



Gas Transmission

Hydrogen Gas Market Plan

The role of Guarantees of Origin in driving a future UK hydrogen market





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Despite their differences, natural gas, biomethane and hydrogen perform the same function: burning these products generates energy. At the meter, it is likewise impossible to differentiate where gas molecules come from, be they from the depths of the North Sea or a local electrolyser.

There is significant emission reduction potential from developing a low carbon hydrogen industry in the United Kingdom (UK), yet to help unlock the potential of a hydrogen transition we will need a system to verify the origin of production/supply of low carbon hydrogen, account for claims of low carbon hydrogen consumption, and associate a climate value premium for low carbon hydrogen products. Guarantees of Origin could perform this role, and therefore play a key part in facilitating a transition to a hydrogen economy.



Through bringing together a working group of gas networks, shippers, consumers, gas industry specialists and Government, the latest National Grid Gas Transmission [Hydrogen Gas Market Plan \(GMAP\)](#) project explored the role Guarantees of Origin could play in driving a UK low carbon hydrogen market.

This final report provides a summary of the findings from the project, including an introduction to how Guarantee of Origin schemes function, the benefits a UK hydrogen Guarantee of Origin scheme could provide to gas market participants, and a set of recommendations for industry to consider to implement the UK's first hydrogen Guarantee of Origin scheme.

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1a. Introduction to the Hydrogen Gas Market Plan (GMaP)

The [Hydrogen Gas Market Plan](#) (GMaP), a focus area of the [Future of Gas](#) programme, is led by National Grid Gas Transmission (NGGT) in collaboration with industry, stakeholders and decision makers.

The purpose of the Hydrogen GMaP is to bring together gas market participants, including networks, shippers, consumers, industry specialists and decision makers, to explore the market change activities needed to integrate hydrogen into the UK's energy mix, and to ensure the gas system and markets continue to deliver consumer value throughout the UK's hydrogen transition.

1b. Introduction to the Hydrogen GMaP hydrogen Guarantee of Origin (GoO) project

This project involved NGGT collaborating with a working group representing the gas industry value chain in the UK and the European Union (EU) to explore the potential for a UK hydrogen Guarantee of Origin (GoO) scheme.

The purpose of this hydrogen GoO project included to:

- Review the current landscape of GoOs in the UK and the EU
- Evaluate the benefits a hydrogen GoO scheme could provide to UK hydrogen producers, transporters and consumers
- Develop recommendations for industry to take forwards to implement a UK hydrogen GoO scheme.

1c. Why explore a UK hydrogen Guarantee of Origin (GoO) scheme?

There are several reasons why exploring a UK hydrogen GoO scheme is a timely and important topic for the UK gas industry to consider.

To begin with, increasing low and zero carbon gases such as hydrogen will be crucial to enabling the UK achieve our ambitious [net zero](#) by 2050 target. If decarbonisation is the key driver for developing low and zero carbon hydrogen, it will be important for market participants to be able to disclose the climate value of these products.

There are a variety of different hydrogen products with different emission benefits. To provide an indication of hydrogen products from most to least emissions as a high-level guide, please see below:

High carbon	Brown: Gasification of coal to generate hydrogen
	Grey: Steam reformation of natural gas to generate hydrogen
Low carbon	Blue: Steam reformation of natural gas to generate hydrogen, with the added process of carbon capture usage and storage
	Turquoise: Natural gas pyrolysis to generate hydrogen with solid carbon by-product
	Pink: Hydrogen generation powered by nuclear, such as electrolysis (separating water into oxygen and hydrogen) powered by nuclear energy
Zero carbon	Yellow: Electrolysis powered by solar energy
	Green: Electrolysis powered by wind/hydro energy
Negative carbon	Bio-Energy with Carbon Capture and Storage (BECCS): Gasification of biomass to generate hydrogen, with added process of carbon capture usage and storage



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A GoO scheme will be essential to verify the origin of hydrogen products and account for claims of hydrogen product consumption.

Please note, in this report we refer to low / zero / negative emission hydrogen products as low carbon hydrogen, based on the assumption that hydrogen products eligible for a UK hydrogen GoO scheme will need to be sufficiently low carbon as to meet the Government UK hydrogen standard.

A GoO scheme will be especially important to verify the origin of low carbon hydrogen products injected into pipeline systems, because it is impossible to physically track gas molecules once injected into pipeline systems. Key to note, pipeline systems are the most efficient and economic route to transport gas to consumers at scale, where the existing (public*) gas transporters in Great Britain are exploring the feasibility of transporting hydrogen through repurposing the existing (public) gas networks. For example, NGGT's [FutureGrid](#) project involves building a representative gas National Transmission System (NTS) facility to test 2%, 20% and 100% hydrogen blends to assess how existing NTS assets will perform. The purpose of the FutureGrid project is to demonstrate that the existing NTS can transport hydrogen. Because gas transported through pipeline systems cannot be tracked from a specific producer to a specific user, GoOs provide a robust market mechanism to verify to consumers the origin of hydrogen energy products.

In addition, considering the energy transition ahead of us it will be essential for energy users to have access to market mechanisms that enable consumers to indicate their preference and to account for claims of consuming energy products, including low carbon hydrogen products. In this project, we explored how GoOs could be used as a market mechanism to enable consumers to indicate their preference for low carbon hydrogen products and give

consumers the ability to generate a market pull force to impact the production of low carbon hydrogen.

Another key reason why it is important to explore the development of a UK hydrogen GoO scheme is that there are multiple UK climate value market mechanisms already in operation, including the [UK Emissions Trading Scheme](#) (UK ETS), [Renewable Energy Guarantees of Origin](#) (REGOs), [Renewable Gas Guarantees of Origin](#) for biomethane (RGGOs), and many more. As UK hydrogen GoOs would closely interact with existing climate value market mechanisms, there is a need to explore how to drive compatibility and efficiencies.

We also know that extensive hydrogen Guarantee of Origin work is taking place in the EU. The development of EU hydrogen Guarantee of Origin schemes will be important to future UK and EU cross border hydrogen trade, driving the need to develop consistency with EU hydrogen GoOs. EU hydrogen GoO progress includes:

- EU Commission funded [CertifHy](#) project that has been developing an EU hydrogen GoO scheme since 2014.
- The 2018 (recast) EU [Renewable Energy Directive](#) (RED II) includes a provision that 'Guarantees of Origin in place for renewable electricity should be extended to cover renewable gases'. Although the definition of renewable gases is still in development for RED II, the provision to extend the legal definition of GoOs to renewable gases is still significant progress for gas GoOs.
- The (2020) [EU hydrogen strategy](#) stated 'The specific, complementary functions that Guarantees of Origin already play in the Renewable Energy Directive can facilitate the most cost-effective (hydrogen) production and EU-wide trading.'

