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Using guarantees of origin for electricity from renewable energy sources as an instrument for reducing product carbon footprint: A case study

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ABSTRACT

Objective: The article aims to demonstrate the potential for reducing the carbon footprint of products through the use of guarantees of origin (GOs) for electricity from renewable energy sources, based on a case study of an energy-intensive company.

Research Design & Methods: We employed regulatory source analysis and a case study methodology to evaluate the use of GOs within a company.

Findings: The research results demonstrate that GOs can serve to reduce a product's carbon footprint only for purchased electricity. The study also indicates that we cannot recognise such instruments in the cost of generating electricity produced using conventional fuels.

Implications & Recommendations: The study highlights the regulatory and accounting consequences of the use of GOs. Our findings imply the use of a separate allocation method to ensure compliance with ISO 14067 and European Union sustainability reporting standards.

Contribution & Value Added: The study contributes to the literature on carbon footprint reduction by combining aspects of renewable energy certification, legal compliance, and corporate sustainability strategy in the Polish context.

Article type: research article

Keywords: guarantee of origin; carbon footprint; energy transition; sustainability; renewable energy; cost accounting

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INTRODUCTION

About half of Poland's GDP relies on exports, with around 3/4 of this export volume headed to European Union countries (Broniewski & Liszka-Dobrowolska, 2024). Currently, the competitiveness of exports to the EU depends on climate competitiveness, considered on par with other factors determining the survival and profitability of individual industries, such as product quality and production costs. The Polish economy is facing the need to adapt to new climate realities and undergo an energy transition. The core components of climate competitiveness include corporate climate strategies, the carbon footprint of both organisations and products, and the progressive reduction of emission levels (Draghi, 2024). The unfavourable structure of electricity generation in Poland means that the carbon footprint of Polish electricity is 2 to 15 times higher than in other EU countries. The greatest challenges that Poland needs to face in terms of its energy transition are, above all, time and costs. According to estimates, the cost of the transition to a net-zero economy is projected to reach EUR 380 billion by 2050.

Due to its high energy intensity and emission levels, the industrial sector is particularly vulnerable to the negative effects of climate competition within the European Union. This sector reveals the greatest disparities between Polish and foreign companies, which justifies addressing this issue given its urgent and significant implications for the competitiveness of the Polish economy. In addition to improving energy efficiency, Polish companies operating in the country's energy-intensive industries face the need to undertake measures aimed at reducing emissions and carbon footprint in the short, medium, and long term alike. Simultaneously, they are struggling with a significant deterioration in profitability indicators, which, in turn, hampers their access to funding for costly transition projects.

ISO 14067 defines the carbon footprint of a product (CFP) as 'the sum of greenhouse gas emissions (3.1.2.5) and greenhouse gas removals (3.1.2.6) in a product system (3.1.3.2), expressed as carbon dioxide equivalents (3.1.2.2) and based on a life cycle assessment (3.14.3) using the single impact category (3.14.8) of climate change.' To enable the reduction of the carbon footprint in relation to electricity use, ISO 14067 allows the application of so-called contractual instruments, understood as any type of agreement between two parties regarding the sale and purchase of energy bundled with energy generation attributes or claims concerning unbundled attributes. For example, contractual instruments may include energy attribute certificates, renewable energy certificates (RECs), guarantees of origin (GOs), or green energy certificates.

The article aims to present the possibilities of reducing product carbon footprint through the use of GOs for electricity from renewable energy sources, based on a case study of an energy-intensive industrial company with its own generation source that uses conventional fuel in the combustion process. We argue that GOs can serve to reduce the product carbon footprint in the company under examination, but only in relation to purchased electricity. More specifically, we conjecture that under the currently applicable legal framework, GOs cannot serve to reduce the carbon footprint of a product with respect to electricity generated on-site using conventional fuels in the combustion process. The research methods applied include an analysis of regulatory sources and a case study of the company under examination.

