Subsidized RES generation (2021 basis[178]) in Europe without countries already auctioning these	200 TWh	May come into effect only in steps and unlikely to fullest extend	Not applicable	Not applicable
	Germany: "Doppelver marktungsverbot "	German RES generated 2023	250 TWh[179]	May come into effect without large transition phase	Not applicable	Not applicable

[175] https://www.statista.com/statistics/878412/number-of-smes-in-europe-by-size/

[176] https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_e/default/table?lang=en

[177] https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/24_2023_cc_analyse_eines_unternehmensentwertungsrechts_fuer_strom-herkunftsnachweise_in_deutschland.pdf and https://ec.europa.eu/eurostat/databrowser/view/nrg_cb_e/default/table?lang=en

[178] https://www.ceer.eu/wp-content/uploads/2024/04/RES_Status_Review_in_Europe_for_2020-2021.pdf

[179] https://www.umweltbundesamt.de/sites/default/files/medien/11850/publikationen/24_2023_cc_analyse_eines_unternehmensentwertungsrechts_fuer_strom-herkunftsnachweise_in_deutschland.pdf

	(Potential) Development	Proxy chosen	Quantified value maximum in 2030 (TWh/a)	Uncertainty/ Elasticity	Risk to reach tipping point (Structural oversupply at stake?)	Risk for temporal undersupply ? (based on yearly)
	France: Nuclear GOs	Nuclear electricity generation France (long-year average[180])	400 TWh	Ongoing, but little cancellation in practice (~50 TWh)	Not applicable	Not applicable
Parallel developments	**RE100 (< 15 years)**	RE100 GO demand Europe[181]	34 TWh	Elastic, since RE100 actually also "accepts" non-GO reported claims	No effect structurally	Minor risk for technology specific GOs
	Voluntary full disclosure in industry sector (e.g. joining RE100)	RE share in industry electricity consumption reaching 42.5% ambition	~100-150 TWh	Very elastic	Elasticity too high to have structural effects	Unlikely
	RFNBO production	Bottom-Up: 5 Mio. t target if industry target + fuel production Top down: 10 Mio. t target → for 2030	225-500 TWh[182]	Very inelastic, after production period, but high uncertainty for changes in overall magnitude (delayed H2 ramp-up)	Risk of reaching tipping point given	Unlikely, due to long planning horizons
	PPAs demand increase[183]	IEA estimation of 17% PPA share in procured RE electricity Europe[184]	(200-)250 TWh	Very inelastic, because contractually fixed, but significant volumes already incorporated in market today (cumulated RE produced under	None, since issuance intrinsically tied to demand - See more detailed discussion in BOX 5	Not applicable

[180] https://www.statista.com/statistics/749532/raw-nuclear-energy-production-france/
[181] https://www.there100.org/our-work/publications/re100-2023-annual-disclosure-report
[182] https://energy.ec.europa.eu/news/renewable-hydrogen-production-new-rules-formally-adopted-2023-06-20_en
[183] Note that the estimations by IEA and validation via Baringa et al. do NOT include RFNBO production in these estimations. Hence the associated estimation can be considered independent from RFNBO uncertainties.
[184] https://iea.blob.core.windows.net/assets/17033b62-07a5-4144-8dd0-651cdb6caa24/Renewables2024.pdf

(Potential) Development	Proxy chosen	Quantified value maximum in 2030 (TWh/a)	Uncertainty/ Elasticity	Risk to reach tipping point (Structural oversupply at stake?)	Risk for temporal undersupply ? (based on yearly)
			PPAs to date = 217 TWh[185])		

3.3. Discussion of different pathways

Some of the impacts associated with the listed developments may cancel each other (for example RFNBO demand is directly associated with further PPA demand), while others may stack up and therefore, if combined, may reach the tipping point of more than 100 TWh additional demand per year. This may lead to a change of the fundamental (im)balance of the market today and potentially may influence the associated price discovery mechanism.

Pathway 1: GO demand and supply developments materialize (Supply and demand act)

Under the assumption that only RFNBO production and CSRD reporting will materialize as demand drivers, demand will reach about 450 TWh in 2030. This is even under current assumptions on issuing rates covered by the overall build-out trajectory of renewables and associated GOs towards 2030 (~500 TWh). The additional demand may be even fully absorbed by additional supply available from to-date not auctioned GOs. Moreover, the omnibus legislation will likely delay reporting obligations, allowing supply to be build-out to higher levels in the meantime. Neither structurally, nor temporally, the market will reach being undersupplied.

Risk to reach tipping point in 2030 (Structural oversupply at stake?)	Risk for temporal undersupply? (yearly changes)
No	**No**

Impact on market volume: The market will remain structurally oversupplied and thus price discovery mechanisms will not fundamentally change. The market will more or less "carry on": Reaching a market volume of around EUR 0.75 billion in 2030[186]. This is smaller compared to estimations by other sources, estimating EUR 3.7 billion for 2030.[187] However, these reports are also generally more optimistic with regards to price developments.

Pathway 2: Ambitious GO demand developments materialize (Supply reacts)

In a more hypothetical case that would combine an increasing share of RFNBO production, as well as 30% of green energy tariffs (to be based on GOs due to GCD) across Europe and implementation of CSRD, the demand for GOs could increase on the order of (cumulative) 650 TWh towards 2030. When comparing this number with the current trajectory of renewable build-out and thus GO supply increase, the market may in

[185] https://www.spglobal.com/commodity-insights/en/news-research/latest-news/electric-power/080124-infographic-european-renewable-power-purchase-agreements
[186] Assuming GO prices as paid at end of 2024 (~0.5€/MWh).
[187] https://auroraer.com/media/guarantees-of-origin-market-set-for-growth-trajectory-projected-to-reach-3-7-bn-e-by-2030/

fact only be able to provide (cumulative) 500 TWh of additional GOs (compared to today). Actually reaching undersupply will remain unlikely however, due to flexibility of supply to issue GOs at higher rates (additional 5%points for hydro, and further up from 70-80% for solar/wind) as well as the expected elasticity on demand side (households, if affected by higher GO prices will quickly switch tariffs or not consider switching into "green" in the first place). Furthermore, the market length today has accumulated at least at around 100-200 TWh, further mitigating the gap.

Risk to reach tipping point in 2030 (Structural oversupply at stake?)	Risk for temporal undersupply? (yearly changes)
Possible, but elasticities of supply and demand may mitigate	**Unlikely, but possible**

Impact on market volume: The existing elasticities of the market keep it structurally oversupplied, yet supply and demand reach a balance with possible shortages requiring appropriate hedging strategies (via futures). The market volume could reach up to EUR 2 billion in 2030[188], and providing an additional revenue to renewable energy producers of EUR 0.8 billion (using the 60% lost to fees, market uncertainty Figure 2-43).

Pathway 3: Maximum GO demand developments materialize

Only in the even more extreme case of full disclosure of renewable electricity shares in energy consumption in the industry sector via GOs (e.g. via an unlikely case of all corporations joining initiatives such as RE100)) and the previously mentioned increase of additional RFNBO production (full H2 ambitions met) as well as ambitious household GO demand, a combined additional GO demand of up to ~1000 TWh could be reached in 2030;this is on the order of overall (renewable) electricity build-out foreseen towards 2030 (~1100 TWh) and may hence reach orders effectively considered to make the market undersupplied for both renewable energy as well as associated GOs. This in itself does incentivize further to invest into renewable energy assets. As a consequence, even in these cases and due to the medium-term perspective, it remains unlikely that the market despite a possible temporal shortage around 2030 will remain structurally undersupplied for longer periods of time.

Risk to reach tipping point in 2030 (Structural oversupply at stake?)	Risk for temporal undersupply? (yearly changes)
Possible, elasticities may not suffice to mitigate	**Likely**

Impact on revenue streams: Price discovery will fundamentally change. Some demand remains elastic enough to show elasticity on extreme prices. Therefore, we expect the market to reach orders of magnitude paid during the energy crisis, but not exceeding it, since demand elasticity will in principle allow to "step-out". The market volume could reach up to EUR 6.5 billion in 2030 and providing an additional revenue to renewable energy producers of EUR 2.6 billion (using the 60% lost to fees, market uncertainty Figure 2-43).

[188] Assuming the GO price towards 2030 to be reflected in the Yr4+ futures as of end of 2024.

On the long run, towards 2040 and 2050, overall power consumption in Europe will remain on the order or below available renewable energy[189]. The GO instrument will thus be required to enable informed decision making upon consumers within the various qualities. This also means that the overall renewable energy build-out will not be an appropriate proxy to estimate the market volume. And especially the private end-consumers electricity consumption will determine the relevant market size, since this group will possibly show a willingness-to-pay for certain qualities, such as (regional) wind and solar other than only renewable (including Norwegian Hydro).

3.4. Deep dive: New national participants

A specific deep dive is provided for the possibility of a Contracting Party from the Energy Community entering the GO market in the next years. The Energy Community is elaborating on a roadmap together with AIB and the European Commission to eventually join the regional GO system with the European market[190]. The Republic of Serbia was chosen as representative example, since its issuing body EMS (Elektromreza Srbije[191]) became a member of the Association of Issuing Bodies (AIB) already in 2019. Furthermore, Serbia was already prepared to enter the market just before RED II established the need for an agreement between the European Union and the third country on mutual recognition of GOs.

Status quo on GOs in Serbia

Currently, Serbia is the only Energy Community Contracting Party to have successfully implemented a functional GO system for electricity, which includes the adoption of disclosure rules and the publication of a national residual mix.

The energy certificate registry provider Grexel has provided the Serbian registry system since 2017. The current Serbian GO market is dominated by the state-owned utility EPS (Elektroprivreda Srbije[192]), which owns 3 GW of hydropower capacity generating approximately 10 TWh per year. Most wind and solar producers are part of a support scheme and are unable to offer GOs.

Beginning in 2023 market participants from the Serbian registry started the export of GOs to various countries (~ 7 TWh by end of 2023). Serbian GOs were in fact transferred to several countries such as Italy, Switzerland, etc, but can only be used for disclosure in Switzerland.[193]

The total issued guarantees of origin in the period from the first issued GOs (November 2018) until end of 2023 amounted to about (cumulated) 13 TWh, with almost 9 TWh GOs issued only in 2023. The number of imported guarantees of origin into Serbia in the period since import was enabled via AIB until the end of 2023 amounted to 0.55 TWh out of which 0.25 TWh of them were imported in 2023.[194].

[189] https://www.strommarkttreffen.org/wp-content/uploads/2024/10/David-Jamissen-THEMA-Consulting-Group-The-long-view-%E2%80%93-Is-a-decline-of-GO-prices-inevitable.pdf
[190] https://balkangreenenergynews.com/eu-readies-criteria-for-recognizing-energy-communitys-guarantees-of-origin/
[191] https://ems.rs
[192] https://www.eps.rs
[193] https://veyt.com/articles/serbia-starts-go-exports-but-eu-deal-still-pending
[194] https://www.aers.rs/media/FILES/Izvestaji/Godisnji/Eng/AERS%20Annual%20Report%202023.pdf

The total number of issued Guarantees of Origin for electricity produced in 2023 is 8,686,978, while the total number of cancelled Guarantees of Origin for the electricity consumption in 2023 is 1,909,203[195].

In 2023, 44 market participants were registered in the GO system in Serbia, which is double the number from 2022. Currently 56 market participants (Wholesale Suppliers, Suppliers and Producers) are registered [status 01.01.25 EMS 2025], suggesting that interest in the market is growing[196].

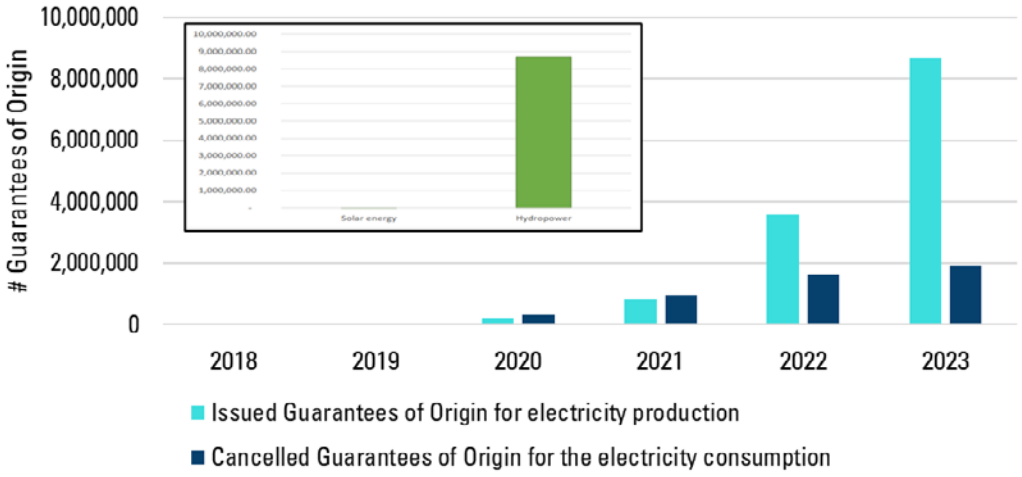

Figure 3-2 Registry of Guarantees of Origin for Serbia 2018-2023

Based on National Residual Mix Annual Reports for Serbia for 2018-2023.

Currently, roughly one third of Serbia's electricity is produced from renewable energy sources (especially hydropower) and GOs are issued for about 72% of the total renewable electricity production (80% of hydropower).

Although Serbia's GO market has seen continuous growth in recent years, and Serbia has evolved into a net exporter of GOs (exporting 7 TWh of GOs via AIB), illustrates the GO activity (TWh) for European countries involved in the GO trade system and comparison to countries with similar GDP and historic background (i.e. Croatia exporting ~5 TWh) shows that GOs are exported in the same order of magnitude (despite not fully accepted in the AIB region). Further comparing the data of issuance and cancellations with Croatia (7.9 TWh of GOs were issued and 5.1 TWh were cancelled[197]) shows that the hydro power access in Serbia supports the strong oversupply of the market, despite potential for further increasing domestic demand.

Renewable deployment in Serbia and implications on the EU GO market

Overall electricity generation in Serbia is currently dominated by fossil fuels, with coal playing the most important role. In 2023, the total net electricity generation amounted to 34 TWh[198].