Clearly, there are a range of important reasons why exploring a UK hydrogen GoO scheme is a timely and relevant topic for the UK gas industry.

...considering the energy transition ahead of us it will be essential for energy users to have access to market mechanisms that enable consumers to indicate their preference for energy products

* Definition of public gas network: A national asset that market participants can access in a process governed and facilitated by rules.

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1d. Overview of Hydrogen GMaP project on a UK hydrogen Guarantee of Origin scheme

Problem statement: Decarbonisation is the chief driver for developing a UK low carbon hydrogen industry. In addition to decarbonisation, domestic production of low carbon hydrogen would increase security of supply, where the [UK Hydrogen Strategy](#) states: ‘moving quickly to develop a strong UK hydrogen economy by 2030 can help ensure security of supply and wider investment, create high-quality and sustainable jobs, and position UK companies to take advantage of opportunities in international markets.’

Considering the drivers of decarbonisation and security of supply for developing a UK low carbon hydrogen industry, a system such as GoO scheme will clearly need to be in place to track the production/ supply of hydrogen, account for claims of hydrogen product use, and associate a climate value premium* for hydrogen products.

The aim of this hydrogen GoO project was to explore the role a UK hydrogen GoO scheme could play in accelerating a UK hydrogen market, through maximising the climate value premium of injecting low carbon hydrogen into the UK’s gas system and enabling consumers to demonstrate market ‘pull’ forces for low carbon hydrogen products.

Project engagement: The main stakeholder engagement for this project was conducted over a four-month period (June 2021 – September 2021) followed by wide gas industry engagement and project findings dissemination (October 2021 – January 2022). To develop the project, NGGT collaborated with a 70-member working group representing over 25 companies from the UK and EU gas industry value chain (see Figure 1 below).

Project scope: This agile project sought to bring clarity to the complex market area of GoOs by examining the current GoO landscape in the UK and the EU, assessing the benefits of a UK hydrogen GoO scheme and developing recommendations to implement a UK hydrogen GoO scheme.

* Definition of climate value premium: Premium associated with carbon savings of low carbon hydrogen products over fossil fuel natural gas.

Figure 1: Hydrogen GMaP working group for the hydrogen GoO project



Structure of this report

The following report for the Hydrogen GMaP project on a UK hydrogen Guarantee of Origin scheme is structured as follows:

- 06 Section 2: What is a Guarantee of Origin?** This section includes a definition of GoOs and an explanation for how GoO schemes function.
- 09 Section 3: Current landscape of hydrogen Guarantees of Origin in the EU and the UK** This section includes a literature review of the development and current use of GoOs, for both gas and electricity products, in the EU and the UK.
- 22 Section 4: Benefits of a UK hydrogen GoO** This section explores the benefits a UK hydrogen GoO scheme could provide to UK hydrogen producers, transporters, and consumers.
- 28 Section 5: Recommendations for a UK hydrogen GoO** This section details six recommendations for the UK gas industry to consider in order to implement a UK hydrogen GoO scheme.

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2a. Defining Guarantees of Origin

A GoO is a digital document, a digital certificate, that provides information on the origin of energy products. GoOs provide information on where, when, how (and other information) on the production of energy products. Please see Figure 2 for an example of the information included within a Guarantee of Origin, this example is a Renewable Gas Guarantee of Origin (RGGO) generated by the [Green Gas Certification Scheme](#).

One of the most important principles of a GoO is that a GoO can be traded independently from the physical energy commodity it represents. By de-coupling GoOs from physical energy, low carbon energy producers can sell GoOs to maximise the low carbon attributes (i.e., information specifying the characteristics) of their energy products.


Please note, while GoOs can be traded independently from the physical commodity it represents (this is known as a book and claim GoO system), GoOs can also be bought and sold with the physical commodity it represents. Buying a GoO with the physical commodity it represents, with evidence to indicate physical molecule injection into a system with evidence the same volume of physical molecules taken off the same system, is known as mass balancing.

It is key to note that throughout this project we worked on the basis UK hydrogen GoOs would be traded independently from the physical commodity, referred to as a book and claim system.

Our view was that a robust GoO scheme should allow for the de-coupling of GoOs from the physical energy commodity to enable a more liquid, competitive traded hydrogen GoO market. In addition, by considering the UK's gas system as a single logistical facility (i.e., considering the UK (public) gas networks as a single, interconnected network), this corresponds to a single mass balanced unit.

While we developed this project under the basis a UK hydrogen GoO scheme could operate as a book and claim system, it is key to note that in particular use cases requirements could be put in place to satisfy some or all mass balancing criteria. For example, requiring the hydrogen producer and consumer to both be connected to the UK's gas system.

Figure 2: Example of information included within a GoO certificate



Green Gas
CERTIFICATION SCHEME

Example Certificate – DOES NOT CONTAIN VALID RGGOs

RGGOs issued on:	05/03/2018 11:06:29
RGGOs retired on:	05/03/2019 17:05:20
Retirement Statement downloaded on:	06/06/2019 10:45:13
RGGOs allocated to:	UK Supermarket Ltd
Renewable Gas Guarantees of Origin:	G001MP0000001E0920 to G001MP10395371E0920
Injection Date:	01/17/2020 to 30/09/2020
Biomass Information:	GGCS - Biomass (Unspecified) Classification (Waste)
RGGOs issued by:	GGCS – UK
Amount:	10395371 kWh
Production Support received:	Yes
Sustainability Criteria Met:	Non-Domestic Renewable Heat Incentive (RHI) - UK
Certificate pin number:	keh975d
Green Gas producer:	Biogas Biogas Ltd, Peterhead, Aberdeenshire, OX14 3JJ, Green Gas (Biomethane), Process (Anaerobic Digestion), Delivery (Grid Injection), Metering Point (0000012345), Commissioning Date (Dec '17), Capacity (5 MW), Investment Support (No)
Retirement statement generated by:	Example Gas Suppliers Ltd, Drayton, Oxford, OX14HT, UK

The RGGOs listed on this Retirement Statement have been allocated to the party named and cannot be transferred or allocated to any other party.
These RGGOs have been issued according to a calculation of the number of kWh of green gas produced, net of any fossil gas consumed during the production process. For more information, visit [www.greengas.org.uk/certificates](#).
If 'Non-Domestic Renewable Heat Incentive (RHI)' is stated in the 'Sustainability Criteria' field then the lifecycle emissions associated with the production of the biomethane, up until its injection into the grid, is no more than 125.28 gCO₂ equivalent per kWh. Biomass information will be recorded according to the RHI criteria. If International Sustainability and Carbon Certification (ISCC) is stated, then an emission factor will be available within the documentation produced under the ISCC scheme. Biomass information will be recorded according to the ISCC criteria. For information about the criteria within the Non-Domestic Renewable Heat Incentive (RHI) and the International Sustainability and Carbon Certification (ISCC) scheme, visit [www.greengas.org.uk/certificates/emissions-reporting](#).
Any GHG values related to the production of green gas are calculated against the lower calorific value, whereas the kWh represented by the RGGOs are the higher calorific value of the green gas.
To verify that this Retirement Statement is genuine, visit [www.greengas.org.uk/certificates/validate](#).
For information about additional claims, visit [www.greengas.org.uk/certificates/additionality](#).