The remainder of the article is structured as follows. Section 2 provides a literature review, followed by a research methodology that outlines the characteristics of the company under study. Section 4 analyses the legal requirements related to accounting records in connection with licensed activities and the redemption of the GOs as a method to reduce the product carbon footprint (PCF). The final section concludes the most significant findings of the study.

LITERATURE REVIEW

Nowadays, many EU countries have adopted ambitious plans to increase the share of renewable energies in the so-called electricity mix. For EU countries, 75% of energy-related greenhouse gas (GHG) emissions come from energy sources (International Energy Agency). Therefore, reducing GHG emissions strongly depends on the energy sector's investment in renewable energy sources (RES) and the abandonment of fossil fuels. For example, in France, the government aims to generate 40% of the electricity from renewable sources (Galzi, 2023). Achieving the goal involved a huge amount of public support and various tools. A special role belongs to GOs, the EU's electricity-tracking system based on certificates that one can transfer independently of the physical energy (Holzapfel *et al.*, 2024). Companies in the energy industry are obliged to use GOs, which allow them to earn additional income or incur additional expenses depending on the 'energy quality.' However, the main function of GOs is to inform final consumers about the energy source (Hamburger, 2019).

The research on energy transformation driven by green energy has been dated since at least the 1990s and addressed the socio-economic factors (Bollino, 2009; Calikoglu & Aydinalp Koksal, 2022), environment (Saidi & Omri, 2020), consumer profile (Hansla *et al.*, 2008; Zografakis *et al.*, 2010), product attributes (Borchers *et al.*, 2007; Kalkbrenner *et al.*, 2017), EU targets for RES (Knopf *et al.*, 2015; Poschmann *et al.*, 2022) or GOs system (Hulshof *et al.*, 2019; Wimmers & Madlener, 2024). The last strand of research investigates how effective the incentive and support system for investments in renewable energy is.

The research on the GO system remains scant and inconclusive. We aim to fill this gap by presenting findings of a case study of a Polish energy company. Poland's case is especially intriguing because its energy sector is based on fossil fuels and is underinvested. The case study provides insights into GO's problems in practice and the potential to reduce the product's carbon footprint. Whereas the existing research literature addresses the GOs system, RES targets, and carbon footprint reporting separately, there is a lack of literature that addresses all of those issues together.

RESEARCH METHODOLOGY

The company under examination (hereinafter: 'the Company') was a Polish business operating in Poland's energy-intensive industry. The Company's business operations encompass the following operational segments:

1. 'Export production' segment.
2. 'Domestic production' segment.
3. 'Energy' segment.

The Company qualifies as an energy enterprise within the meaning of the Energy Law (hereinafter: 'the EL'). When it comes to its 'Energy' segment, the Company conducts licensed activities based on concessions issued by the President of the Energy Regulatory Office, including for electricity generation (under a so-called WEE licence), electricity trading (so-called OEE licence), and electricity distribution (so-called DEE licence). The individual electricity supply points (so-called PPEs) and the Company's own generation source under its WEE electricity generation licence are integrated into a common internal electricity grid, which is connected in turn to the National Power System (so-called KSE). The Company uses electricity in the course of its operations through:

- the purchase of electricity for internal use (including within the 'Export Production' and 'Domestic Production' segments),
- the purchase of electricity for generation purposes (WEE),
- the consumption of electricity for distribution purposes (DEE),
- the purchase of electricity for resale (OEE), in accordance with the relevant regulations of the Energy Law, as well as,
- the consumption of electricity by the Company as a WEE-licensed entity, in accordance with the relevant provisions of the Excise Duty Act, or the generation of electricity for its own use.

The Company is listed in the Register of Industrial Consumers who have submitted the declaration referred to in the Renewable Energy Sources Act. Electricity cost allocation for the 'Export Production' and 'Domestic Production' segments is based on the calculation of a unit electricity cost for the Company as the volume-weighted average of the purchase price and the cost of electricity generation (including any necessary costs associated with public-law obligations borne by energy enterprises or industrial consumers). Subsequently, the total electricity cost for the 'Export Production' segment and the 'Domestic Production' segment, respectively, in a given period, is calculated as the product of the unit electricity cost and the actual consumption volume in that period.