[195] https://ems.rs/wp-content/uploads/2024/06/National-Residual-Mix-Annual-Report-for-Serbia-for-2023-Unofficial-translation.pdf
[196] https://ems.rs/wp-content/uploads/2025/01/SPISAK-GOS-eng.pdf
[197] https://files.hrote.hr/files/PDF/RJP/GI_2023_HROTE_Sustav%20jamstva%20podrijetla%20energije.pdf
[198] https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Publications/Statistics/Factsheet/entsoe_sfs2023_web.pdf

Hydropower has been the dominant energy source for electricity generation from renewable energies in Serbia for years. At around 10 TWh per year, it contributes the largest share of renewable electricity generation and remains almost constant within the range of natural fluctuations. Although wind and solar power have been making an increasing contribution to electricity generation since 2018, their share is still relatively low. While wind power has undergone remarkable development in recent years (reaching a maximum build-out from 2022 to 2023 of just under 1 TWh of additionally generated renewable electricity), the use of solar energy is still at an early stage.

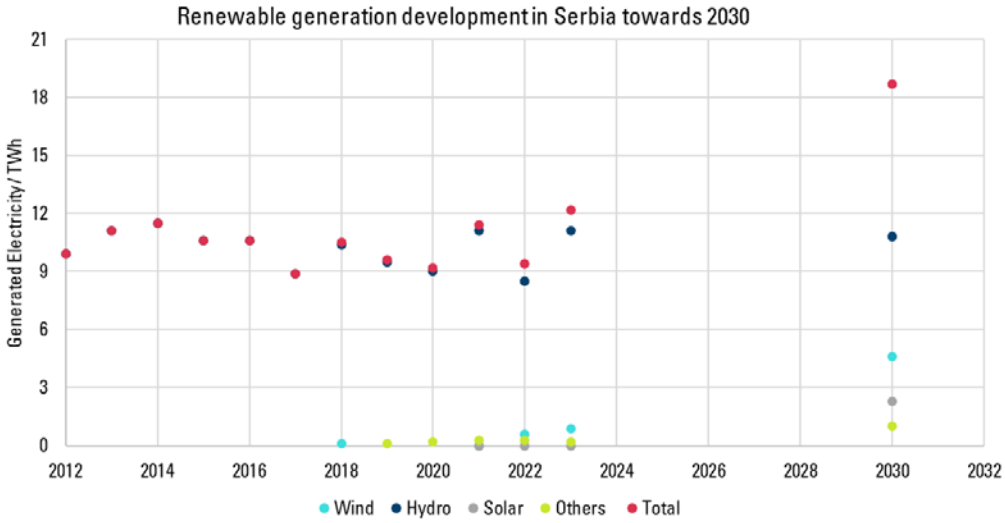

Figure 3-3: Renewable generation development in Serbia towards 2030
LBST based on Serbia's INECP and https://www.entsoe.eu/data/power-stats

The Serbia's Integrated National Energy and Climate Plan (INECP) adopted 25 July 2024 for the period until 2030 with projections until 2050 anticipates an increase in renewable energy generation. Serbia aims to invest in renewable energy sources and to add around 3.5 GW of new solar and wind power capacity by 2030, in order to generate nearly half (45%) of its power from clean sources by 2030, and 73% by 2040[199] respectively. Serbia's INECP outlines plans for a growing RES share, with a projected renewable energy output of roughly 18 TWh in 2030. The largest growth will come from wind (4.6 TWh) and solar (2.3 TWh) generated electricity, while hydro power is expected to continue at a similar order of magnitude at 10.8 TWh annually.

"*The available hydro energy potential in Serbia is estimated at approximately 25 TWh per year. Over 70% of this potential is concentrated in several large rivers: the Danube, the Drina, the Velika Morava, the Lim and the Ibar. By some estimates, there are more than 100 small-scale hydropower plants currently operating in Serbia, while more than 700 are designed or in construction. However, due to active and widespread criticism of small-scale hydro power plants (given their limited benefits and the expected detriment to Serbian flora and fauna) few projects on smaller rivers are expected to be developed*[200]."

[199] https://www.mre.gov.rs/extfile/sr/5928/Draft%20-%20Energy%20Strategy%2015072024.pdf
[200] https://www.wolftheiss.com/app/uploads/2024/05/wt_RES-guide_all_countries_final-1.pdf

Due to the special role of hydropower in the balancing of the electricity sector the Energy Strategy of the Republic of Serbia outlines as a priority the construction of hydropower plant Bistrica (628 MW) by 2032.

Relative variability of the renewable production in Serbia is likely to decrease, because the largest growth is expected in fluctuating energies like PV and wind, while hydropower generation remains at a similar level to today. However, hydropower is also subject to certain fluctuations depending on weather conditions. Reduced rainfall can decrease the flow rate of rivers, which results in a reduction of electricity production. This could reduce the availability of hydro GOs in the market.

The Serbia's INECP (Scenario S) projects that hydropower generation stays largely the same, at roughly 12-13 TWh per year, continuing up to 2050.

If applying today's issuing rate of about 72% this means that around 13 TWh of GOs may be issued in 2030. From today's issuing this would corresponds to about 4 TWh of GOs additionally available per year. The Serbian market is structurally oversupplied with hydropower by about 6 TWh (2023 basis). **As a consequence, the GO market in Europe will experience further oversupply, if the markets are joined together, not mitigating the current situation, but due to the rather small volumes also not dramatically worsening the current state-of-play.**

Serbia aims to support domestic demand for GOs; Serbia's INECP envisages a number of decarbonisation-related policy measures in terms of energy and non-energy related GHG emissions. This includes "*Fostering the further utilization of guarantees of origin for energy from RES*" Consequently, the guarantees of origin scheme is slated for improvement between 2025-2030. The existing legislative framework will be expanded to cover not only the produced electricity from RES, but the utilized RES in heating, cooling and transport. The operation of the registry of guarantees of origin will be continued enhanced facilitating the provision of information to all citizens. Furthermore, an auction mechanism will be implemented, enabling companies to acquire guarantees of origin.

A reliable forecast of the Guarantees of Origin (GO) domestic demand for Serbia is not feasible at present. However, it can be stated that the INECP's proposed measures may significantly alter the domestic demand for both green electricity and the GOs.

Similarly to Serbia, most other Energy Community countries'[201] renewable generation is dominated by hydro power (with potentially high GO issuing rates), but policies are even less advanced with regards to developing the overall framework for using GOs ("GO demand") and hence, while likely remaining limited in its overall impact, new national participants on the joint market with the EU countries will lead to further oversupply of GOs.

Regarding gas GOs in Serbia, "*the existing legal framework envisages the issuance of GOs solely for renewable electricity without encompassing other energy carriers as required by the RED II*[202]." Hence, no impacts are expected on the gas GO markets.

For a projection towards 2040: the Energy Sector Development Strategy of the Republic of Serbia up to 2040 with projections up to 2050 adopted in November 2024[203] envisages an increase in the renewable energy generation and the demand for green energy consumption is expected to grow as well.

[201] https://www.energy-community.org/implementation/report.html
[202] Energy Community Secretariat: Serbia Annual Implementation Report 1 November 2023, p.7.
[203] https://www.mre.gov.rs/extfile/sr/5928/Draft%20-%20Energy%20Strategy%2015072024.pdf

3.5. Identification and mapping of potential measures and development options for GO markets

3.5.1. Objectives and working approach

The primary objective of the work outlined in this chapter was to systematically identify and map measures and development options for GO markets, with a specific focus on the systems and application of guarantees of origin (GOs). This has been achieved based on the four working steps:

Working step 1: The initial phase involved the comprehensive identification of potential options for further measures and development options of GO-related systems and their application. This was achieved firstly by expert input by structured interviews and surveys conducted during Task 2. This provided insights from relevant experts and stakeholders, which have been supplemented by findings from Task 3. Furthermore, literature has been analysed in desktop research in order to identify relevant proposals or request for further development of the GO system. This included documents from public authorities, market participants, associations, non-governmental organisations (NGOs), and the academic community.

Working step 2: Following identification, the options were subjected to a general characterisation process to facilitate systematic comparison and clustering. This entailed:

- Typification of measures: Options were categorised according to their **field of action**, meaning their principal objective and functional mechanism. This can help for a comprehensive discussion on alternative or complementary approaches to the same underlying issue.
- Specification of **GO system elements**: Specification of the component of the GO system targeted primarily per each measure respectively. This can help for a comprehensive discussion of potential measures relating to such system elements.

Working step 3: Subsequently, individual measures associated with the same field of action were synthesised into a limited number of "**specific development options**". This step aimed to reduce redundancy and improve analytical clarity. In a final consolidation phase, these specific development options were further aggregated across all fields of action to generate a refined list of distinct "**general development options**" suitable for further in-depth consideration.

Working step 4: In a final step, each of the identified general development options was systematically documented and analysed using a standardised fact sheet format. These fact sheets include the following elements:

- General description of the development option.
- Linkage to the primary field of action and the corresponding GO system element.
- Indicative potential effects of the option in relation to different market and system dimensions (as described in Chapter 2).
- Potential levels of implementation, distinguishing between EU-level legislation, national (Member State) legislation, and non-legislative measures.
- Responsible actors, identifying the potential roles of the European Commission, Member State governments, market stakeholders, and other relevant organisations.

Through this structured approach, a comprehensive and analytically robust basis for mapping and characterising development options of the GO system and their respective effects on the functioning of GO systems and markets.

3.5.2. Fields of action for development options, and addressed elements of GO systems

Identification of fields of action

Based on the initial screening research as described in chapter 3.5.1 above, over 130 individual proposals for measures have been identified. Those proposals for individual measures have been clustered within nine identified different fields of action (see Figure 3-4).

Figure 3-4: Identified fields of action of possible measures / development options

The identified fields of action comprise the following:

- **Improvement of technical framework**: this includes measures particularly focussing on the technical aspects of registries and data handling within GO system.
- **Increase & flexibilisation of GO supply**: this includes measures which aim at or result in increased volumes of GO supply in the market, and which increase the flexibility of market actors for the allocation of these GOs.
- **Restriction and focussing of GO supply**: this includes measures which aim at or result in the restriction of volumes of GOs which are supplied to the market, and which restrict the flexibility of market actors for the allocation of these GOs.
- **Increase & flexibilisation of GO demand**: this includes measures which aim at or result in increased volumes of the GO demand in the market, and which increase the flexibility of market actors to demand certain GOs.
- **Focussing of GO demand (mandatory measures)**: this includes mandatory (i.e. legislative) measures which aim at or result in a focussed demand by end-consumers on specific GOs.
- **Measures outside GO system to influence voluntary demand**: this includes measures which do not address the GO system itself, but aim at influencing the demand for GOs on a voluntary basis.
- **Harmonise rules in order to increase market liquidity**: this includes measures which aim at the harmonisation of GO related rules and systems with the major objective to avoid unintended barriers and to increase market liquidity.
- **Tools and mechanisms for market transparency and market facilitation**: this includes the introduction of tools and mechanisms in order to increase market transparency and the facilitation of market processes.
- **For gas GOs: clarify relation to PoS / UDB**: this relates to the general request which has been found to be of primary relevance for gas GOs. Specifically on the way Member States could implement the requirements on handling gas GOs and proofs of origin (PoS), and the deal with the respective data processes in national databases or GO registries and the union database (UDB).

The individual proposals for measures to a large extent have been found to be relevant for several of these fields of action. Accordingly, the related measures have separately been listed within each of the relevant fields of action for further consideration.

Taking into account that GO markets for electricity GOs have already developed for several years, involving a large number of market actors and a high volume of GOs, the vast majority of identified proposed measures to further develop the GO system refer to electricity GOs. The outstanding exception refers to the clarification of the relation of gas GOs to PoS and the UDB. However, the identified measures (later on referred to as “development options”), which are further described in the following sections, can also be considered for their relevance for further developments in the field of gas GOs and also of GOs for heating and cooling.

Overview of addressed elements of GO systems

For all identified measures / development options the component of the GO system ("GO system element") that each measure primarily targets was specified. This can help for a comprehensive discussion of potential measures relating to such system elements. The addressed GO system elements are listed in .

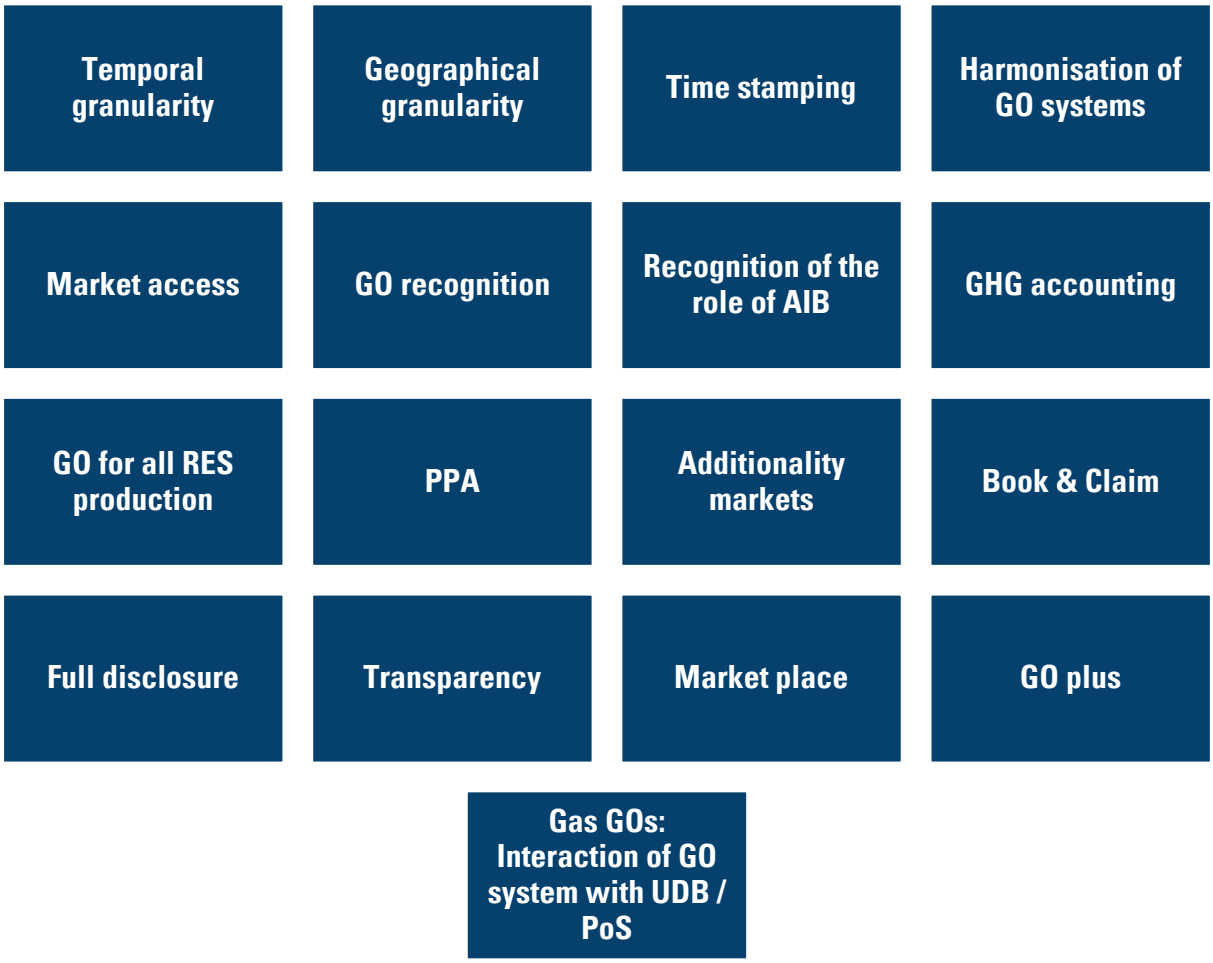

Figure 3-5: Overview over GO system elements which are addressed by the identified development

Overview of development options relating to the different fields of action

As described in chapter 3.5.1, individual measures associated with the same field of action were synthesised into a limited number of "specific development options". This step aimed to reduce redundancy and improve analytical clarity. In a final consolidation phase, these specific development options were further aggregated across all fields of action to generate a refined list of distinct "general development options" suitable for further in-depth consideration (Working step 3). For each field of action, the following tables (from Table 3-5 to Table 3-13) provide an overview for all specific development options, the related general development option and the related GO system element.