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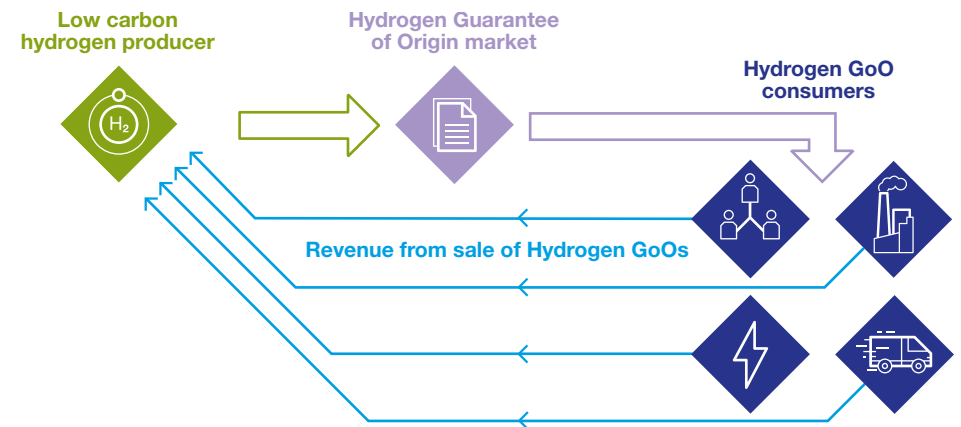
A helpful analogy on the role of GoOs is to compare GoOs to crowdfunding. Crowdfunding is where numerous funders contribute to a single project. GoOs work in this manner as a range of consumers can buy GoOs (representing 1 MWh energy unit from an energy producer), and the revenue from the sale of GoOs is gained by the energy producers.

For example (please see Figure 3 below), if a low carbon hydrogen producer sold hydrogen GoOs to gas consumers (i.e., domestic users, power generators, industrial sites, or transport users), the low carbon hydrogen producer would gain revenue from the sale of the GoOs from numerous consumers. On top of the revenue from the GoO, the low carbon hydrogen producer would also gain a greater understanding of consumer appetite for their product, potentially justifying the expansion of the hydrogen production facility.

However, buying GoOs does not influence the energy that physically enters consumer meters (neither gas nor electric meters). This is because it is impossible to control or know which gas molecules or electricity electrons enter consumer meters (unless a consumer is directly physically connected to an energy source). Consumers can, however, influence the market by choosing to opt for 'green' energy supplies. The greater the demand for such products sends a signal, a market 'pull' force, to incentivise increased 'green' energy production.

Because it is impossible to track where electrons or molecules go once injected into the electricity and gas networks, a reliable mechanism to make claims about the use of specific energy products is needed and can be delivered through GoOs. A GoO, representing 1 MWh of energy products (i.e., evidenced by metering), bought by an energy user would entitle that user to be the only entity to claim the use of a specific MWh of energy product.

Figure 3: Crowdfunding analogy on the role of Guarantees of Origin



In a book and claim GoO system, energy producers inject (or book) their product into the gas or electricity systems, and energy consumers claim the use of this energy through purchasing GoOs representing the physical energy product. In this report we demonstrate how the use of a book and claim GoO scheme could provide a robust system to account for (i.e., book and claim), as well as associate a climate value premium for low carbon hydrogen products within the UK's energy system.

2b. How do Guarantee of Origin schemes work?

When considering how GoO schemes function, it is key to emphasise that a GoO market operates separately to the physical energy commodity market. Please see Figure 4 below for a simplified illustration for how a hydrogen book and claim GoO scheme could function.

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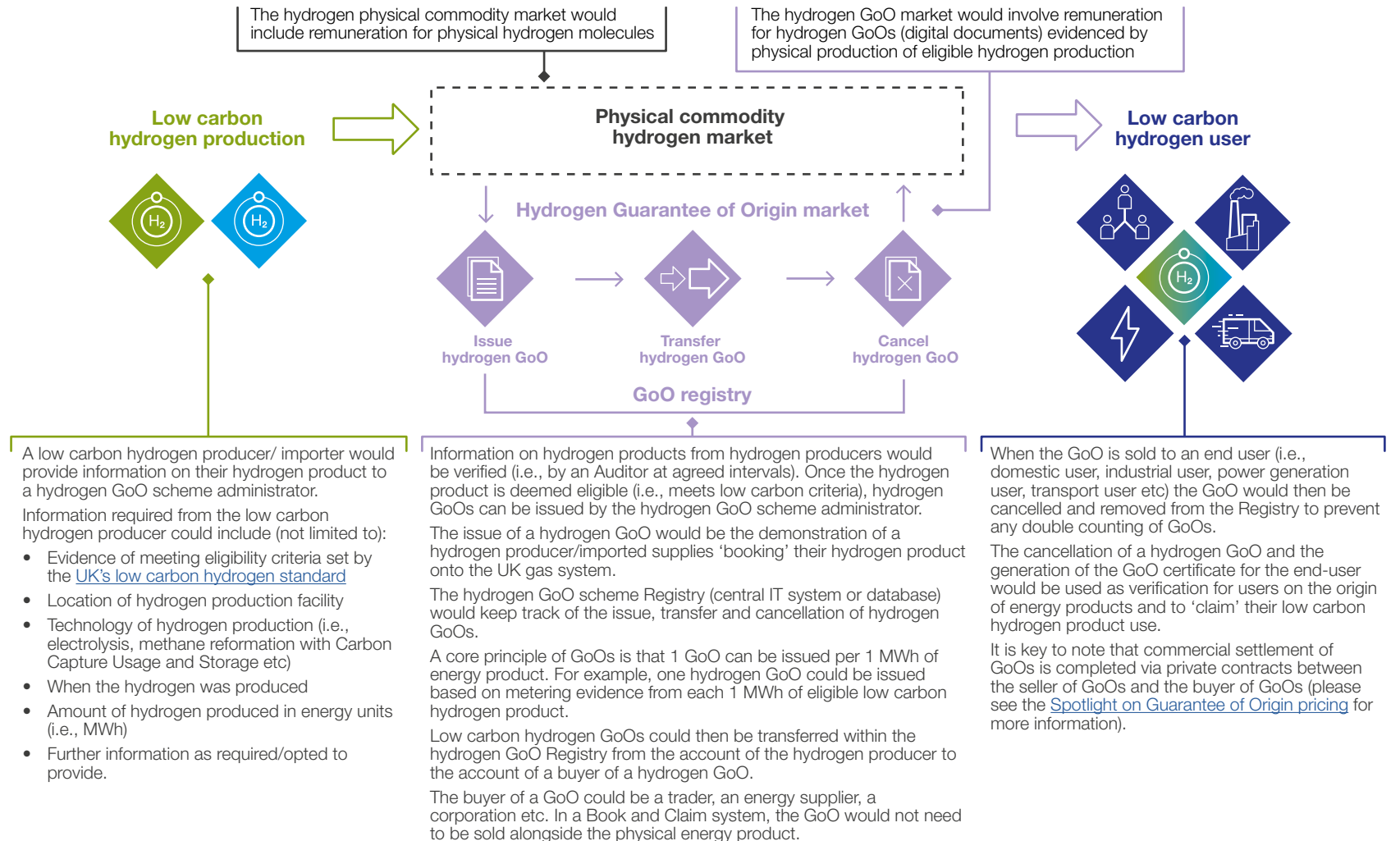
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Figure 4: (Simplified) Illustration of how a book and claim hydrogen Guarantee of Origin scheme could operate