Seeking to enhance both climate and cost competitiveness of its products offered to Western European markets, The Company was considering the purchase of GOs (as an instrument for reducing its product carbon footprint, referred to either as CFP or PCF), along with a change in the electricity cost allocation model (because electricity market prices are significantly lower than the cost of generating electricity using the Company's own source that makes use of conventional fuels in the combustion process). The following potential solutions to achieve the stated objectives have been identified:

1. changing the current electricity cost allocation model so that the unit price of purchased electricity for internal use, increased by the unit cost of acquiring the GOs and considering the actual electricity consumption volume by the 'Export Production' segment in a given period, would make up the total electricity cost allocated to that segment for the respective period;
2. maintaining the current cost allocation method, whereby the Company would purchase Guarantees of Origin in a volume equal to the volume of electricity purchased for internal use. Regardless

of the actual volume of GOs purchased, the total cost of their acquisition would be evenly distributed across each MWh of actual electricity consumption solely within the 'Export Production' segment for the given period (based on the so-called isolated allocation model).

The term 'isolated allocation' refers to a cost allocation method where the costs assigned to a given segment do not affect the results of other segments (Dobija & Kucharczyk, 2014).

RESULTS AND DISCUSSION

Legal Requirements Concerning Accounting Records in Connection With Licensed Activities

Since the Company is an energy enterprise conducting licensed economic activities under WEE, OEE, and DEE licences, it is subject to the provisions of Article 44 of the Energy Law. This provision requires the Company to maintain accounting records in a manner that makes it possible to calculate costs, revenues, profits, and losses separately for:

- activities conducted under each of the licences held, especially WEE, OEE, and DEE licences;
- separately with respect to customer groups[1] specified in the tariff (within the scope of OEE activity), and
- separately in relation to other areas of activity, in particular the 'Export Production' and 'Domestic Production' segments.

This provision aims to eliminate the so-called cross-subsidisation, meaning the covering of part of the costs incurred for one type of economic activity (or in connection with the generation of energy or provision of services for one customer group) using revenues derived from another type of activity (or from activity serving other customer groups). The statutory obligation to maintain separate accounting records does not require identifying and determining the cost of electricity from own generation consumed by the Company in the 'Export Production' and 'Domestic Production' segments. The use of electricity from its own generation is not based on an agreement, as the Company cannot enter into an agreement with itself. Therefore, the drawing of electricity from own generation at electricity supply points earmarked for 'Export Production' or 'Domestic Production' does not constitute consumption by a 'customer' within the meaning of Article 3(13) of the EL.

The requirement for the Company to determine the cost of electricity from its own generation arises from its status as an industrial consumer as defined in the Renewable Energy Sources Act. One of the statutory conditions in this respect is to determine the so-called electricity intensity ratio. It is defined as the ratio, expressed as a percentage, of the cost of electricity consumed for own use to gross value added. The detailed method for calculating the electricity intensity ratio is defined in the provisions of the Regulation of the Minister of Climate of 27 August 2020 on the method of calculating the electricity intensity ratio for industrial consumers, issued pursuant to Article 53(4) of the Renewable Energy Sources Act (hereinafter: 'Regulation on the Method of Calculating the Electricity Intensity Ratio'). The cost of electricity consumed for own use includes, *e.g.*, the cost of electricity from own generation and the cost of purchased electricity for own use.

Considering the legislative requirements described above, we must conclude that they necessitate the maintenance of separate accounting records, along with appropriate classification of each business transaction as constituting or not constituting an entry in such separate records for the relevant type of activity.