Table 3-5: Identified development options in the field of action "Improvement of technical framework"

Improvement of technical framework		
Specific development option	**Related general development option**	**Related GO system element**
Temporal granularity: ensure technical preconditions	Enhance temporal granularity (technical)	Temporal granularity
Geographical granularity: ensure technical preconditions	Enhance geographical granularity (technical)	Geographical granularity
Harmonise time stamping	Harmonise time stamping	Time stamping
Harmonise and digitalise GO registries	Harmonise and digitalise technical GO systems	Harmonisation of GO systems
For gas GOs: Expand registries to cover PoS	For gas GOs: Integrate and harmonise GOs / PoS and GO registries / UDB	For gas GOs: Interaction of GO systems with UDB/PoS

Table 3-6: Identified development options in the field of action "Increase & flexibilisation of GO supply"

Increase & flexibilisation of GO supply		
Specific development option	**Related general development option**	**Related GO system element**
Maintain single GO market (without geographical restrictions)	Maintain single GO market and abolish any geographical limitation	Geographical granularity
Harmonise GO systems: rules & governance	Harmonise GO systems (rules & governance)	Harmonisation of GO systems
Harmonise GO systems: technical harmonisation & registries	Harmonise and digitalise technical GO systems	Harmonisation of GO systems
Recognise GOs also from 3rd countries	Recognition of GOs also from 3rd countries	GO recognition
Issue GO for all RES (including supported)	Issue GO for all RES (including supported)	GO for all RES production
Introduce full disclosure	Introduce full disclosure	Full disclosure

Table 3-7: Identified development options in the field of action "Restriction & focussing of GO supply"

Restriction & focussing of GO supply		
Specific development option	**Related general development option**	**Related GO system element**
Apply stricter temporal correlation (monthly / daily / hourly)	Enhance temporal correlation (application)	Temporal granularity
Apply annual temporal correlation	Enhance temporal correlation (application)	Temporal granularity
Apply geographical correlation	Enhance geographical correlation (application)	Geographical granularity
Apply geographical correlation (in the sense of trade limitations according to interconnectors)	Enhance geographical correlation (application)	Geographical granularity
Issue tradeable GOs only for new plants	Issue tradeable GOs only for new plants	Additionality markets
Introduce "GO plus"	Introduce GO plus	Additionality markets
Abolish or restrict book & claim approach	Abolish or restrict book & claim approach	Book & Claim

Table 3-8: Identified development options in the field of action "Increase & flexibilisation of GO demand"

Increase & flexibilisation of GO demand		
Specific development option	**Related general development option**	**Related GO system element**
Maintain single GO market (without geographical restrictions)	Maintain single GO market and abolish any geographical limitation	Geographical granularity
Allow for cancelling by non-suppliers (intermediaries, traders, consumers)	Harmonise market access for different stakeholders and eliminate access restrictions	Market access
Recognise GOs also from 3rd countries	Recognition of GOs also from 3rd countries	GO recognition
Introduce full disclosure	Introduce full disclosure	Full disclosure

Table 3-9: Identified development options in the field of action "Focussing of GO demand (mandatory measures)"

Focussing of GO demand (mandatory measures)		
Specific development option	**Related general development option**	**Related GO system element**
Apply mandatory temporal correlation (monthly/daily/hourly…)	Enhance temporal correlation (application)	Temporal granularity
Apply annual temporal correlation	Enhance temporal correlation (application)	Temporal granularity
Apply mandatory geographical correlation	Enhance geographical correlation (application)	Geographical granularity
Apply mandatory geographical correlation (in the sense of trade limitations according to interconnectors)	Enhance geographical correlation (application)	Geographical granularity
(Official / public) additionality criteria or label	Develop and apply (official/public) additionality criteria or label	Additionality markets
Abolish or restrict book & claim approach	Abolish or restrict book & claim approach	Book & Claim

Table 3-10: Identified development options in the field of action "Measures outside GO system to influence voluntary demand"

Measures outside GO system to influence voluntary demand		
Specific development option	**Related general development option**	**Related GO system element**
Apply voluntary temporal correlation	Enhance temporal correlation (application)	Temporal granularity
Apply voluntary geographical correlation	Enhance geographical correlation (application)	Geographical granularity
GOs and market-based approach should be generally applicable for GHG accounting	GOs and market-based approach should be generally applicable for GHG accounting	GHG accounting
GOs and market-based approach should only be applicable based on advanced criteria	GOs and market-based approach should only be applicable based on advanced criteria	GHG accounting; Additionality markets
Promotion of impactful PPAs (in combination with GOs)	Promotion of impactful PPAs (in combination with GOs)	PPA
(voluntary) additionality criteria or label	Enhance voluntary green label(s) and standards	Additionality markets
Introduce harmonised EU label	Develop and apply (official / public) additionality criteria or label	Additionality markets
Increase consumer awareness by campaigning	Increase consumer awareness by campaigning	Additionality markets
Implement GO dashboard / transparency platform for consumers	Implement GO dashboard / transparency platform for consumers	Transparency

Table 3-11: Identified development options in the field of action "Harmonise rules in order to increase market liquidity"

Harmonise rules in order to increase market liquidity		
Specific development option	**Related general development option**	**Related GO system element**
Harmonise temporal granularity	Enhance temporal correlation (application)	Temporal granularity
Harmonise time stamping	Harmonise time stamping	Time stamping
Harmonise GO systems: rules & governance	Harmonise GO systems (rules & governance)	Harmonisation of GO systems
Harmonise GO systems: technical harmonisation & registries	Harmonise and digitalise technical GO systems	Harmonisation of GO systems
Harmonise EU policies relating to GOs	Harmonise EU policies relating to GOs	Harmonisation of GO systems
Harmonise gas GO systems with PoS	For gas GOs: Integrate and harmonise GOs / PoS and GO registries / UDB	For gas GOs: Interaction of GO system with UDB / PoS
Harmonise and eliminate market access restrictions for different stakeholders	Harmonise market access for different stakeholders and eliminate access restrictions	Market access
Establish a formal role for the AIB in the context of the GO system	Establish a formal role for the AIB in the context of the GO system	Establish a formal role for the AIB in the context of the GO system

Table 3-12: Identified development options in the field of action "Tools and mechanisms for market transparency and market facilitation"

Tools and mechanisms for market transparency and market facilitation		
Specific development option	**Related general development option**	**Related GO system element**
Improve market transparency	Improve market transparency & monitoring	Transparency
Improve market monitoring	Improve market transparency & monitoring	Transparency
Promote central GO market places	Promote central GO market places	Market place

Table 3-13: Identified development options in the field of action "For gas GOs: clarify relation to PoS / UDB"

Gas GOs: clarify relation to PoS / UDB		
Specific development option	**Related general development option**	**Related GO system element**

Integrate and harmonise GOs / PoS and GO registries / UDB	Integrate and harmonise GOs / PoS and GO registries / UDB	For Gas GOs: Interaction of GO system with UDB / PoS

3.5.3. Guiding questions for assessing the potential effects of development options with a view to the different market and system dimensions

Market imbalances have been assessed in the context of this report based on the of six market and system dimensions (see chapter 2) and the GO system was assessed regarding its effectiveness. In the following analysis of identified potential development options, a high-level qualitative assessment of the individual development options is made. This should provide an indicative overview of the potential impact of the individual development option on the market, in relation to one or several of the market and system dimensions. The assessment is based on the following guiding questions:

- **Liquidity:** Does the development option influence the market length as core proxy for the level of liquidity (also taking into account that a high level of liquidity relates to an oversupply as described in chapter 2.2.1.)?
- **Completeness and harmonisation:** How does the development option contribute to the harmonisation of GO rules and systems across Europe?
- **Stability:** How does the development option influence the (monthly) volatility of GO prices?
- **Efficiency:** how does the development option affect administrative (and thereby also economic) efficiency of the GO system)?
- **Transparency:** How does the development option affect transparency on market-relevant information?
- **Responsiveness/Competitiveness:** How does the development option influence whether changes in supply and demand are reflected in price changes?
- **Effectiveness:** How does the development option influence the extent of incentives for investments into renewable energy sources, the guidance of the market on renewable build-out, and the overall system efficiency?

The assumed effects of the individual development options are indicated in the following fact sheets according to the following categories:

- Supportive
- Neutral
- Restrictive
- Unclear (either no conclusive assessment, or heterogeneous, depending on individual market segments, geographical areas, or also perspectives of actors)
- Depending on the specific design

It should be noted that this assessment does focus on indicators describing the GO system as such. At the same time, some of the described development options also have implications beyond the GO system in a

narrow sense. However, it is beyond the scope of this study to cover a comparative assessment against options and scenarios for other policy regimes.

3.5.4. Description of the identified general development options

Overview

In the following, all identified general development options are described in a standardised fact sheet format. This aims at providing a broad overview of potential general development options, which have been identified based on the findings of the screening phase, which included surveys, interviews and literature research, supplemented with own considerations.

Taking into account that GO markets for electricity GOs have already developed for several years, comprising a large number of market actors and a high volume of GOs, the vast majority of identified proposed measures to further develop the GO system (which have been synthesised to "development measures" in the course of the analysis) refer to electricity GOs. The outstanding exception refers to the clarification of the relation of gas GOs to PoS and the UDB. However, the identified development options, which are further described in the following sections, can also be considered for their relevance for further developments in the field of gas GOs and also of GOs for heating and cooling.

The listing of a given development option and the description of the potential reasoning for proposing these development options does not mean that the project team necessarily adopts these arguments and reflections as its own, or that the project team found the described development option to be effective, appropriate or feasible. However, only development options which directly address EU GO markets have been listed. Explanations on the background and potential reasonings for proposing the individually described development options are formulated by the project team based on best knowledge and understanding.

This assessment has resulted in the identification and description of the following 27 development options:

1. Enhance temporal granularity (technical)
2. Enhance temporal correlation (application)
3. Enhance geographical granularity (technical)
4. Enhance geographical correlation (application)
5. Maintain single GO market and abolish any geographical limitation
6. Harmonise time stamping
7. Harmonise GO systems (rules & governance)
8. Harmonise and digitalise technical GO systems
9. Harmonise EU policies relating to GOs
10. Harmonise market access for different stakeholders and eliminate access restrictions

11. Recognition of GOs also from 3rd countries
12. Establish a formal role for the AIB in the context of the GO system
13. GOs and market-based approach should be generally applicable for GHG accounting
14. GOs and market-based approach should only be applicable based on advanced criteria
15. Issue GO for all RES (including supported)
16. Promotion of impactful PPAs (in combination with GOs)
17. Enhance voluntary green label(s) and standards
18. Develop and apply (official / public) additionality criteria or label
19. Issue tradeable GOs only for new plants
20. Increase consumer awareness by campaigning
21. Introduce GO plus
22. Abolish or restrict book & claim approach
23. Introduce full disclosure
24. Implement GO dashboard / transparency platform for consumers
25. Improve market transparency & monitoring
26. Promote central GO market places
27. For gas GOs: Integrate and harmonise GOs / PoS and GO registries / UDB

3.5.5. Summary and conclusion

The description of all identified general development options in standardised fact sheet format provides a broad overview of potential general development options on imbalances within GO markets, particularly referring to the market for electricity GOs. The underlying analysis also allows for structured discussions on which development options are finally found relevant and feasible to be pursued in the different fields of action, or in order to address imbalances relating to specific market and system dimensions. Figure 3-6 provides a simplified overview of the assumed effects of general development options in relation to individual market and system dimensions (not including more nuanced differentiations, if those are provided in the underlying assessment).

	Liquidity	Harmonisation	Stability	Efficiency	Transparency	Responsiveness	Effectiveness
Enhance temporal granularity (technical)							
Enhance temporal correlation (application)							
Enhance geographical granularity (technical)							
Enhance geographical correlation (application)							
Maintain single GO market and abolish any geographical limitation							
Harmonise time stamping							
Harmonise GO systems (rules & governance)							
Harmonise and digitalise technical GO systems							
Harmonise EU policies relating to GOs							
Harmonise market access for different stakeholders and eliminate access restrictions							
Facilitate recognition of GOs also from 3rd countries							
Generally recognise the role of AIB							
GOs and market-based approach should be generally applicable for GHG accounting							
GOs and market-based approach should only be applicable based on advanced criteria							
Issue GO for all RES (including supported)							
Promotion of impactful PPAs (in combination with GOs)							
Enhance voluntary green label(s) and standards							
Develop and apply (official / public) additionality criteria or label							
Issue tradeable GOs only for new plants							
Increase consumer awareness by campaigning							
Introduce GO plus							
Abolish or restrict book & claim approach							
Introduce full disclosure							
Implement GO dashboard / transparency platform for consumers							
Improve market transparency & monitoring							
Promote central GO market places							
For gas GOs: Integrate and harmonise GOs / PoS and GO registries / UDB							

Legend:

Supportive
Neutral
Restrictive
Unclear (either no conclusive assessment, or heterogeneous, depending on market segments, areas or perspectives of actors)
Depending on the specific design

Figure 3-6: Simplified indication of the assumed effects of general development options in relation to individual market and system dimensions (not including more nuanced differentiations, if those are provided in the underlying assessment).