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3a. Development of Guarantees of Origin in the EU

The following section outlines the development and current state of play of EU Guarantee of Origin schemes (in the EU, Guarantees of Origin are referred to as GOs). This section begins with policy direction on the development of gas GOs, and then dives into the detail of EU gas market groups and their role in the progress and current state of play of EU gas GO schemes.

3b. Policy direction on GOs in the EU

Renewable Energy Directive

Guarantees of Origin were first introduced and defined in the 2001 Renewable Energy Directive (RED). Since 2001 subsequent legislation has been developed to strengthen EU GO schemes. However, it is key to note that GO schemes in the European Union are all voluntary schemes, as GOs cannot be used to meet EU Member state compliance with renewable energy targets:

‘Guarantees of Origin ... have the sole function of showing to a final customer that a given share or quantity of energy was produced from renewable sources ... Guarantees of origin shall have no function in terms of a Member State’s compliance with Article 3 (ensuring that the share of energy from renewable sources in the Union’s gross final consumption of energy in 2030 is at least 32%) ([RED II](#))’

Below we have outlined the various iterations of the Renewable Energy Directive and definitions of GOs:



2001 Renewable Energy Directive (RED)

Summary of RED:

- The 2001 Renewable Energy Directive (RED) established an overall policy for the promotion of renewable energy sources in the EU. RED set out that all EU Member States should set national indicative targets for the consumption of renewable electricity.

RED and Guarantees of Origin:

- GOs were defined as a tool for producers of renewable electricity to document their renewable electricity production. Article 5 of RED outlines the eligibility criteria for RED recognised electricity GOs and also included a requirement that EU Member States should establish electricity Guarantee of Origin schemes that meet RED criteria.
 - UK Government established our [Renewable Energy Guarantee of Origin](#) (REGO) scheme for renewable electricity products in 2003 to be administered by Ofgem.

RED and hydrogen Guarantees of Origin:

- It is key to note that RED did not extend the definition of GOs to cover gases.

Guarantees of Origin were first introduced and defined in the 2001 Renewable Energy Directive (RED)

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2018 Renewable Energy Directive, recast (RED II)

Summary of RED II:

- The 2018 updated version of the Renewable Energy Directive provided a general framework for the promotion of renewable energy within the EU to ensure the achievement of meeting the binding EU target of achieving at least 32% renewable energy by 2030.

RED II and Guarantees of Origin:

- Article 19 of RED II sets out the eligibility criteria for Guarantees of Origin for renewable energy sources, including:
 - GOs should be issued in the standard size of 1 MWh and should be valid for 12 months after the physical energy production or cancelled after 18 months of energy delivery.
 - GOs should include information on:
 - > Energy source
 - > Location, type & capacity of energy production installation
 - > Whether installation benefited from support schemes (and if so, which)
 - > Date installation become operational
 - > Start and end dates of production
 - > Unique identification number
 - > Vector (electricity, gas) or whether it relates to heating/ cooling
 - > Meet CEN 16325 standard
 - GOs should be issued, transferred and cancelled electronically, and must be accurate, reliable and fraud resistant.
 - GOs should be issued to renewable energy sources (GOs for non-renewable energy sources can be arranged on a Member State basis)
 - Renewable gases can also be eligible for GOs: 'Guarantees of Origin currently in place for renewable electricity should be extended to cover renewable gases.'

RED II and hydrogen Guarantees of Origin:

- While RED II does include the provision to extend GOs for renewable gases, it is key to note there remain unresolved challenges before a RED II eligible gas GO scheme (including for hydrogen) can be implemented, including:
 - A key area in progress is the revision of the [CEN standard 16325](#) for application to gas GOs, this is the standard that gas GOs must adhere to for RED II compliance. The revised standard is yet to be issued.
 - Only hydrogen produced by renewables (i.e., green hydrogen) would be recognised by RED II, where the development of a GO scheme for low carbon hydrogen products (such as blue hydrogen) would be optional for EU Member States. This could risk fragmenting the EU hydrogen GO market if different GO schemes for low carbon hydrogen products emerged across the EU.

Revision to the Renewable Energy Directive (RED III) as part of the 2021 'Fit for 55' package (proposal for an updated Renewable Energy Directive – RED III)

Summary of (proposed) RED III:

- In 2021 the European Commission proposed the 'Fit for 55' package. 'Fit for 55' includes a targeted revision of the (recast) Renewable Energy Directive (RED II), including the ambition to increase the target (from 32%) to achieving 40% overall renewable energy in the EU by 2030.
- The Fit for 55 package has been presented to the European Parliament and Council for consideration for implementation into law.

While RED II does include the provision to extend GOs for renewable gases, it is key to note there remain unresolved challenges before a RED II eligible gas GO scheme can be implemented

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(Proposed) RED III and hydrogen Guarantees of Origin:

- RED III includes proposals for new rules for renewable fuel certification and traceability.
 - [Article 31a of RED III](#) extends the scope of the RED II [Union Database](#) (a monitoring and reporting tool) to trace the production of liquid and gaseous low carbon and renewable fuels (including hydrogen) as well as their life-cycle emissions. This is key, as [RED III proposals for the Union Database](#) therefore aim to combine the purpose of GOs and PoCs* into a single system for all (renewable and low carbon) energy vectors.

Finally, it is key to note the EU no longer recognises GOs issued in non-Member states.