At this point, it seems reasonable to consider the correctness and justification of the Company's potential application of solution (A), consisting in a change in the allocation of electricity costs such that electricity from purchases, together with GOs, would be allocated to the 'Export Production' segment. However, given the actual technical situation, in which individual electricity supply points (including those assigned to the 'Export Production' segment) are connected to an internal electricity network linked both to the Company's own generation source (using conventional fuel in the combustion process) and to the National Power System, there are no grounds to attribute only purchased electricity to the 'Export Production' segment. Furthermore, considering the provisions of the Accounting Act (hereinafter: 'the AA')

[1] A customer, according to Article 3(13) of the Energy Law, is any person who receives or draws fuels or energy based on an agreement with an energy enterprise.

regarding the reliability of accounting books, we must conclude that changing the method of electricity cost allocation would not reflect the actual state of affairs in a better way, which is a fundamental condition for justifying any change in the method of recording electricity costs. It should be noted that, according to accounting regulations and pursuant to Article 24(2) of the Accounting Act, accounting books are deemed reliable if the entries made therein reflect the actual state of affairs. Any business arguments in this regard do not justify such a change because, under the AA, all modifications in the accounting treatment of individual items must aim to reflect the actual state better.

In light of the analysis of the applicable regulatory sources, we emphasise that implementing solution (A) under the current factual circumstances carries the risk of being challenged by auditors as a breach of the reliability of accounting records. These circumstances include, first, that the 'Export Production' segment is neither a separate enterprise nor a customer within the meaning of the EL (organisational aspect), and second, that the actual electricity flow within the internal network makes it technically impossible to attribute purchased electricity specifically to this segment (technical aspect)

Redemption of Guarantees of Origin as a Method to Reduce Product Carbon Footprint (PCF) Through Accounting Records Based on Isolated Allocation of Indirect Costs

In accordance with the Rules of the Guarantees of Origin Register (hereinafter: 'the GOR'), GOs maintained by the Polish Power Exchange (Towarowa Giełda Energii S.A., hereinafter: 'TGE'),[2] serve as confirmation for the final customer that exactly 1 MWh (one megawatt hour) of electricity generated from renewable energy sources in a renewable energy installation (or generated in a renewable energy source) has been fed into the distribution or transmission grid. Alternatively, a GO may confirm that exactly 1 MWh of electricity has been generated in high-efficiency cogeneration and introduced into the distribution or transmission grid (§2(1) of the Rules of the Guarantees of Origin Register of 1 February 2024).

The acquisition and redemption of GOs is not a legal obligation, but rather a right granted to final customers of electricity. Moreover, TGE records GOs held by a given GOR member in its system. Guarantees are credited to the register account of a given GOR member, and TGE records all changes in holdings between GOR members occurring within the framework of the GOR. Transfer of a GO occurs at the moment the relevant entry is made in the GOR. Contracts concerning GOs are concluded off-exchange and exclusively between GOR members. GOR members enter into contracts for the sale of GOs only by means of the GOR ICT system. TGE is not a party to such contracts, does not act as an intermediary in their conclusion, and does not participate in their financial settlement, nor does it assume any liability in relation to transactions involving contracts for the sale of GOs concluded between GOR members.

According to Article 120(1) of the Renewable Energy Sources Act, a GO is an electronic document certifying to the final customer that a specified amount, expressed in MWh, of, respectively, electricity, biomethane, heat or cooling, renewable hydrogen, biogas or agricultural biogas was generated from renewable energy sources and fed into the appropriate grid of the relevant grid operator. The essence of a GO under the Renewable Energy Sources Act is to certify that the electricity consumed by a given final customer originates from renewable energy sources. This certification is possible only through the redemption of GOs for the benefit of the final customer, confirming that the volume of electricity consumed corresponds to the volume of GOs redeemed and is thus considered non-fossil-based (*i.e.*, zero-emission).