This overview shows that some of the described development options have adverse effects on different market and system dimensions , e.g. when comparing liquidity with responsiveness and effectiveness. Obviously, some of the described development options themselves are contradictory, aiming at different visions of GO systems. This applies, for example, to the development options "GOs and market-based approach should be generally applicable for GHG accounting" and "GOs and market-based approach should only be applicable based on advanced criteria". Another example is the development option "Maintain single GO market and abolish any geographical limitation" in comparison to "Abolish or restrict book & claim approach", or to all development options aiming towards more (geographical) granularity.

This suggests that for many of the development options described, it is first necessary to clarify the intended role of GOs themselves and the role of market-driven demand for GOs in the context of European developments towards a renewable energy system, before a decision on implementation can and should be made.

4. ANNEX

4.1. ANNEX to Chapter 2: Repeatable methodology to monitor the Functioning of the European GO system and Market

With this study, a clear and repeatable methodology for monitoring the GO system and the market balance is developed, to allow for a regular monitoring process (foreseen at least once up to 2030) following the initial assessment with this study. As such, this will enable DG ENER and all other GO system stakeholders in the future to track the impact of actions taken. The methodology hence differentiates the initial assessment (which is to be conducted in this study), and the review assessments of the future.

The **initial assessment** follows 5 + 1 working steps:

- **Step 1**: **Establishment of a longlist** of preferably quantitative indicators for the effectiveness of the GO system and per market dimension as defined above. This is guided by the availability of comparable literature and datasets.
- **Step 2**: **Collection of datasets** and further literature.
- **Step 3**: **Shortlisting of indicators** based on a review of the suitability and significance of the indicators in the longlist with regard to providing measurement for the functionality of the GO system and the balance of the GO market. This will be conducted by brief and high-level analyses of historic data and relevant differences of the implemented GO systems and markets in Member States (MSs), as well as comparable monitoring studies and, will be validated with the help of expert interviews.
- **Step 4: Dedicated surveys and interviews** to fill data gaps
- **Step 5: Detailed analysis of the shortlisted indicators** to understand correlations and to reach conclusions on the effectiveness of the GO system, on the balance of the (current) GO market and on the influencing factors affecting the supply and demand in the case of imbalance.

The **initial assessment** is supplemented by a more comprehensive analysis of the GO market. Here, additional loops of validation are possible. This further work is conducted in the following working step:

- **Step 6**: **Additional evaluations**: Analysis of and conclusions on future developments for the GO market, and mapping and structuring of developments and measures discussed among the stakeholders to influence the market in the future..

The **review assessment**[204] , as part of another GO system and market monitoring process in the future, will use the outcomes of the initial assessment (this study) as the basis. The review assessment will then follow four steps:

- **Step 1a**: **Review of the previous set of indicators** (those identified as part of this work) and assessment whether it may be appropriate to either adjust them, select those of particular interest, or choose new indicators on the basis of feedback received over the past years or as response to any concrete market/regulatory adjustments. However, the ambition of the present work is to provide a set of indicators that is suited for regular monitoring.

[204] A frequency of less than five years and more than 2 years is considered here.

- **Step 2a**: **Procurement of data** as needed. Similarly to the initial assessment, sources will be selected with regard to the highest available data quality. Note, the analysis of historical datasets is then not required anymore.
- **Step 3a**: **Detailed analysis** of the functioning of the GO system and market balance including the discussion of the implications of the observed trends

Step 4a may be added depending on the level of ambition:

- **Step 4a**: **Specific analysis on the impact of actions taken** to address imbalances in the GO market and possibly conclude on any measures taken in the market to address remaining and new imbalances.

4.1.1. Step 1 – Longlist of indicators for monitoring the GO system and market balance

A longlist of indicators has been created to enable a monitoring of the effectiveness of the GO system in terms of achieving its associated objectives, and for assessing the market balance and the relevant factors affecting supply and demand developments of GOs. This was based on literature research including

- GO market monitoring reports[205] and studies outlining points of criticism of the GO system[206]
- A review of available datasets on GO market data, such as provided by the Association of Issuing Bodies (AIB)[207] and offered by commercial platforms Data collection.

The indicators in the longlist were chosen such that quantitative measurement and analysis is enabled for as many aspects as possible. The measurement of these indicators is mainly associated with the flow of GO certificates, price developments and associated revenue streams.

The effectiveness was evaluated along 4 goals:

Goal A: Effectiveness for (renewable) energy tracking

Goal B: Effectiveness as trusted instrument for reporting against criteria

Goal C: Effectiveness for incentivizing renewable build-out

Goal D: Guide the market (one renewable build-out) and support overall system efficiency

For the evaluation of the different market dimensions, as defined earlier and including liquidity, stability, competitiveness, transparency, efficiency and harmonisation, at least 2 indicators have been identified to reach quantifiable conclusions on the status of the existing GO market.

4.1.2. Step 2 – Data collection from desktop research

After having generated a longlist of indicators, Step 2 in the initial assessment is designed to gather all available data of high quality from desktop research for the subsequent high-level analysis (Step 3) and for the detailed analysis (Step 5) for the monitoring of the GO system functioning and the GO market balance. To establish the fundamental correlations and impacts per final indicator the evaluation of historical data

[205] Including Hulsdorf et al., 2019: Performance of markets for European renewable energy certificates; L. David & C. Feng, 2019: Development of the guarantees of origin market 2009-2018; Becour 2024: Understanding Guarantees of Origin;
[206] Wimmers & Madlener, 2023: The European Market for Guarantees of Origin for Green Electricity: A Scenario-Based Evaluation of Trading under Uncertainty
[207] https://www.aib-net.org/facts/market-information

and differences in the implementation of the GO system and the performance of the GO market across different MSs will be required, as well as the inclusion of studies and (scientific) literature. While the identified sources from desktop research will be sufficient for the high-level analysis to attain the shortlist of indicators (Step 3), surveys and interviews to fill data gaps for the detailed analysis in Step 5 will be executed after the shortlisting of the indicators (Step 4). This will ensure that our resources are used purposefully and efficiently.

As indicated by the indicator categories, to provide a comprehensive assessment of the GO system, the effectiveness of the GO system and all 6 market dimensions need to be evaluated, if possible, in a quantitative manner. The longlist of indicators revealed that many depend on the same set of input data (i.e. AIB datasets, prices, tariffs, etc.) which thus reduces the risk of overlooking available datasets useful for monitoring the GO market during this initial assessment. The access to historical GO price data, as required for a high-quality evaluation e.g. of the market dimension of responsiveness/competitiveness, as well as some indicators for the effectiveness of the GO system, is limited and only available from commercial sources (see also discussion below).

For the data collection process, we follow a hierarchy to identify the **best available data sources,** while taking into account the level of repeatability for the future monitoring process:

1. We first scan **publicly available databases**,
2. then check for literature, particularly for **reports with recurring publication** (ideally at least in the frequency of the foreseen assessments (bi-annual).
3. If input data cannot be found, we consider **commercial sources** and pick the source with best value for price.

As mentioned above, primary data collection methods, such as surveys and interviews, will become relevant for the detailed analyses of the shortlisted indicators. Below we detail the data collection methods with regard to the longlist of indicators. **All relevant sources are provided at the point of use in the analysis**.

1) Databases

At least 24 out of 34 indicators included in the longlist are to be found on databases. For monitoring purposes, regularly updated databases from official sources provide the best data. This includes:

- EUROSTAT[208] - e.g., for indicator #1.8 "Issuance of certificates vs. Increase of RES installations / investments into RES production"
- AIB[209] - for many indicators, relying on data regarding issued, traded and cancelled GO volumes, i.e. mainly for the market dimension of liquidity, and on information on and from AIB participants. Data were analysed as published by end of 2024.
- PPA Deal Tracker[210] - e.g., for indicator #1.11 "PPA demand"

Official and institutional sources will be generally preferred over private/associations' databases.

2) Literature

[208] Eurostat
[209] AIB market information
[210] PPA Deal Tracker

Literature and reports can provide data which is not available in databases, and may offer similar benefit if there are periodic publications. This includes:

- Retail market report by ACER/CEER[211] and e.g. previous report on establishing a Union-wide green energy label[212] - e.g., for indicator #1.1 "Implementation of billing information requirement"
- Monitoringbericht BNetzA[213] for Germany – e.g., for indicator #1.5 "Private consumer's Willingness-to-switch tariff / switching rate"
- RE100 Annual Disclosure reports[214] – e.g., for indicator #1.11 "PPA demand"

Additionally, literature will be considered for complementary information, for example for those indicators that are not unambiguously interpretable based on their evolution over time.

3) Commercial sources (for price data)

About a third of the indicators identified (such as, #4.1 "Volatility of GO price") relies on data related to GO prices. This information is only available from commercial sources and at a cost. It was chosen to use data as provided by S&P Platts.

Table 4-1: Overview of commercial data providers (focus GO price data)

Company Name	Data Offer	Data Sources	Historical Data?
Veyt	Market data: price developments, GO trades, different vintage years, technologies, and geographical locations (UK, AIB countries) Country profiles (GO, electricity profile) Qualitative analyses Forecasts (long-term and end-of-year)	Bid-ask-prices, closing prices	Available, to be determined how far back, at least 2016
Argus Media	Subscription to Argus Global Energy Certificates (GEC) Report Weekly GEC PDF reports News, analysis & historical data Argus Direct Platform European GOO price data (Nordic hydro, Europe wind, Europe solar, Europe any renewable) UK Regos (Non-biomass, biomass)	According to Methodology: price assessments are informed by information received from a wide cross section of market participants, including producers, consumers and intermediaries. -> "all credible market sources", electronic trading platforms	Available, unclear how far back

[211] ACER & CEER, 2024: Energy retail market monitoring report
[212] European Commission 2024, Technical assistance for assessing options to establish an EU-wide green label with a view to promote the use of renewable energy coming from new installations
[213] Bundesnetzagentur, e.g. Monitoringbericht 2023
[214] RE100, 2024: 2023 Annual Disclosure Report

	Spanish domestic (any renewable) European biomethane GOs (Denmark crop/waste, Netherlands crop/waste, UK crop/waste)		
TP ICAP	Daily price overview of AIB GOs bid/ask prices for: Hydro Hydro/Wind/Solar Wind Solar Any RES Nuclear	unclear	Available from 2015; potentially even further (from 2004)
Green Power Hub	EECS & ELCERT trends since Sep. 2022; EECS price trends weekly (any renewable, hydro, wind, solar); EAC-I-RECS latest developments	GPH's own trading platform; market share unclear	Data including 2021 available; some earlier data points
Montel	Access to Montel Online or GO part of the platform only; Go data includes: Montel Match (data from own trading platform) EEX data Market volume / share of the market "hard to pin down"	Own trading platform Montel Match; EEX futures	Data starting in March 2023
S&P Global Commodities	Free: access to GO price developments for EU Wind and Nordic Hydro since July 2022 in table format, not exportable Paywall: more data and exportable	market data collected from active market participants (including traders, brokers, utilities etc.) contacted on a daily basis.	Nordic Hydro and EU Wind assessments launched in November 2019, EU Solar and EU Biomass launched in February 2021

4.1.3. Step 3 – Shortlisting based on review of suitability and significance

Step 3 provided a shortlist of indicators which was agreed on with the COM during a dedicated meeting before continuing with the detailed monitoring analysis. The indicators for the shortlist will be selected based on their suitability and significance for the monitoring process which will be concluded from a brief and high-level analysis of the data gathered in Step 2.

Consideration is given to potential "retrenchment/prioritising" of indicators, thus cutting costs and efforts for data procurement in the future using the guiding question of "Which indicators could lead to similar conclusions?": e.g. observing the price of Nordic Hydro vs. EU wind as traded via AIB may be sufficient to draw conclusions on the relative price developments for old and new installations as well as for the overall conclusion that the build-out of renewables is supported. Particular attention is also given to identifying those indicators with data inputs "easily" obtained thus potentially allowing GO market monitoring even in between official assessments in the form of studies like this one.

After the analyses, Step 3 will therefore allow for a selection of indicators in a final shortlist (2-3 indicators per analysed dimension) with the highest suitability and significance, as well as lowest efforts and will thus ensure repeatability in the review assessment(s) following.

The **review assessment** in future monitoring in contrast will profit from the previously established correlations and can - depending on the level of ambition - be conducted in a basic manner (i.e. only update of existing indicators) or advanced manner (incl. critical assessment of existing set of indicators, other questions of interest etc.).

4.1.4. Step 4 – Dedicated surveys and interviews for complementing data and validation of conclusions drawn (optional)

4) Surveys

Under the proposed methodology, surveys may serve two purposes: on the one hand, some indicators (e.g. #4.2 "Relevance of GOs for business models") require the provision of data that are not available from other sources and may need to be generated. Additionally, surveys may provide contextual information to draw a conclusion on specific indicators. Due to the difficulty in engaging with potential participants, we plan to cover both purposes in one survey. The survey will be designed as follows:

- **One survey will be structured to cover several targeted stakeholder groups**:
  A cover page will allow for a self-assessment of the survey participants with regard to their respective backgrounds. Based on their input, they will then be led into different "branches of the survey tree" allowing to include target group-related questions).
- **The survey will be user friendly**:
  Via web interface (EUSurvey) a user-friendly experience will ensure fast and efficient data collection. Where possible, multiple choice will be filled via simple clicks. Text boxes will allow to comment with deeper insights.
- **The survey will be repeatable**:
  Some questions will evaluate the current status, and will allow to draw limited conclusions, but will be valuable when answered repeatedly over time.

5) Interviews

Interviews are especially interesting for evaluating the suitability and significance of the selected indicators (see Step 3). The repeatability of interview data is too low and should thus be only a last-resort option in for actual data collection. Thus, the methodology foresees the use of interviews as an important instrument to validate the choice of indicators and gain insights regarding GO system effectiveness and potential imbalances in the market as seen by the interviewed stakeholder, respectively. We have structured the multitude of stakeholders involved in the GO market according to main stakeholder groups allowing to conduct targeted interviews with at least one party for the most important groups. Eventually 12 semi-structured interviews were conducted, covering: Producers, Suppliers, Issuing Bodies, Traders, Consumer representatives (both industrial and private) and Labels.