At the end of the BREXIT implementation period (31/12/2020), the EU no longer accepted UK GOs (although the [UK does currently accept EU GOs](#)). The EU will only accept GOs issued by a third country if the following conditions are met:

- GOs meet RED eligibility criteria
- Mutual recognition of agreement of GOs issued in the Union
- Where there is direct import or export of energy.

3c. EU gas market role in accelerating GOs in the EU

The following section provides detail of EU gas market groups and their role in the progress and current state of play of EU gas GO schemes.

European National Transmission System Operators Gas (ENTSO-G) on hydrogen Guarantees of Origin

The purpose of the [European National Transmission System Operators Gas \(ENTSO-G\)](#) is to facilitate cooperation between national gas transmission system operators to achieve EU energy goals. ENTSOG currently has 45 gas transmission system operator members, as well as several associated partners and observers.

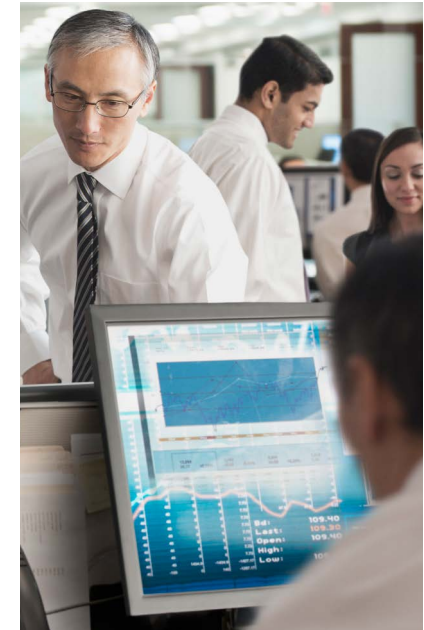
Since 2018 ENTSOG and GIE (Gas Infrastructure Europe) have been co-chairing a [Prime Movers Group focused on Guarantees of Origin \(GO\) and certification](#). Common goals from the Prime Movers Group for GOs include:

- Development of a pan-European GO system for renewable and low carbon energy products
- Aim for GOs to be easily transferable between energy carriers and between borders
- Aim for gas GOs to be compatible with the EU ETS.

Through the Prime Movers Group on GOs, a series of recommendations for an optimal GO system design has been developed. Going forwards, this work will continue with the aim to establish a robust pan-European GO system, including for renewable and low carbon hydrogen products.

European Federation of Energy Traders (EFET) on hydrogen Guarantees of Origin

The mission of the [European Federation of Energy Traders \(EFET\)](#) is to 'promote competition, transparency, and open access in the European energy sector', including the power, gas, and carbon markets. EFET represents over 100 energy trading companies from 27 EU countries.



* It is key to note that in the EU there are a range of different (voluntary) climate value market mechanisms that perform different functions. While Guarantees of Origin (GOs) document the production of renewable energy, there are also Proof of Sustainability (PoC) certificates that document sustainability information (i.e., emissions) of energy products.

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EFET has been exploring the potential for gas GOs for several years through a series of workstreams. While EFET's views are continually evolving as the gas GO space emerges, recent key messages on GOs from a [position paper](#) developed in response to revisions to RED II include 'Harmonised EU-wide rules should be developed for the issue, use and cancellation of GOs for the power and gas sectors.'

Association of Issuing Bodies (AIB) on Hydrogen Guarantees of Origin

The purpose of the [Association of Issuing Bodies](#) (AIB) is 'to develop, use and promote standardised certification system for all energy carriers, through the European Energy Certificate System (EECS)'. The role of AIB is to facilitate the link between national registries for GOs, where the AIB hub enables the transferral and tracking of GOs (transferred as EECS) between registries (please see Figure 5 below for an example of an EECS certificate). AIB's members currently include the administrators for GO schemes in 28 countries.

Reflecting RED (I) requirements, the AIB EECS system was designed to facilitate cross-border trade of electricity GOs. However the EECS system is a flexible framework suitable for multiple energy carriers, including GOs for gas.

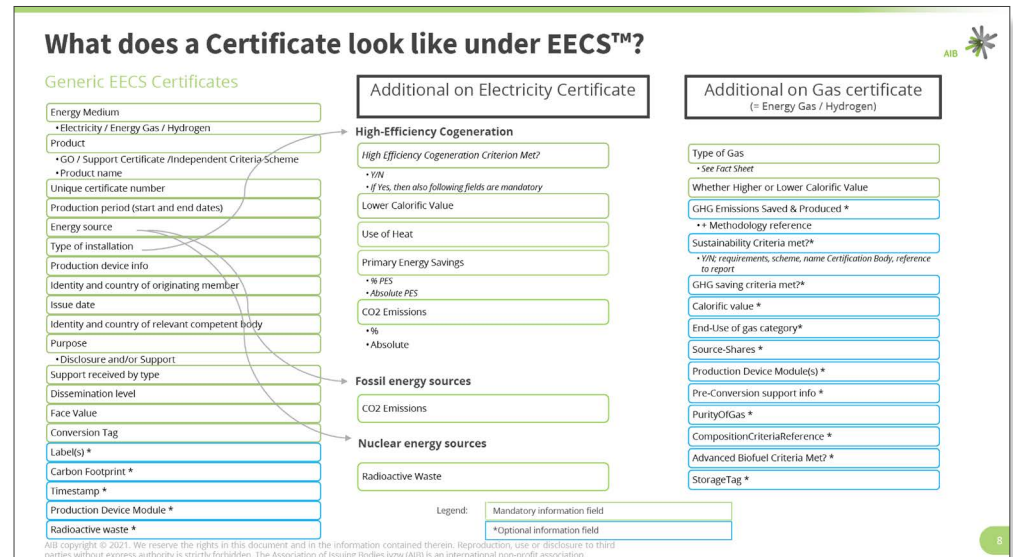
AIB is currently involved in several projects exploring the integration of gas (including hydrogen) GOs within the EECS cross-border trade system, including:

- [REGATRACE](#) (Renewable Gas TRADE Centre in Europe): The REGATRACE project is exploring the coordination between electricity, renewable gas and hydrogen GO systems. AIB is leading a work package that includes exploring the challenges associated with GO energy carrier conversion, to feed into the development of harmonised rules for GO energy carrier conversion to enable cross-border trade.

- [CertifHy](#): AIB aims to integrate CertifHy (please see the Spotlight on CertifHy below) as an Independent Criteria Scheme within the EECS gas scheme to facilitate cross-border hydrogen GO trade.

Please note, the interaction between the AIB EECS scheme and the proposed Union Database role in RED III is as yet undefined.

Figure 5: Generic EECS certificate



A helpful analogy for how the AIB GO trading hub works, is to consider buying a can of Coca Cola in a different country. Even though the language may be different, the label on the can of Coca Cola will still contain the same information, in the same format (i.e., ingredients, calories etc).