Based on this statutory condition (the requirement to be a final customer – Article 2(21) of the Renewable Energy Sources Act, which defines the term 'final customer' by reference to Article 3(13a) of the Energy Law), we must conclude that it is not possible for the Company to certify, by way of redemption of a GO, that the consumption of electricity from its own generation constitutes consumption of electricity from renewable sources. Since a 'final customer' is anyone purchasing electricity for own use, and the Company does not purchase electricity from itself, it does not meet the statutory definition in question. This means that the possibility of certifying renewable electricity consumption through the acquisition and redemption of GOs applies exclusively to purchased electricity.

[2] Pursuant to Article 124(1) of the Renewable Energy Sources Act, the entity authorised to maintain the register of Guarantees of Origin is the entity operating a commodity exchange within the meaning of the Commodity Exchange Act or a regulated market within the meaning of the Act on Trading in Financial Instruments.

In the European Sustainability Reporting Standards (ESRS), the European Commission recognises GOs as a valid method of confirming renewable energy sourcing for the market-based emissions calculation method. The ESRS are components of the Corporate Sustainability Reporting Directive (CSRD). According to paragraph AR 32 of the Regulation of 31 July 2023 supplementing Directive 2013/34/EU of the European Parliament and of the Council with regard to sustainability reporting standards, an entity may identify consumed energy as energy obtained from renewable sources only where the source of the purchased energy is clearly specified in contractual arrangements with its suppliers, *e.g.*, through GOs.

The CSRD requires certain entities to disclose organisational carbon footprint data in their non-financial reports. Although the directive does not directly regulate product carbon footprint calculation, it is referenced here to support the credibility of using GOs to confirm renewable energy sourcing and to anchor this practice within the EU legal framework.

The legal solutions currently in force in Poland concerning GOs should be considered consistent with ISO 14067. This standard includes guidelines on how electricity should be treated in the context of product carbon footprint calculations, especially with regard to GOs for renewable electricity and other contractual instruments used for disclosing environmental characteristics of electricity generation (see ISO 14067, sub-clauses 6.4.9.4.2 – 6.4.9.4.4).

At this point, we should also note that these statutory solutions translate into a legal fiction. This fiction consists of the fact that a producer of electricity from a renewable energy source is entitled to receive a GO for electricity that has (essentially) been generated and fed into the grid during a period covering between one and six calendar months of a given calendar year (Article 121(2)(1) of the Renewable Energy Sources Act, pursuant to which an application for the issuance of a GO for electricity that has been generated and fed into the grid is submitted to the electricity distribution system operator or transmission system operator in whose area of operation the renewable energy installation is connected).[3] At the same time, the certification for the final customer, confirming that the electricity consumed by that customer originates from a renewable energy source, is possible for a period of 12 months, counted from the last day of the period covered by the application for the issuance of the GO (Article 122(3) of the Renewable Energy Sources Act, pursuant to which a GO is valid for a period of 12 months from the end date of electricity generation in the renewable energy installation covered by the application for the issuance of the GO, and may not be transferred after this period).

The cost of acquiring GOs for the purpose of their redemption on the Company's own behalf is an indirect cost, since they cannot directly attribute it to specific revenue or its timing. However, incurring this type of cost is clearly justified in terms of achieving a certain level of revenues and maintaining a portfolio of customers who consider climate aspects (such as carbon footprint levels in this particular case) in their purchase-related decisions (see Letter of 10 March 2023, issued by: Director of the National Tax Information Office, reference: 0111-KDIB1-2/4010/13/2023/2/AK, published at http://sip/mf.gov.pl). Therefore, recording this cost in the accounting system as an indirect cost of the 'Export Production' segment (in addition to separately recorded electricity costs for this segment), based on the so-called isolated allocation method, is both appropriate and justified. It also supports the adoption of a zero-emission factor for the volume of electricity purchased and used within this business segment. ISO 14067 does not prohibit an approach based on allocation of emissions via accounting operations, provided that the Company can demonstrate compliance with the principles of credibility, consistency, and transparency, as well as its avoidance of double counting, as defined in clause 5.12 of ISO 14067. This means that organisations must use GOs only once for a given volume of electricity and only for products manufactured within a single business segment (in this case, the 'Export Production' segment) and limited to the volume of electricity purchased.