Table 4-2: Stakeholders in the field of GOs

Stakeholder group		Role	Examples
Energy Producers / Suppliers	Renewable Energy Producers	Generate renewable electricity and request GOs to certify the renewable origin.	Solar Power Europe, WindEurope
	Energy Suppliers	Engage in GO trading to offer renewable energy options or comply with renewable energy targets.	E.ON, RWE
Issuing Bodies	National Authorities	Issue GOs according to national and EU regulations; oversee issuance, transfer, and cancellation.	UBA (DE), VertiCer (NL), E-Control (AT), CertifHy (EU; H2)
	Association of Issuing Bodies (AIB)	Provides a standardized framework and facilitates cross-border GO trading through the European Energy Certificate System (EECS).	AIB
Traders and Brokers	Traders	Buy and sell GOs on behalf of producers, consumers, and intermediaries; facilitate liquidity, support price discovery, enable cross-border transactions.	Statkraft Markets ACT Commodities
	Brokers	Act as intermediaries between buyers and sellers, providing market access and facilitating transactions.	ICAP Energy, Marex Spectron, Becour
Consumers	Industrial / Commercial	Purchase GOs to certify the use of renewable energy for corporate sustainability goals, regulatory compliance, or market differentiation.	IFIEC

Stakeholder group		Role	Examples
	Residential	Purchase electricity from suppliers using GOs to certify renewable energy, often influenced by environmental awareness.	BEUC, National consumer organisations: National consumer organisations - Verbraucherzentrale (DE), Forbrugerrådet Tænk (DK), National Association for Consumer Protection in Hungary (HU) or France (FR)
Regulatory Bodies and Standard Setters	European Commission	Develops and enforces EU-level legislation and policies related to GOs and renewable energy; monitors compliance with directives, harmonization across member states.	European Commission DG ENER
	ENTSO-E	Ensures integration and transparency in the electricity market, including GO activities[215]; facilitates coordination between national grid operators and data transparency.	ENTSO-E
Market Platforms and Registries	Marketplaces	Provide platforms for trading GOs, ensuring efficient and transparent transactions.	Powernext (FR)
	Electronic Registries	Maintain and manage GO accounts, enabling secure tracking of issuance, transfer, and cancellation.	VertiCer (NL) NECS (NO) iCAP
Certification / Verification Bodies	Auditors and Inspectors	Verify compliance with standards and ensure the credibility of GOs; conduct audits and inspections of renewable energy producers and GO transactions.	TÜV SÜD
NGOs and Consumer Organizations	Environmental NGOs	Advocate for transparent and effective GO systems; monitor environmental impacts.	WWF, Greenpeace
	Consumer Advocacy Groups	Represent consumer interests; promote awareness of renewable energy and GOs.	BEUC, Consumer Council

Researchers and Academia	Research Institutions	Conduct studies on GO market dynamics, regulatory impacts, and technological advancements.	DIW et al.
	Think Tanks	Provide policy recommendations and market analysis to support the development of GOs.	Energy Tag, Agora Energiewende
Technology Providers	IT / Software Companies	Develop and maintain platforms for GO management, trading, and tracking.	Grexel, Energy Web Foundation

4.1.5. Step 5 – Detailed analysis of the effectiveness of the GO system and the balance of the market

In Step 5, detailed analyses of the indicators of the shortlist, will deliver the following outcomes:

1. Conclusions on the balance of the GO market and identification of imbalances
2. Identification of the underlying key factors affecting the supply and demand of GOs
3. Conclusions on the functioning of the GO system in terms of effectiveness

Starting from the final agreed shortlist of indicators, the detailed analysis will be conducted using the sources identified in Step 2 and the results from surveys and interviews in Step 4. Further details as to expected outcomes are also described in Analysis of the existing market of Guarantees of Origin in Europe.

Calculation of indicators

The indicators will be evaluated according to their described "methodology for measurement", which is mainly expressed in terms of issued, traded and cancelled certificates, GO prices and associated revenues. Since most indicators must be set in relation to their historical developments to be able to draw conclusions, we will try to provide the annual "output" values on the basis of historical datasets (where applicable and subject to data availability and continuity), e.g. for indicator #1.8 "Issuance of GO certificates vs. increase of RES installations".

Different national frameworks for the implementation of the GO system as well as different country-specific prerequisites will enable us to compare the performance of the GO system and the level of market balance for different circumstances from which influencing factors can be deduced. For this, up to three countries will be assessed. The choice of countries will be meaningful for the following two cases:

- Countries with similar prerequisites e.g. with regard to market size, shares of RES etc., but (specific) differences in the implementation of the GO system in their national frameworks
- Countries with similar national frameworks for the implementation of GOs, but differing in their prerequisites

[215] See also: ENTSO-E Position Paper: Views on a Future-Proof Market Design for Guarantees of Origin, July 2022;

Prominent candidates for comparison include Germany as the largest GO importer[216], Spain with the highest potential for the growth of RES[217] and Poland with a low share of RES[218] as of today.

Rating of the level of market balance

Within each market dimension (i.e., liquidity, responsiveness/competitiveness, stability, transparency, efficiency, completeness/harmonisation)) and the respective group of indicators, conclusions on the balance of the market are drawn regarding the respective target characteristic of the market dimension. Identified imbalances are rated with regard to their severity:

- **High:** target characteristic of market dimension is hardly fulfilled, major barriers and roadblocks identified
- **Medium:** target characteristic of market dimension is partially fulfilled
- **Low:** target characteristic of market dimension is fulfilled to the largest part, potential for improvements

This analysis will furthermore provide an overview of financial streams within the GO system. We will cover four to five stakeholder groups.

Correlation with influencing factors

Based on the identified imbalances, the influencing factors affecting the demand and supply of GOs are elaborated. The (quantitative) analysis of correlations is already partly covered in Subtask 2.0 as possible influencing factors were already incorporated in the definition of the indicators, such as associated (national) regulatory frameworks, roll-out of renewable energy sources, type of RES technology etc. In cases, when imbalances are identified, a closer look is taken at the influencing factors. With the help of the output of the indicators, which are based on the historical developments and comparison of the implementations of GO systems on national level, barriers or supporting effects on the GO market dimensions and the respective effect on the supply and demand of GOs is analysed. These are then rated qualitatively to identify the key (influencing) factors: In case of obstructing factors, their severity, and in case of supporting factors, their potential for improving the market is rated from high to low.

Rating of level of effectiveness of the GO system

Especially for the dimension of effectiveness, conclusions on the GO system require qualitative and holistic interpretation besides analysis of the respective indicators.

4.1.6. Step 6 – Additional evaluations on future market developments and mapping of measures

This step is not part of the repeatable methodology and serves to complement the initial assessment. Details for the respective evaluations are provided in the respective chapter Future (Electricity) GO market development. Any insights gained may, however, be used to improve the indicators in future monitoring.

[216] AIB activity statistics
[217] S. Coronas et al., 2022: 23 Years of Development of the Solar Power Generation Sector in Spain
[218] Eurostat: Share of energy from renewable sources

4.2. ANNEX to Chapter 3.5 on potential measures and development options for GO markets

4.2.1. Enhance temporal granularity (technical)

Table 4-3: Characterisation of the development option "Enhance temporal granularity (technical)"

Enhance temporal granularity (technical)	
General description	This development option describes the adaptation of technical registries in order to allow for granular issuing and handling of GOs. For this, such activities can build on the implementation of CEN/EN16325, relevant work by AIB and several existing private activities on granular certificates. This development option relates to the development options "Enhance temporal correlation (application)" and also "Harmonise and digitalise technical GO systems." Both technical and regulatory system development should follow a joint road map in order to facilitate the application of granular GOs. *Potential effects of the development option:* The development of a technical framework for the handling of more granular GOs is a prerequisite for the voluntary or also mandatory application of temporal correlation and can therefore contribute to the effects described for the development option "enhance temporal correlation (application).
Addressed field of action	Improvement of technical framework
Addressed GO system element	Temporal granularity
Potential effects on key dimensions	Liquidity: neutral Harmonisation: depending on the specific design Stability: neutral Efficiency: restrictive Transparency: neutral (supportive for product attributes) Responsiveness: supportive Effectiveness: supportive
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measure
Main responsible actors	COM MS governments Market Stakeholders

Other organisations: Major role for AIB and for Competent Authorities, but also for the responsible committees at CEN/CENELEC when it comes to further adaptations of EN 16325. Also, private initiatives for developing technical frameworks for granular certificates can play an active innovative role. It also would be possible to mandate this within a next revision of the Renewables Directive, which would require action by the European Commission.

4.2.2. Enhance temporal correlation (application)

Table 4-4: Characterisation of the development option "Enhance temporal correlation (application)"

Enhance temporal correlation (application)	
General description	This development option covers both voluntary but also mandatory application of temporal correlation between the production of energy and the respective consumption. The extent to which such a measure is legally mandatory could cover a broad range: • Mandatory matching requirement based on the Renewables Directive and the Internal Market Directive (for electricity) and the Gas Directive (for renewable (gases); it can also address more specific applications, as is e.g. already done for the definition of renewable fuels of non-biological origin (RFNBOs). • Application of temporal correlation as stipulated by Member States' governments based on guidelines and best-practice recommendations, e.g. by the European Commission. • Consideration of criteria on temporal correlation in related support programmes by the European Commission and by Member States, e.g. relating to Indirect Cost Compensation. • Enhancement of temporal correlation by respective criteria of a potential EU wide public label • Enhancement of temporal correlation by respective criteria of voluntary programmes, such as labels, low-carbon initiatives (like RE100) and consideration of such requirements also in standards and guidelines for carbon accounting, particularly the GHG Protocol. With a view to the temporal granularity to be promoted, the respective time limitations can develop from an annual consistency towards seasonal matching or monthly periods, and on the long-term perspective towards daily or even more granular matching. A stepwise introduction, where a potential mandatory granularity is only introduced with a time-lag after the development of technical system solutions and a voluntary application of more granular ambitions, could prepare the markets and avoid market distortions. *Potential effects of the development option:* An increased level of granularity would increasingly restrict the volume of available RES attributes. It has been argued that this might increase credibility and public

	acceptance of the GO system and incentivise investments in new plants which should allow for (RES) production which is increasingly correlated with the consumption of energy. Furthermore, it could promote flexibility by e.g. storage and demand side management (DSM). However, it should be noted that for the flexibilization of demand the respective consumers needs upfront information. Granular GOs, which are issued ex-post, can hardly provide that information upfront. Therefore, with increased level of granularity GOs could at best provide the incentive that time-correlated (or real-time) consumption can be documented afterwards if the signal for flexibilization is provided either by day-ahead markets for granular GOs or by other means upfront, and can therefore be taken into account.
Addressed field of action	Measures outside GO system to influence voluntary demand Harmonise GO rules in order to increase market liquidity
Addressed GO system element	Temporal granularity
Potential effects on key dimensions	Liquidity: restrictive (acknowledging that this may differ for between time periods) Harmonisation: Depending on the specific design Stability: restrictive Efficiency: restrictive Transparency: supportive Responsiveness: supportive Effectiveness: supportive
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measure
Main responsible actors	COM MS governments Other organisations: AIB, CEN/CENELEC, private initiatives for granular certificates, organisations providing voluntary standards like GHG protocol or RE100

4.2.3. Enhance geographical granularity (technical)

Table 4-5: Characterisation of the development option "Enhance geographical granularity (technical)"

Enhance geographical granularity (technical)	
General description	Basic information is already provided by information on the domain of the issuing body, and information on the location of the production plant as required by Art. 19 of the Renewables Directive. In order to apply stricter criteria on geographical correlation, it would be relevant to provide more detailed and structured information which allows for a clearer correlation on sub-domain level, e.g. relating to specific grid areas. *Potential effects of the development option:* The development of a technical framework for the handling of more granular GOs is a prerequisite for the voluntary or also mandatory application of geographical correlation and can therefore contribute to the effects described for the development option "enhance geographical correlation (application).
Addressed field of action	Improvement of technical framework
Addressed GO system element	Geographical granularity
Potential effects on key dimensions	Liquidity: neutral Harmonisation: depending on the specific design Stability: neutral Efficiency: restrictive Transparency: neutral (supportive for product attributes) Responsiveness: supportive Effectiveness: supportive
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measure
Main responsible actors	COM EU MS governments Other organisations: Major role for AIB and for Competent Authorities, but also for the responsible committees at CEN/CENELEC when it comes to further adaptations of EN 16325. Also, private initiatives for developing technical frameworks for granular certificates can play an active innovative role. It also would be possible to mandate this within a next revision of the Renewables Directive, which would require action by the European Commission.