Within the AIB GO trading hub, the EECS system functions in a similar manner, where information on energy products (GOs) from different countries is packaged into the same format (EECS) to facilitate cross-border trade through providing a uniform product.

Spotlight on CertifHy

The **CertifHy** project is an EU Commission funded project tasked with designing the first EU-wide Guarantee of Origin system for hydrogen. CertifHy brought together a range of stakeholders to explore the development of a common European-wide certification scheme and a roadmap for implementation. CertifHy was founded in 2014 and has been progressed through three work packages:

Phase 1: Definition of an EU hydrogen Guarantee of Origin

In the first phase of the project, CertifHy set criteria that would define which hydrogen products could be eligible to join the CertifHy hydrogen GO scheme. In addition, the CertifHy scheme developed a labelling system to differentiate hydrogen GOs based on fuel input, including:

- Renewable energy input into hydrogen products (such as electrolyzers connected to renewable electricity generation) would be labelled with a CertifHy green hydrogen label
- Non-renewable energy input into hydrogen products (such as natural gas reformation with carbon capture utilisation and storage - CCUS) would be labelled with a CertifHy low carbon hydrogen label.

For any hydrogen producer to claim a CertifHy Green or CertifHy Low Carbon label in addition to the GO, the hydrogen producer must be able to demonstrate that the greenhouse gas emission content of their product is less than 60% of the benchmark emission level. The benchmark emission level is defined as the production of hydrogen through steam reformation of natural gas (without CCUS), set at the current GHG footprint of 91g CO₂eq / MJ. The demonstration of emission reduction must be shown over a period of at least 12 months to avoid “opportunistic approaches” and improve the overall acceptability of the hydrogen GO labelling system.

Phase 2: Designing a EU hydrogen Guarantee of Origin scheme

In its second phase, CertifHy finalised the EU hydrogen GO design. This included developing the processes and procedures for issuing, transferring, and cancelling EU hydrogen GOs, as well as developing a methodology tool to enable harmonised calculation of carbon emissions from hydrogen products (please see Figure 6 below for an overview of the CertifHy steps of certification for the hydrogen GO scheme).

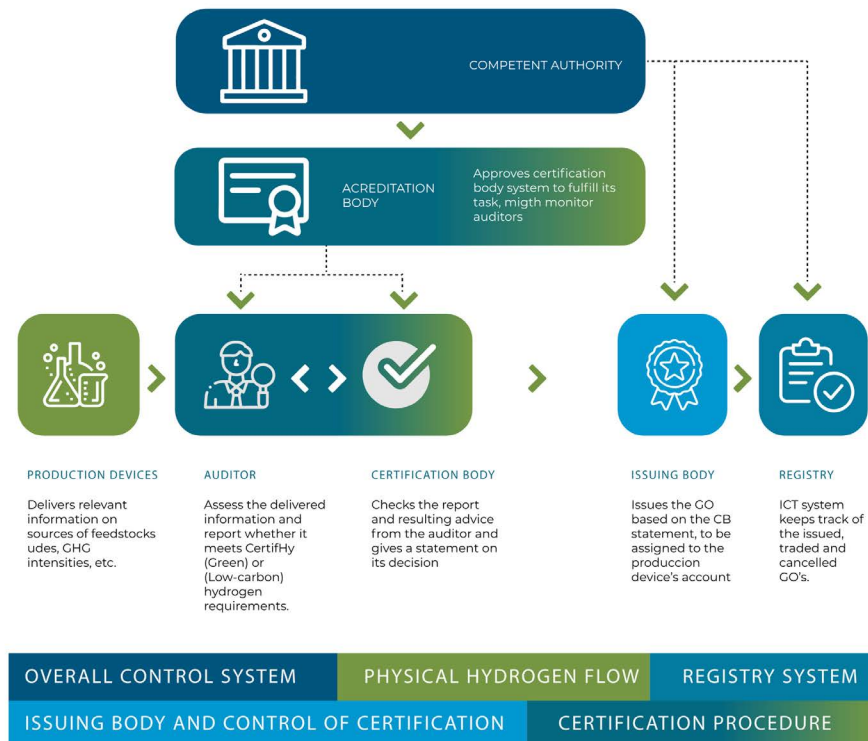
CertifHy also developed a pilot scheme including four hydrogen production plants to demonstrate different hydrogen production pathways and test their interaction with the CertifHy GO scheme, including testing the functionality of issuing, transferring and cancellation GOs on the CertifHy system.

Phase 3: Preparing for EU-wide deployment

The third and ongoing stage of CertifHy is focused on preparing for and accelerating the EU wide deployment of the CertifHy hydrogen GO scheme. This includes liaising and aligning the CertifHy hydrogen GO scheme with existing EU regulation, codes and standards for existing GO and wider certification schemes.

It is key to note that CertifHy is a non-governmental certification scheme, and solely aims to facilitate the implementation of hydrogen GO schemes into EU Member States without a hydrogen GO scheme in place, similarly to how [The International REC \(Renewable Energy Certificate\) Standard](#) scheme facilitates harmonised energy tracking systems in countries without low carbon energy product certification schemes.

Figure 6: **CertifHy** GO steps of certification



CertifHy scheme developed a labelling system to differentiate hydrogen GOs based on fuel input

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3d. Development of Guarantees of Origin in the UK

The following section outlines the development and current state of play of UK Guarantee of Origin schemes. This section begins with outlining existing UK climate value market mechanisms, followed by UK Government policy direction on GoOs, and then details recent progress and potential future development of gas GoO schemes in the UK.

3e. Existing UK climate value market mechanisms

To begin with, it is important to differentiate Guarantees of Origin from other instruments available in the UK market to assign climate value to energy products (Figure 7).