To summarise, reducing the carbon footprint of products (CFP) manufactured under the 'Export Production' segment through redemption of GOs for the Company's benefit in a volume of purchased elec-

[3] See Article 121(3)(4) of the Renewable Energy Sources Act, pursuant to which an application for the issuance of a guarantee of origin must specify the period covering one or more consecutive calendar months of a given year during which electricity was generated from renewable energy sources in a renewable energy installation, indicating the start and end dates of generation, with the period not exceeding six months.

tricity consumed in this segment over a given period (no less than one calendar month and no more than six calendar months within a single year), in which both the acquisition (incurring the cost) and accounting of such costs are allocated within the same business segment is compliant with ISO 14067, particularly with its electricity-related provisions defined under clauses 6.4.9.4.2 – 6.4.9.4.4. Therefore, we should consider solution (B) feasible and implementable within the Company, and the acquisition and redemption of GOs will positively contribute to reducing the product carbon footprint (PCF).

CONCLUSIONS

We achieved the study's objective, defined as a presentation of the possibility of reducing the product carbon footprint level through the use of GOs for electricity from renewable energy sources, based on an analysis of regulatory sources and a case study. The subject of the case study was an energy-intensive enterprise which, in addition to its production activities (within the 'Export Production' and 'Domestic Production' segments), conducts licensed activities in the fields of electricity generation, trading, and distribution, and holds the status of an industrial consumer within the meaning of the Renewable Energy Sources Act. The situation was also caused by the fact that the Company's electricity supply points (PPEs) and its own generation source operated under the WEE licence are interconnected within a common internal electricity grid, which in turn is connected to the National Power System (KSE).

We argue that GOs can serve to reduce the product carbon footprint in the Company, but only in relation to purchased electricity. We provided evidence supporting this thesis. Furthermore, we conjectured that GOs cannot serve to reduce the carbon footprint of electricity generated in the Company's own generation source using conventional fuel in the combustion process, and again, we provided another evidence supporting our thesis.

Seeking to enhance both climate and cost competitiveness of its products offered to Western European markets, the Company was considering the purchase of GOs as an instrument for reducing its product carbon footprint, referred to either as CFP or PCF, along with a change in the electricity cost allocation model because electricity market prices are significantly lower than the cost of generating electricity using the Company's own source that makes use of conventional fuels in the combustion process.

An enterprise's ability to present confirmation of the redemption of GOs in its favour, issued by TGE as the entity maintaining the Guarantees of Origin Register, contributes to the reduction of that enterprise's carbon footprint by recognising that the given volume of purchased electricity for which the GOs have been redeemed has a zero emission factor. However, it is not possible to certify, through the redemption of Guarantees of Origin in favour of the enterprise as a final customer, that electricity from the Company's own generation is electricity obtained from renewable energy sources. This restriction results from a statutory requirement under which such certification is only available to a final customer within the meaning of Article 3(13a) of the Energy Law. A 'final customer' is any entity that purchases electricity for their own use. A business entity that generates electricity for its own use does not engage in a purchase transaction (and therefore does not meet the legal definition in relation to electricity generated in its own sources). Any potential change in the allocation of electricity costs under these factual circumstances is not permissible for the Company, as it creates a risk of being challenged by auditors as a breach of the reliability of accounting records.

Recognising the cost of acquiring GOs in the accounting records as an indirect cost under the 'Export Production' segment (in addition to separately recording the cost of electricity consumed within this segment), based on the so-called isolated allocation method, is justified (including in terms of compliance with ISO 14067), and also supports the adoption of a zero emission factor for the volume of purchased electricity used for own needs within this business segment. Moreover, such a solution seems to comply with the requirements of the Accounting Act, especially Article 4(1).

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Use of Artificial Intelligence

The authors declare that their text is free of AI/GAI usage.

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