4.2.4. Enhance geographical correlation (application)

Table 4-6: Characterisation of the development option "Enhance geographical correlation (application)"

Enhance geographical correlation (application)	
General description	Geographical correlation can be based on different definitions: • Referring to connectivity: this would affect particularly Iceland with a view to electricity GOs. With a view to H/C GOs, such a correlation limits the tradability and applicability of GOs on individual district H/C grids (as is already implemented in most EU Member States). • Referring to individual countries or bidding zones • Stricter requirements on deliverability: this would require real-time assessment of deliverability from the point of production to the point of consumption, including a consideration of possible grid congestions, and limited transmission capacities. The instrument for the promotion of such correlation can also vary in a broad range: • Legal mandatory requirements, as imposed by the European Commission and Member States • Legal requirements relating to support systems, as has been done e.g. in the context of RFNBOs. • Mandatory indication of the country of origin of disclosed GOs • Application of respective criteria by voluntary labels and initiatives *Potential effects of this development option:* Requirements on enhanced geographical correlation reduce the flexibility for trading GOs. As primary effect, this does not affect the total volume of supply and demand, but aims at a higher fragmentation. In markets with high (RES) demand compared to the available (RES) volumes this may lead to shorter GO markets, thus ideally leading to market-driven incentives for further investments in new RES capacities. However, depending on the definition, a legal introduction of such correlation has to be balanced against fundamental principles of free trade of goods in the European Union. This development option is – obviously – conflicting with the development option "Maintain single GO market and abolish any geographical limitation"
Addressed field of action	Restriction & focussing of GO supply Focussing of GO demand (mandatory measures) Measures outside GO system to influence voluntary demand
Addressed GO system element	Geographical granularity
Potential effects on key dimensions	Liquidity: restrictive (acknowledging that this may differ for between geographical areas) Harmonisation: depending on the specific design

	Stability: neutral Efficiency: restrictive Transparency: supportive Responsiveness: supportive Effectiveness: supportive
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measure
Main responsible actors	COM MS governments Other organisations: AIB, CEN/CENELEC, private initiatives for granular certificates, organisations providing voluntary standards like GHG protocol or RE100

4.2.5. Maintain single GO market and abolish any geographical limitation

Table 4-7: Characterisation of the development option "Maintain single GO market and abolish any geographical limitation"

Maintain single GO market and abolish any geographical limitation	
General description	This development option is to a large extent a continuation of the current status quo in the existing GO market (besides H/C). It can be understood as a conscious decision against promoting any geographical correlation requirements, and a renunciation of corresponding activities. *Potential effects of this development option:* It focusses on maintaining a common and liquid market, allowing market participants a flexible trade and allocation of GOs. This development option is therefore – obviously – conflicting with the development option "Enhance geographical correlation (application)".
Addressed field of action	Increase & flexibilisation of GO supply
Addressed GO system element	Geographical granularity
Potential effects on key dimensions	Liquidity: supportive Harmonisation: supportive Stability: supportive Efficiency: supportive Transparency: neutral Responsiveness: restrictive Effectiveness: restrictive
Possible levels of legislative implementation	(EU legislation) (MS legislation) (Non-legal measure)
Main responsible actors	(COM) (MS governments) (Market Stakeholders) (Other organisations)

4.2.6. Harmonise time stamping

Table 4-8: Characterisation of the development option "Harmonise time stamping"

Harmonise time stamping	
General description	This development option is a technical measure, which aims at harmonising the time stamping on issued GOs. While this can be understood (e.g. if as a monthly time-stamping) as a clear alternative to more granular approaches, it could also be implemented by agreeing on a harmonised real-time time stamping (based on start and end minute of the represented unit of energy). This development option has a strong overlap with the described development options "Enhance temporal granularity" and "Harmonise and digitalise technical GO systems".[219] *Potential effects of this development option:* Harmonised time-stamping can particularly enhance any implementation of the development option "Enhance temporal granularity (application), and support the effects described there.
Addressed field of action	Improvement of technical framework Harmonise GO rules in order to increase market liquidity
Addressed GO system element	Time stamping
Potential effects on key dimensions	Liquidity: neutral Harmonisation: supportive Stability: neutral Efficiency: supportive Transparency: neutral Responsiveness: neutral Effectiveness: neutral
Possible levels of legislative implementation	Non-legal measure While it is possible to regulate such a measure in national or EU legislation, it seems appropriate that this development option is addressed on the level of organisations which are responsible for detailed technical requirements. This comprises particularly AIB and CEN/CENELEC with a view to CEN/EN 16325.
Main responsible actors	Other organisations: AIB, CEN/CENELEV

[219] However, this development option is listed here as distinct development option as it has been explicitly proposed from various parties in the course of the screening research for this task.

4.2.7. Harmonise GO systems (rules & governance)

Table 4-9: Characterisation of the development option "Harmonise GO systems (rules & governance)"

Harmonise GO systems (rules & governance)	
General description	This development option describes the general approach to harmonise rules and governance principles relating to GOs. Depending on the specific aspects which are to be harmonised, it might be appropriate that this is implemented on EU level by respective legislation, but also has in any case to include respective action by AIB and CEN/CENELEC. Depending on the specific aspects which may be harmonised this development option can strongly overlap other development options. *Potential effects of this development option:* In general this development option has the potential to reduce unintended market barriers and to reduce transaction cost for market participants. Specific aspects of harmonisation should be balanced with any argument by individual GO domains on applying diverging rules.
Addressed field of action	Increase & flexibilisation of GO supply Harmonise GO rules in order to increase market liquidity
Addressed GO system element	Harmonisation of GO systems
Potential effects on key dimensions	Liquidity: neutral (to some extent depending on the specific design) Harmonisation: supportive Stability: neutral Efficiency: supportive Transparency: neutral Responsiveness: neutral Effectiveness: neutral (to some extent depending on the specific design)
Possible levels of legislative implementation	EU legislation Non-legal measure
Main responsible actors	(COM) Other organisations: AIB, CEN/CENELEC

4.2.8. Harmonise and digitalise technical GO systems

Table 4-10: Characterisation of the development option "Harmonise and digitalise technical GO systems"

Harmonise and digitalise technical GO systems	
General description	This development option comprises both the harmonisation and the digitalisation of GO registries. Compatibility of GOs and GO registries is a prerequisite for international trade and mutual recognition of GOs, particularly taking into account that not all MSs are Member of the AIB and connected to the EECS Hub. With a view to increasing volumes and trade, and presumably increased complexity e.g. due to the trend to more granular systems, a higher level of digitalisation is needed in order to allow for efficient and robust handling of GOs. The implementation of CEN/EN 16325 will contribute to this development, but this will also have to be developed further. While the technical harmonisation can be supported by respective EU legislation, a major role applies for AIB and CEN/CENELEC: *Potential effects of this development option:* Harmonisation limits the administrative burden for market participants, while digitalisation allows for efficient processes and the application of further development options, particularly with a view to granularity.
Addressed field of action	Improvement of technical framework Increase & flexibilisation of GO supply Harmonise GO rules in order to increase market liquidity
Addressed GO system element	Harmonisation of GO systems
Potential effects on key dimensions	Liquidity: neutral Harmonisation: supportive Stability: neutral Efficiency: supportive Transparency: neutral (to some extent depending on the specific design) Responsiveness: neutral Effectiveness: neutral
Possible levels of legislative implementation	(EU legislation) Non-legal measure
Main responsible actors	(COM) Other organisations: AIB, CEN/CENELEC

4.2.9. Harmonise EU policies relating to GOs

Table 4-11: Characterisation of the development option "Harmonise EU policies relating to GOs"

Harmonise EU policies relating to GOs	
General description	This development option describes a harmonised EU policy with a clarified and strengthened definition of the role of GOs in the respective context. Two examples which have been identified in the screening of potential development options include the Battery Delegated Act and CBAM. In any case, it is recommended that this development option should be understood in a way that the role of GOs should be clarified in any case, while the level of relevance of GOs and specific requirements on the applicability still are subject to balanced arguments for the pros and cons of specific requirements. This development option has to be addressed particularly by the European Commission. *Potential effects of this development option:* The effects of this development options are obviously strongly depending on the further details of actual implementation.
Addressed field of action	Harmonise GO rules in order to increase market liquidity
Addressed GO system element	Harmonisation of GO systems
Potential effects on key dimensions	Liquidity: depending on the specific design Harmonisation: supportive Stability: unclear Efficiency: depending on the specific design Transparency: depending on the specific design Responsiveness: depending on the specific design Effectiveness: depending on the specific design
Possible levels of legislative implementation	EU legislation
Main responsible actors	COM

4.2.10. Harmonise market access for different stakeholders and eliminate access restrictions

Table 4-12: Characterisation of the development option "Harmonise market access for different stakeholders and eliminate access restrictions"

Harmonise market access for different stakeholders and eliminate access restrictions	
General description	This development option addresses the request to reduce access restrictions for market participants in GO systems. This particularly includes that besides energy suppliers also traders and (large) consumers should have the possibility to open registry accounts and to cancel GOs on their own behalf, or as a service for other market participants, while in some domains restrictions apply at least with a view to cancellation rights. As some of the existing market restrictions are justified by the Renewables' Directive rule that GOs are to be used by suppliers in order to demonstrate a renewable energy supply, this development option might need a respective clarification by the European Commission. However, it could also be practically adapted based on respective decisions by Member States, if it is understood that the Renewables Directive provides sufficient room for interpretation. *Potential effects of this development option:* This development option can reduce transaction cost particularly for large consumers interested in claiming GOs, if purchase and cancellation of these GOs can take place independently from the respective energy supplier. This can lead to an increased demand for GOs. At the same time, such a liberal interpretation of cancellation rights can lead to inconsistencies in accounting systems for disclosure, taking into account that electricity consumption volumes may be "double-disclosed" by the respective energy supplier on the one hand, and by consumers themselves or third service providers based on GOs which are cancelled independently from the supplied energy.
Addressed field of action	Increase & flexibilisation of GO supply Harmonise GO rules in order to increase market liquidity
Addressed GO system element	Market access
Potential effects on key dimensions	Liquidity: neutral (possibly restrictive with increased demand) Harmonisation: supportive Stability: neutral Efficiency: supportive Transparency: neutral Responsiveness: neutral Effectiveness: neutral

Possible levels of legislative implementation	EU legislation MS legislation
Main responsible actors	COM MS governments Other organisations: AIB

4.2.11. Recognition of GOs also from 3rd countries

Table 4-13: Characterisation of the development option "Facilitate recognition of GOs also from 3rd countries"

Recognition of GOs also from 3rd countries	
General description	A recognition of GOs from 3rd countries is possible based on Art 19 (11) of the Renewables Directive, provided that the Union has concluded an agreement with that third country on mutual recognition of guarantees of origin issued in the Union and compatible guarantees of origin systems are established in that third country, and only where there is direct import or export of energy. However, there is not yet a precedence established for the detailed criteria that a 3rd country should meet. This development option aims at specifying the requirements and establish a precedence for the use of this legal option. For the time being, such recognition has been discussed particularly for electricity GOs fromthe Energy Community Countries[220] and Switzerland (CH. Building on this, criteria could include e.g. technical compliance with CEN/EN16325, establishing independent issuing bodies and implementation of similar legislation on renewables and electricity markets as in the European Union. The main responsibility for the implementation of this measure lies with the European Union. *Potential effects of this development option:* By finally allowing for the import of GOs from third countries, the supply of GOs to EU markets would be increased, and generally leading to a flexibilisation of trade.
Addressed field of action	Increase & flexibilisation of GO supply Harmonise GO rules in order to increase market liquidity
Addressed GO system element	GO recognition
Potential effects on key dimensions	Liquidity: neutral (potentially supportive in case of expanded trading areas) Harmonisation: supportive Stability: neutral Efficiency: supportive Transparency: neutral Responsiveness: neutral (potentially restrictive in case of expanded trading areas) Effectiveness: neutral (potentially restrictive in case of expanded trading areas)
Possible levels of legislative implementation	Legal or non-legal measures
Main responsible actors	European Union

[220] https://www.energy-community.org/ (Albania, Bosnia and Herzegovina, Georgia, Kosovo, Moldova, Montenegro, North Macedonia, Serbia, Ukraine)

4.2.12. Establish a formal role for the AIB in the context of the GO system

Table 4-14: Characterisation of the development option "Generally recognise the role of AIB"

Establish a formal role for the AIB in the context of the GO system	
General description	The Association of Issuing Bodies has developed and implemented rules and technical systems for Guarantees of Origin within the framework of the European Energy Certificate System (EECS). The AIB facilitates the pan-European trade of GOs within most of the EU Member States at least for electricity GOs, and for some domains also for gas GOs. At the same time, the AIB and the EECS have no formal role in the EU legislation. This development option refers explicitly to the possibility for European legislators to mandate the AIB with a formal role in legislation and facilitate the trade of GOs within the EECS. However, according to the understanding of the project team, the European Commission has not the legal mandate for such an official recognition. Any official assignment of today's responsibilities of AIB would rather require the establishment of an official European entity in the RES Directive defining the relevant tasks and responsibilities, but also organisational set-up, financing etc. AIB would therefore be either be replaced or amended by such a new organisation, or will have to develop further in order to transform into this new official institution. This expected effort and finally decreased organisational flexibility should be weighted against the increased legitimacy and the binding nature of its role, taking into account that also market forces are expected to strongly promote the further participation of Member States within AIB. *Potential effects of this development option:* By establishing a formal facilitating role of AIB or a similar European entity it would be ensured that MS which are not applying the EECS for the time being would join the common practical implementation of GO systems in the EU. This can enable more harmonised rules for market participants and contribute to a more integrated EU-wide GO market.
Addressed field of action	Harmonise GO rules in order to increase market liquidity
Addressed GO system element	Recognition of the role of AIB
Relevance for addressing imbalances of key indicators	Liquidity: supportive Harmonisation: supportive Stability: neutral Efficiency: supportive Transparency: supportive Responsiveness: unclear

	Effectiveness: unclear
Possible levels of legislative implementation	EU legislation
Main responsible actors	European Union

4.2.13. GOs and market-based approach should be generally applicable for GHG accounting

Table 4-15: Characterisation of the development option "GOs and market-based approach should be generally applicable for GHG accounting"

GOs and market-based approach should be generally applicable for GHG accounting	
General description	The accounting of Scope 2 emissions in corporate and product carbon footprint in the so-called "market-based approach" is a major driver for the demand for GOs from institutional consumers. However, there are also other options to account for specific electricity supply and related emissions, based on GHG Protocol Guidelines, public standards (ISO/EN) and other accounting standards. This includes other market-based mechanisms as well as the accounting according to the location-based approach. This development option aims at clarifying the primacy of market-based accounting based on GOs over other accounting approaches within the scope of carbon accounting. This could be done by a respective clarification in relevant standards and guidelines like the GHG Protocol Scope 2 Guidelines, which are currently under revision. In a wider sense, this also applies to relevant EU regulation like the Battery Directive. *Potential effects of this development option:* By strengthening the role of GOs in GHG accounting an increased demand for GOs could be incentivised. This would particularly apply for countries with a low-carbon production mix (e.g. Norway or Iceland), as the application of a location-based approach is comparably advantageous for consumers in these countries for the time being. Furthermore, double counting of attributes by different accounting approaches (particularly in relation to the location-based accounting approach) could be minimised. At the same time, this development option would reduce transparency on the GHG emission relating to the situation of the specific system situation at the point of energy consumption. However, this could be addressed by applying enhanced requirements on temporal and geographical correlation).
Addressed field of action	Measures outside GO system to influence voluntary demand
Addressed GO system element	GHG accounting
Potential effects on key dimensions	Liquidity: restrictive Harmonisation: supportive Stability: neutral Efficiency: neutral Transparency: neutral Responsiveness: unclear Effectiveness: unclear

Possible levels of legislative implementation	EU legislation Non-legal measures
Main responsible actors	COM Other organisations: GHG Protocol, SBTi, CDP, ISO, CEN/CENELEC

4.2.14. GOs and market-based approach should only be applicable based on advanced criteria

Table 4-16: Characterisation of the development option "GOs and market-based approach should only be applicable based on advanced criteria"