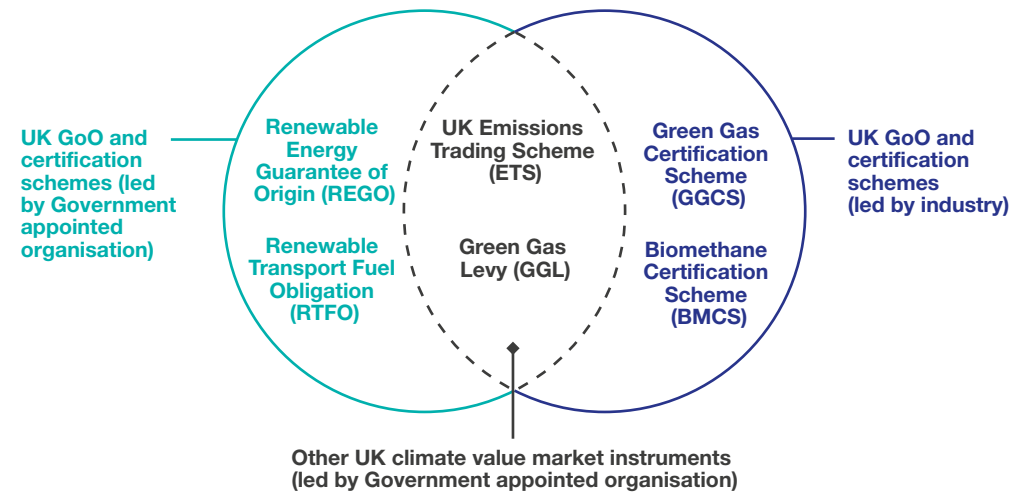
Renewable Energy Guarantees of Origin (REGO)

- Guarantees of Origin were first defined in the EU 2001 Renewable Energy Directive, this legislation required all EU member states to have an electricity Guarantee of Origin scheme. The UK version is called the Renewable Energy Guarantee of Origin (REGO) scheme.
- Ofgem administers the scheme, where 1 REGO certificate is issued per megawatt hour (MWh) of eligible renewable electricity.
- The purpose of the REGO scheme is to prove to a final customer that a given share of electricity was produced from renewable sources (please see the [Spotlight on REGOs](#) below for more information).

Renewable Transport Fuel Obligation (RTFO)

- Under the RTFO suppliers of transport and non-road mobile machinery fuel in the UK must be able to show that a percentage of the fuel they supply comes from renewable and sustainable sources.
- Obligated suppliers may meet their obligation by redeeming Renewable Transport Fuel Certificates (RTFC). One RTFC may be claimed for every litre of eligible sustainable renewable fuel supplied.

Figure 7: Range of climate value market mechanisms in the UK



UK Emissions Trading Scheme (UK ETS)

- The UK Emissions Trading Scheme replaced the UK's participation in the EU Emissions Trading Scheme on 1 January 2021.
- The UK ETS works on a 'cap and trade' principle, a cap is set on the total amount of certain greenhouse gases that can be emitted by sectors covered by the scheme and the emissions cap will decrease over time (sectors that must be compliant with the UK ETS include energy intensive industries, power generation and aviation).
- Within the emissions cap, sectors covered by the scheme receive free allowances and the ability to buy emission allowances and trade with other scheme participants as needed.

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Green Gas Levy (GGL)

- The Green Gas Levy (GGL) applies to licensed fossil fuel gas suppliers in Great Britain, and involves a requirement to make a quarterly levy payment to fund the GGSS (Green Gas Support Scheme).
- The GGSS is a Government scheme that provides financial incentives for new biomethane plants to increase biomethane supplies in the gas networks.
- Exemptions are available to suppliers who can evidence they have provided at least 95% certified biomethane (see below for eligible certified biomethane products).

Certified biomethane schemes

- [Green Gas Certification Scheme](#) (GGCS)
 - The Green Gas Certification Scheme (GGCS) issues, transfers and retires (biomethane) Renewable Gas Guarantees of Origin (RGGOs).
 - (Please see the [Spotlight on the Green Gas Certification Scheme](#) below for more information).
- [Biomethane Certification Scheme](#) (BMCS)
 - The BMCS provides a process for certifying biomethane products injected into the gas networks, or liquified/compressed for use as transport fuel.
 - BMCS provides a trading platform to trade certificates for certified biomethane products.

The above (not comprehensive) overview provides an indication of the wide range of existing UK climate value market mechanisms. It is also key to note that the interaction between these mechanisms is not streamlined.

To provide an example, **Renewable Gas Guarantees of Origin (RGGOs) from the GGCS can be used for the purposes of:**

- Consumer disclosure
- Evidence for exemption to the Green Gas Levy (GGL)
- Evidence for compliance with the [Bus Service Operators Grant](#)
- Evidence for (some sections of) the [Green House Gas \(GHG\) protocol](#)

RGGOs from the GGCS cannot be used for:

- Evidence for compliance with UK Emissions Trading Scheme (ETS)
- Evidence for compliance with the Renewable Transport Fuel Obligation (RTFO).

Because the UK climate value market is not streamlined, this can lead to risks of increased administrative burden and complexity for market participants to comply with the various schemes, risks of reduced efficiency of interaction between climate value schemes, and risks of missed opportunities to engage consumers that in turn play a key role in providing market pull forces for low carbon energy products.

It is also key to note that none of the above instruments include a gas GoO or certification scheme led by a UK Government recognised organisation, they are all industry led.

This Hydrogen GMaP project explored the role a hydrogen GoO scheme could play in driving a UK hydrogen market, and how the development of a UK hydrogen GoO scheme could interact with existing UK climate value market mechanisms.



Spotlight on the UK Renewable Energy Guarantee of Origin (REGO) scheme

Development of REGO scheme

UK electricity GoOs are referred to as Renewable Energy Guarantees of Origin (REGOs). REGOs were first introduced in the UK in 2003 to achieve compliance with the EU Renewable Energy Directive (RED), in a scheme administered by Ofgem on behalf of UK Government (for more detailed information on the REGO scheme, please visit the [Ofgem website](#)).

The primary use of REGOs in Great Britain and Northern Ireland is for [Fuel Mix Disclosure](#) (FMD). FMD requires electricity suppliers in Great Britain to disclose the mix of fuels used to generate electricity annually (please note, Ofgem administers REGOs on behalf of Northern Ireland via an agency service agreement). In order for electricity suppliers to offer 'green' or 'renewable' electricity tariffs to consumers, electricity suppliers must provide evidence that the electricity has come from renewable sources ([Electricity Supplier License Condition, 21D](#)). To prove that electricity has come from renewable sources, electricity suppliers use the REGO scheme. REGOs are issued for every 1 MWh of eligible renewable electricity production and are matched with the energy consumed by consumers in a retrospective, average, annualised process.

Criticism of the REGO scheme

100% 'Green' electricity tariffs, backed up and evidenced by REGOs, can be seen as an easy step for consumers to make to reduce emissions and demonstrate a commitment to decarbonisation. Green tariffs have become the most common type of electricity tariff offered to electricity consumers in Great Britain, and green electricity tariffs have in recent years converged with prices of standard electricity tariffs.

There is increasing criticism on the transparency of green electricity tariffs amidst growing concerns of 'greenwashing'. [Greenwashing](#) involves overemphasising a company's environmental credentials through misinformation (for more information on the distinction between the role of GoOs and greenwashing, please see the [spotlight on greenwashing](#) below).

UK Government made a commitment in the [2020 Energy White Paper](#) to 'ensure consumers are provided with more transparent and accurate information on carbon content when they are choosing their energy services and products.' Considering this commitment, and in order to explore the concerns outlined above, UK Government issued a Call for Evidence on [Designing a Framework for Transparency of Carbon Content in Energy Products](#) to begin a dialogue on the future of consumer energy tariffs.