GOs and market-based approach should only be applicable based on advanced criteria	
General description	The broad application of the market-based approach for GHG accounting in a GO-based book&claim-system has been broadly criticised in recent scientific studies, as this would primarily lead to resource shuffling and misleading low carbon claims. In order to address this shortfall, this development option describes the introduction of advanced criteria for the applicability of market-based instruments like GOs. This can include requirements relating to the plant age and level of support, or to a higher level of temporal and geographical granularity. This could be done by a respective clarification in relevant standards and guidelines like the GHG Protocol Scope 2 Guidelines, which are currently under revision. In a wider sense, this also applies to relevant EU regulation like the Battery Directive. To some extent, this development option contrasts with the development option "GOs and market-based approach should be generally applicable for GHG accounting" described above. *Potential effects of this development option:* This development option obviously would restrict the applicability and therefore the demand for GOs in general. At the same time, the demand would be focussed on GOs which could be considered impactful. Therefore, incentives for investments in new RES capacities or increased flexibilisation of demand and supply could be increased (see also the development options " Enhance temporal correlation (application)", Enhance geographical granularity (technical)", and "Enhance voluntary green label(s) and standards".
Addressed field of action	Measures outside GO system to influence voluntary demand
Addressed GO system element	GHG accounting Additionality markets
Potential effects on key dimensions	Liquidity: unclear Harmonisation: neutral Stability: depending on the specific design Efficiency: neutral Transparency: neutral Responsiveness: supportive Effectiveness: supportive
Possible levels of legislative implementation	EU legislation Non-legal measures

Main responsible actors	COM Other organisations: GHG Protocol, SBTi, CDP, ISO, CEN/CENELEC

4.2.15. Issue GO for all RES (including supported)

Table 4-17: Characterisation of the development option "Issue GO for all RES (including supported)"

Issue GO for all RES (including supported)	
General description	In some countries, GOs are not issued for supported RES-E volumes, based on the regulation of Art 19 (2) par. 1 of the Renewables Directive. The most relevant case in terms of volume is RES-E which is supported under the German renewable Energy Act ("Erneuerbare-Energien-Gesetz" - EEG). This is also the major reason for the large volumes of GOs which are imported to the German market, as only limited volumes of German RES-E GO are available in order to meet the demand in Germany. At the same time, the RES-E volumes supported by the German EEG are allocated to all German consumers on a pro-rata basis within their fuel mix disclosure. This development option describes a change of legislation in order to issues GOs also for all supported RES-E volumes. This could be done based on a revision of the Renewables Directive, or by a decision of the respective MS. In any case, this question will have to be considered by Member States with the upcoming introduction of two-sided contracts for difference (CfDs) or equivalent measures as the only acceptable support system by Member States. If GOs are to be issued in any case also for supported RES-E, Member States still can decide whether the GOs are directly issued to plant operators (or to offtakers/suppliers according to Art. 19 (2) par. 5 (c)) or to public bodies, which can auction GOs to the market, thereby reducing public cost of certificate systems. *Potential effects of this development option:* The implementation of this development option would increase the volume of available GOs in the market. At the same time, the demand for GOs might be increased if consumers are motivated to substitute the shares of supported RES-E which has been automatically disclosed on a pro-rata share in their disclosure statement so far. If GOs are to be issued also for already existing supported plants, a sudden issuing of GOs for all this RES volumes might lead to market flooding, and related market distortions.
Addressed field of action	Increase & flexibilisation of GO supply
Addressed GO system element	GO for all RES production
Potential effects on key dimensions	Liquidity: supportive Harmonisation: supportive Stability: neutral Efficiency: neutral

	Transparency: neutral Responsiveness: unclear Effectiveness: unclear
Possible levels of legislative implementation	EU legislation MS legislation
Main responsible actors	COM MS governments

4.2.16. Promotion of impactful PPAs (in combination with GOs)

Table 4-18: Characterisation of the development option "Promotion of impactful PPAs (in combination with GOs)"

Promotion of impactful PPAs (in combination with GOs)	
General description	Power Purchase Agreements are increasingly concluded in the European Union, The Renewables Directive (Art. (3) 4a) requires Member States to establish a framework which facilitates "*the uptake of renewables power purchase agreements, enabling the deployment of renewable electricity […]*" This can be understood to explicitly refer to impactful PPAs. A fundamental element of such PPAs is the provision of the related RES-E GOs to the offtaker. Depending on the contractual specifications, such PPAs are considered to have the potential for generators to lever in investment by securing long-term bankable offtake. This obviously is depending on stable long-term contractual conditions and a focus on new plants. This development option describes any promotion of such impactful PPAs. This could be enhanced by the European Commission (within a revision of the Renewables Directive), by Member States (e.g. by public banking guarantees, reductions in relevant taxes or tariffs), or on a non-legal level e.g. by applying such requirements in the framework of voluntary initiatives (like RE100). In order to focus on the further deployment and also the national development of RES-E, member states could define specific requirements relating to age and level of support of the production plant, to the deliverability of the covered electricity (geographical and potentially temporal correlation) and the contractual character of the PPA (namely physical PPAs). *Potential effects of this development option:* The promotion of impactful PPAs can focus demand on the related GOs and provide incentives for new investments in RES-E plants, thus supplementing the effects of national support systems. By doing so, also the overall cost for public support systems could be reduced.
Addressed field of action	Measures outside GO system to influence voluntary demand

Addressed GO system element	PPA
Potential effects on key dimensions	Liquidity: unclear Harmonisation: neutral Stability: neutral (supportive for GOs covered by PPAs) Efficiency: neutral Transparency: neutral Responsiveness: supportive (to some extent depending on the specific design) Effectiveness: supportive (to some extent depending on the specific design)
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measures
Main responsible actors	COM MS governments Market Stakeholders Other organisations: e.g. RE100, GHG Protocol, SBTi, RECS, labelling organisations, …

4.2.17. Enhance voluntary green label(s) and standards

Table 4-19: Characterisation of the development option "Enhance voluntary green label(s) and standards"

Enhance voluntary green label(s) and standards	
General description	In various European countries and regions there are voluntary green labels, standards or tariff rankings available, particularly with respect to electricity, but also to gases. These labels aim at giving guidance to consumers on impactful choices, based on additionality criteria or ambitious sustainability criteria. With a view to the increased interest in developing and applying higher levels of granularity, also advanced criteria relating to granularity could become applicable. This development option aims at providing support for such labels by any means, which could include public (governmental) lists of impactful labels, or public funding for the establishment of such labels, or potentially further measures. However, due to the purely voluntary character of this approach the major driver would have to come from market players, while the range of specific measures to enhance such labels and standards by public bodies seems limited. *Potential effects of this development option:* Depending on the level of ambition of the label, and the interest by consumers for consumers to labelled products this development option can lead to a focussed demand for impactful renewable energy products.

Addressed field of action	Measures outside GO system to influence voluntary demand
Addressed GO system element	Additionality markets
Potential effects on key dimensions	Liquidity: neutral Harmonisation: neutral Stability: neutral Efficiency: neutral Transparency: neutral Responsiveness: depending on the specific design Effectiveness: supportive
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measure
Main responsible actors	COM MS governments Market Stakeholders Other organisations: e.g. national and international labelling organisations, environmental and consumer organisations (like WWF and BEUC), RE100, GHG Protocol, SBTi

4.2.18. Develop and apply (official / public) additionality criteria or label

Table 4-20: Characterisation of the development option "Develop and apply (official / public) additionality criteria or label"

Develop and apply (official / public) additionality criteria or label	
General description	For the time being, labels and standards relating to the voluntary demand for energy are provided by private parties, while it should be noted that also the Delegated Act on RFNBOs has introduced additionality criteria for the production of such RFNBOs). Article 19 (13) of the Renewables Directive stipulates that "*by 31 December 2025, the Commission shall adopt a report assessing options to establish a Union-wide green label with a view to promoting the use of renewable energy generated by new installations. Suppliers shall use the information contained in guarantees of origin to demonstrate compliance with the requirements of such a label.*" Technical support for the development of this report will also be provided in the course of this study to DG ENER. Depending on the results of the related study, a public label could be developed and established. Besides the development and application of a label, also sets of ranking criteria could be established (e.g. share of new plants, degree of granularity,

	…) which might be mandatorily applied and published in the context of tariff-specific disclosure information, or in public rankings. However, while the Renewables Directive addresses the option of a Union-wide label, such activities could also be tackled on the level of Member States by the respective national governments. If granularity criteria are applied, this would also lead to a more regional development of RES, thereby contributing to the fulfilment of national RES targets. This might motivate Member States to develop and support the application of such criteria. *Potential effects of this development option:* The development and application of public labels could lead to a more focussed demand for GO and green energy based on impactful criteria, depending on consumers' awareness and also voluntary willingness to pay. Depending on the level of demand for labelled electricity, this could also provide incentives for investments in new RES installations.
Addressed field of action	Focussing of GO demand (mandatory measures) Measures outside GO system to influence voluntary demand
Addressed GO system element	Additionality markets
Potential effects on key dimensions	Liquidity: neutral Harmonisation: supportive Stability: neutral Efficiency: neutral Transparency: neutral Responsiveness: depending on the specific design Effectiveness: supportive
Possible levels of legislative implementation	Non-legal measures
Main responsible actors	COM MS governments Other organisations: organisations which might apply public criteria in an own label

4.2.19. Issue tradeable GOs only for new plants

Table 4-21: Characterisation of the development option "Issue tradeable GOs only for new plants"

Issue tradeable GOs only for new plants	
General description	In order to automatically focus the voluntary demand for GOs on production from new plants, the rules for issuing of GOs could be revised so that for older assets the issuing of GOs is restricted to some extent. This could be implemented e.g. in the sense that the tradability of such GOs would be limited, either within a strict geographical scope, with restricted applicability of the unbundled book & claim approach, or with an automated pro-rata allocation of such GOs to domestic consumers. Such a measure would have to take into account principles of legal stock protection which would mean that such a rule could not be applicable for plants which might have been built under the assumption that revenues from voluntary green markets could contribute to the refinancing of the investment. This would mean, that such a regulation might only affect plants which have been built before the market liberalisation in Europe. Furthermore, such a regulation would have to consider to which extent suppliers or also large consumers could continue to claim production attributes for the RES production of their own production facilities. *Potential effects of this development option:* The realisation of this development option would significantly limit the supply of tradable GOs. The resulting scarcity signals could contribute to an increased value of tradeable GOs and therefore incentivise investments in new RES plants.
Addressed field of action	Restriction & focussing of GO supply
Addressed GO system element	Additionality markets
Potential effects on key dimensions	Liquidity: restrictive Harmonisation: depending on the specific design Stability: unclear Efficiency: restrictive Transparency: neutral Responsiveness: supportive Effectiveness: supportive
Possible levels of legislative implementation	EU legislation
Main responsible actors	COM

4.2.20. Increase consumer awareness by campaigning

Table 4-22: Characterisation of the development option "Increase consumer awareness by campaigning"

Increase consumer awareness by campaigning	
General description	This development option aims at increasing consumer awareness for their possibilities to make a conscious choice of electricity supply. This could be done e.g. by means of public campaigning. For that purpose, it is obviously crucial to define the role which consumers are expected to play in free energy markets, so that relevant information can be provided. Assuming that consumers should be able to play a supportive role towards a low-carbon and renewable energy transition, any such public campaign should provide guidance for impactful choices. Such information could be provided by the European Commission, by Member States or also by other market actors and organisations. *Potential effects of this development option:* The potential effects strongly depend on the objectives and the corresponding information content of the campaigning, possibly focussing consumer interest on specific GOs, depending on impactful criteria.
Addressed field of action	Measures outside GO system to influence voluntary demand
Addressed GO system element	Additionality markets
Potential effects on key dimensions	Liquidity: neutral Harmonisation: neutral Stability: neutral Efficiency: neutral Transparency: depending on the specific design Responsiveness: supportive (depending on the specific design) Effectiveness: supportive (depending on the specific design)
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measures
Main responsible actors	COM MS governments Market Stakeholders Other organisations: e.g. national and international labelling organisations, environmental and consumer organisations (like WWF, BEUC, and national organisations)

4.2.21. Introduce GO plus

Table 4-23: Characterisation of the development option "Introduce GO plus"

Introduce GO plus	
General description	In the current regulatory regime, all activities by voluntary markets including the application of guarantees of origin take place within the framework of defined political RES targets on the level of EU and individual Member States. When assuming that GO markets should contribute to an increase of RES production, any such contribution and additional RES volumes would be statistically counted towards these targets. At the same time, public efforts e.g. by means of support systems would be adapted in order to ensure that the public target is reached, but not overfulfilled. This development option includes the regulatory introduction of GO plus, meaning the introduction of a new type of GO which provides a mechanism that the use of such GOs ensures that the represented RES volumes are statistically not or not fully taken into account by the EU and by Member States when assessing the fulfilment of their own political targets. Obviously, this option could only be considered relevant under the expectation that governments are willing to adapt all their policies to ensure that their target is reached also without taking the RES volumes of the GOplus production into account. At the same time the relevance of this option is obviously strongly depending on the expectation whether there is a relevant demand and willingness to pay for such GOplus by highly motivated consumers. This could be promoted by voluntary labels and standards. *Potential effects of this development option:* This development option would allow for impactful demand by consumers, but only depending on several assumptions, including that Member States' governments and the European Union are committed to reach their political RES targets by public support, and that a relevant number of consumers is highly motivated and willing to purchase such GO plus.
Addressed field of action	Focussing of GO demand (mandatory measures) Measures outside GO system to influence voluntary demand
Addressed GO system element	Introduce GO plus
Potential effects on key dimensions	Liquidity: neutral Harmonisation: neutral Stability: neutral Efficiency: neutral (for the standard GO markets) Transparency: neutral Responsiveness: supportive Effectiveness: supportive

Possible levels of legislative implementation	EU legislation
Main responsible actors	COM Other organisations: labelling and standardisation organisations, and low-carbon or RES initiatives

4.2.22. Abolish or restrict book & claim approach

Table 4-24: Characterisation of the development option "Abolish or restrict book & claim approach"

Abolish or restrict book & claim approach	
General description	The broad application of the book and claim approach based on GOs has been criticised, as this would lead to an oversupply of RES attributes in markets, primarily leading to resource shuffling, but not to the financing of new RES. The core of this development option is to restrict or even fully abolish the book & claim approach. This would be a radical step compared to the development of regulations and systems in the last 25 years. In practice, this could be implemented e.g. by only allowing for the application of bundled GOs or in combination with physical PPAs. However, a development towards increased granularity would have, to some extent, similar practical effects which are assumed to be linked with the request for abolishing the book & claim approach (particularly limitation of resource shuffling and incentives for new RES by market scarcity signals). *Potential effects of this development option:* The primary result of this development option would be obviously strong limitation of the applicability of unbundled GOs. Depending on the specific design of this measure, this could lead to scarcity signals and related incentives for new RES installations.
Addressed field of action	Restriction & focussing of GO supply Focussing of GO demand (mandatory measures)
Addressed GO system element	Book & Claim
Potential effects on key dimensions	Liquidity: Restrictive Harmonisation: neutral Stability: unclear Efficiency: restrictive Transparency: neutral Responsiveness: supportive Effectiveness: depending on the specific design
Possible levels of legislative implementation	EU legislation
Main responsible actors	COM

4.2.23. Introduce full disclosure

Table 4-25: Characterisation of the development option "Introduce full disclosure"

Introduce full disclosure	
General description	The Renewables Directive refers to the option of issuing GOs also for non-renewable energy, and some European Member States have already implemented national disclosure systems which are mainly based on the application of GOs for all energy sources (so-called "full disclosure" systems). Reasons for the request for full disclosure are that this would increase consistence of accounting systems, pass on the costs of GO systems also to non-renewables, and facilitate a better documentation of scope 2 attributes in corporate carbon accounting. This development option includes the further application by Member States or even a mandatory union-wide implementation of such full disclosure systems. *Potential effects of this development option:* The GO market would be extended also to non-renewables. There is no clear indication on immediate effects for the market sector for RES GOs.
Addressed field of action	Increase & flexibilisation of GO supply
Addressed GO system element	Full disclosure
Potential effects on key dimensions	Liquidity: restrictive (if commonly applied) Harmonisation: supportive Stability: unclear Efficiency: unclear Transparency: neutral Responsiveness: unclear Effectiveness: neutral
Possible levels of legislative implementation	EU legislation MS legislation
Main responsible actors	COM MS governments

4.2.24. Implement GO dashboard / transparency platform for consumers

Table 4-26: Characterisation of the development option "Implement GO dashboard / transparency platform for consumers"

Implement GO dashboard / transparency platform for consumers	
General description	This development option proposes the establishment of central GO dashboards or transparency platforms for consumers, so that those can have detailed insights on the type of GOs which have been cancelled for their respective consumption. As this requires comprehensive information on used GOs, this measure probably would have to be implemented by GO competent authorities, based on a legal mandate. *Potential effects of this development option:* Depending on the level of interest by end-consumers (or the public in general) and the specific information which would be provided on the platform, this development option could lead to more informed choices by end-consumers and a focussed demand. However, it is assumed that such "advanced" provision of information is only perceived and understood by high-interest consumers.
Addressed field of action	Measures outside GO system to influence voluntary demand
Addressed GO system element	Transparency
Potential effects on key dimensions	Liquidity: neutral Harmonisation: neutral Stability: neutral Efficiency: neutral Transparency: supportive Responsiveness: neutral Effectiveness: depending on the specific design
Possible levels of legislative implementatio	EU legislation MS legislation Non-legal measures
Main responsible actors	COM MS governments Market Stakeholders Other organisations: e.g. national and international labelling organisations, environmental and consumer organisations (like WWF, BEUC, and national organisations)

4.2.25. Improve market transparency & monitoring

Table 4-27: Characterisation of the development option "Improve market transparency & monitoring"

Improve market transparency & monitoring	
General description	For the time being, public available data on GO market volumes and particularly prices is only available to a limited extent. This development option aims at the compilation and publication of such data. This could be sourced by market intelligence, by results of public auctions and information from public market places (like EEX and OTC platforms) where GOs are traded. Responsible actors could be public bodies, but also private organisations or associations. *Potential effects of this development option:* This development option would result in higher transparency on markets, both for market participants as well as for the interested public, for research and for public administration. This can be expected to enhance market liquidity and support informed decisions on the need for further regulation of the market.
Addressed field of action	Tools and mechanisms for market transparency and market facilitation
Addressed GO system element	Transparency
Potential effects on key dimensions	Liquidity: neutral Harmonisation: neutral Stability: unclear Efficiency: neutral Transparency: supportive Responsiveness: neutral Effectiveness: neutral
Possible levels of legislative implementation	EU legislation MS legislation Non-legal measures
Main responsible actors	COM MS governments Market Stakeholders Other organisations: associations of market participants, EEX, others

4.2.26. Promote central GO market places

Table 4-28: Characterisation of the development option "Promote central GO market places"

Promote central GO market places	
General description	Guarantees of origin have been traded in recent years primarily on a bilateral basis and over the counter (OTC). After an initial attempt in 2013, which only covered limited GO volumes, the EEX has recently established an increasing portfolio for GO products to be traded in a central market place. For the time being, this comprises both spot and future products, including a potential differentiation between technology type, issuing country and subsidy scheme. This development option describes the further establishment and promotion of such a central market place. Appropriate means of how to do this would have to be further defined. *Potential effects of this development option:* Such central market places facilitate GO trading and could foster the liquidity of GO markets at the European level by providing standards for GO product categories, improving transparency and publishing information on price signals. In interaction with the development option "Improve market transparency & monitoring" this development option could also allow for insights on the functioning of the GO market support informed decisions on the need for further regulation of the market.
Addressed field of action	Tools and mechanisms for market transparency and market facilitation
Addressed GO system element	Market place
Key challenges and imbalances to be addressed	Liquidity: supportive Harmonisation: supportive Stability: supportive Efficiency: supportive Transparency: supportive Responsiveness: unclear Effectiveness: restrictive
Possible levels of legislative implementatio	EU legislation Non-legal measure
Main responsible actors	COM Other organisations: EEX, others

4.2.27. For gas GOs: Integrate and harmonise GOs / PoS and GO registries / UDB

Table 4-29: Characterisation of the development option "For gas GOs: Integrate and harmonise GOs / PoS and GO registries / UDB"

For gas GOs: Integrate and harmonise GOs / PoS and GO registries / UDB	
General description	This development option has shown to be the dominating request by all consulted parties and references with a view to gas GOs. It includes as core request a clarified, harmonised and to a large extent automated handling of GOs and PoSs (Proofs of Sustainability) within the applicable GO registries and the Union Data Base (UDB) according to Art 31a of the Renewables Directive. While the Union Database itself was operations to track gas consignments at the end of 2024, this very fundamental development option addressed the further implementation of the requirements. This has to be done in cooperation with Members States (being responsible for their national rules, including their national gas registries/dabases and the extent to which they have much wider scope than the GO registries themselves) and relevant actors at the European level, the European Commission, and implementation based on and the recently adopted CEN/EN 16325. *Potential effects of this development option:* The potential effect of this development option is reduced complexity, and a reduction of technical barriers for trading gas from renewable sources, whilst ensuring that this does not undermine the functionalities and objectives of PoS.
Addressed field of action	Improvement of technical framework Harmonise GO rules in order to increase market liquidity For gas GOs: clarify relation to PoS / UDB
Addressed GO system element	Gas GOs: Interaction of GO systems with UDB / PoS
Potential effects on key dimensions	Liquidity: depending on the specific design Harmonisation: supportive Stability: unclear Efficiency: supportive Transparency: depending on the specific design Responsiveness: depending on the specific design Effectiveness: depending on the specific design
Possible levels of legislative implementation	EU legislation National legislation Non-legal measure on a European level
Main responsible actors	Member States Other organisations: COM, AIB, ERGaR, CEN/CENELEC

4.3. ANNEX to analysis sections: Short Minutes of Stakeholder Workshop

Title Workshop on GO System monitoring

Date 28 April 2025, 14:00-16:30

Participants

DG ENER

LBST

Öko-Institut

Trinomics

Audience 150 participants from all relevant stakeholder groups

Agenda

1	Introduction of the project and its objectives	14:00-14:05	DG ENER
2	Objective of the meeting and approach	14:05-14:20	LBST
3	Presentation of preliminary results		
3.1	Analysis of the existing market of GO in Europe	14:20-15:20	LBST
3.2	Future GO market development, including options for enhancements	15:20-16:00	LBST, ÖKO
4	Q&A	16:00-16:15	ALL
5	Wrap-Up	16:15-16:30	ALL and DG ENER

Including a guest presentation from AIB on "GO system Harmonization efforts by AIB" including presentation of the latest EECS standard (v81), the AIB Hub Renewal and concluding with recommendations what can be done to further improve the GO system.

Further including a guest presentation from RE-Source, elaborating on the role of PPAs in the context of GOs.

During the workshop, a live feedback was enabled via MS-Teams allowing participants to give feedback on the conclusions presented. A total of 23 answers were received and in the very few cases where no full alignment with conclusions was seen, the respective answers were taken up into the analysis of chapters 2 and 3.

Furthermore, lively and partially controversial discussions in the chat between various stakeholders on potential ways forward were observed, supporting the fact that experts in the field are not fully aligned as to the best ways forward.

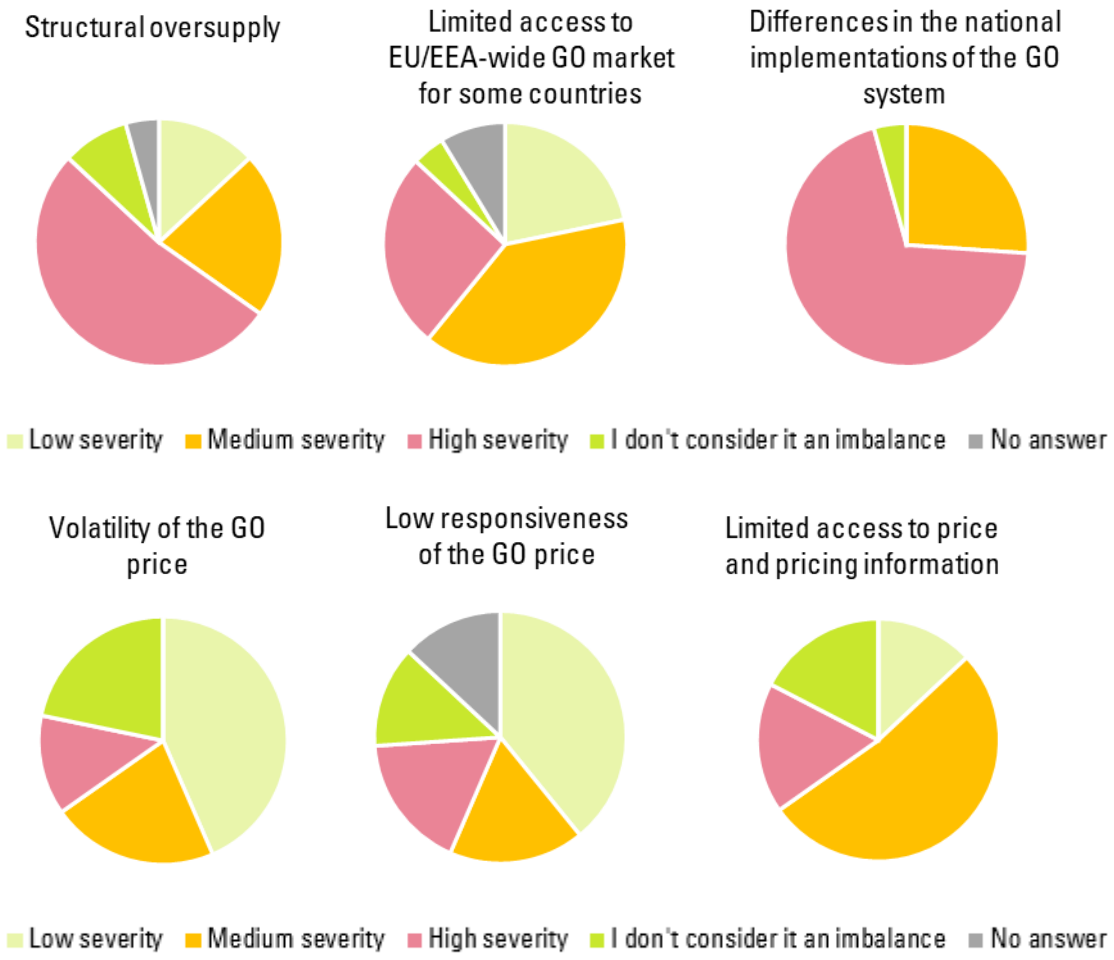

Figure 4-1: Live feedback regarding the severity of identified imbalances of the GO market

Based on survey

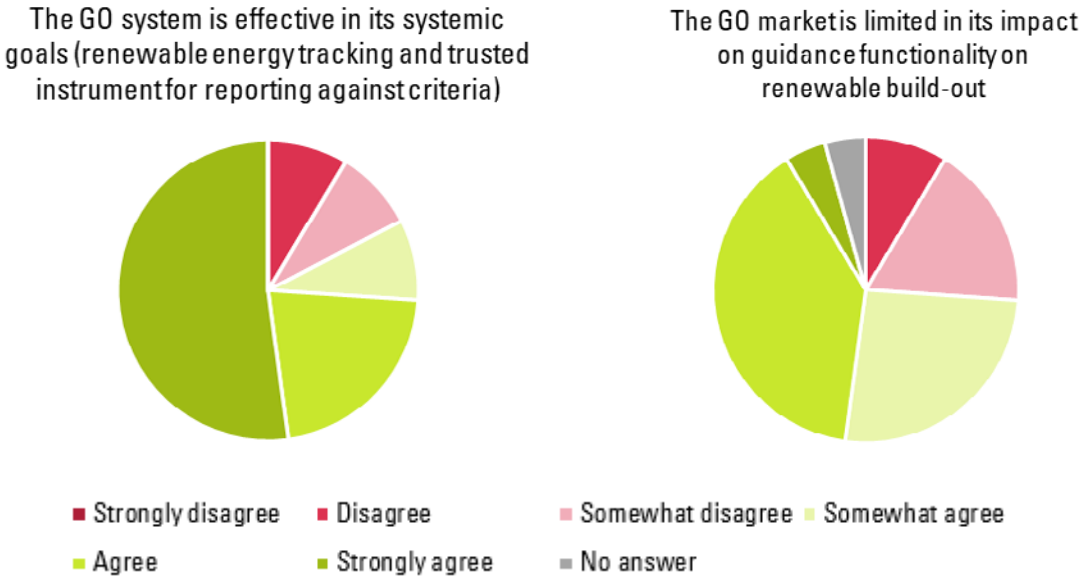

Figure 4-2: Live feedback regarding the effectiveness of the GO system

Based on survey

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