The above Call for Evidence explored the challenges associated with the existing 'green' electricity tariff framework, whether a more transparent framework is needed, and how a more transparent framework for green electricity tariffs could be designed. The Call for Evidence also considered whether a smarter system is needed to better reflect the current physical realities of the UK's energy system and how energy frameworks may need to evolve considering the UK's net zero targets. The outputs from this Call for Evidence will help to inform future policy decisions on enabling consumers to make informed choices on energy services and products, including the role of GoOs. The UK Government response to industry views on this Call for Evidence is expected in 2022.

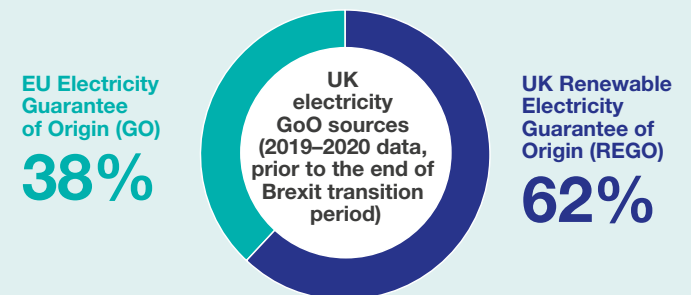
Brexit and REGOs

At the end of the Brexit transition period on the 31st of December 2020, EU Member States no longer recognised UK Guarantees of Origin (neither gas nor electricity). As set out in the (recast) [Renewable Energy Directive \(RED II\)](#), EU Member States will not recognise GoOs issued by a Third Country, unless certain conditions are met including:

- Mutual recognition of agreement on guarantees of origin issued in the Union and compatible guarantees of origin systems established in the third country
- Where there is direct import or export of energy.

However, the UK Government has permitted GOs from the EU to continue to be accepted in the UK, post the Brexit transition period. This is an important point, as pre-Brexit data indicates UK electricity suppliers imported a significant proportion of electricity GOs from the EU (please see Figure 8).

Figure 8: UK sources of Electricity Guarantees of Origin Q2 2019 – Q1 2020 (Greenfact)

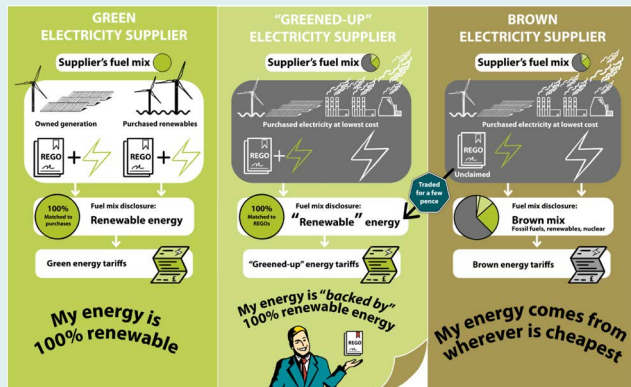


The UK Government has indicated they intend to review the existing GoO arrangement with the EU ([Ofgem website](#)), so that in the longer term, 'domestic recognition of Guarantees of Origin issued in EU countries will take place only on a reciprocal basis.' It is important to emphasise that a decision on cross-border trade of GoOs is yet to be made, and the future of GoO trade between the EU and UK remains uncertain. [UK Government](#) has specified that 'any changes to the use of REGO certificates or changes to the relevant legislation will be consulted on at the appropriate time.'

Spotlight on ‘Greenwashing’ and distinguishing the role of Guarantees of Origin

The definition of ‘Greenwashing’ involves overemphasising a company’s environmental credentials, through misinformation or understating harmful activity (Good Energy). Currently there are ‘greenwashing’ criticisms that electricity suppliers can offer electricity tariffs as ‘100% renewable’ by purchasing GoOs, without directly purchasing renewable energy (please see figure 9, sourced from Regen).

Figure 9: Greenwashing of electricity tariffs (Regen)



As illustrated, electricity suppliers can purchase REGOs (Renewable Energy Guarantees of Origin) without purchasing the electricity the REGOs represent.

If electricity suppliers then purchase electricity from the wholesale market (an anonymous mix of fossil, renewable and nuclear generated power), then the use of REGOs could make an electricity tariff look ‘green’, even if the supplier did not seek to purchase any renewable electricity itself.

There are concerns that the development of a hydrogen GoO scheme could draw similar ‘greenwashing’ criticisms.

To mitigate consumer mistrust of the use of GoOs and to distinguish the role of GoOs from criticisms of greenwashing, it is key to be clear on what a GoO is, and what a GoO is not:

What the role of a GoO is:



GoOs provide information on the origin of energy products.

For example, 1 hydrogen GoO would be issued based on metering evidence from the production of 1MWh of low carbon hydrogen production.

GoOs entitle consumers to be the only entity to claim the use of a specific MWh of energy product.

GoOs can be traded separately to the physical commodity it represents (book and claim GoO system).

What the role of a GoO is not:



Purchasing GoOs does not influence the energy consumers receive at their meters.

This is because it is impossible to track where molecules or electrons go, once injected into the gas or electricity system.

Even if GoOs are purchased along with the physical energy it represents (i.e., mass balancing), this does not mean consumers will receive the energy represented by the GoO, as it is impossible to trace where molecules or electrons go once injected into the gas or electricity systems.

Undoubtedly, further work is needed to ensure energy tariffs are messaged and promoted to consumers in a way that makes the role GoOs play in energy tariffs clear. For example, consumers should have access to clear information on how energy tariffs work, both currently (i.e., green tariffs work today by matching on a retrospective average annualised basis, where suppliers look at how much energy a consumer used in the previous year, and ‘match’ this with renewable energy generated in the previous year with the equivalent GoOs) and how they might change (i.e., the potential to design energy tariffs to better reflect the physical realities of the energy system through temporal and geographic considerations).

However, it must be emphasised that the function of GoOs is to provide information on the origin of energy products and to enable consumers to verify claims of low carbon energy product use. GoOs can provide benefits to all market participants and have clear role in accelerating a low carbon energy market (please see [Section 4](#) for more details).

Emphasis must be placed on demonstrating that GoOs are used within robust frameworks free from double-counting, as well as ensuring that the role of GoOs in evidencing energy tariffs and other climate value market mechanisms is messaged clearly to address concerns of ‘greenwashing’.

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3f. UK progress in the gas Guarantee of Origin landscape

Previously published (March 2021) UK Government insight on the role of gas Guarantees of Origin from [the Government response to consultations on the Green Gas Levy](#) included:

- The Government will not be requiring gas Guarantees of Origin for the GGSS (Green Gas Support Scheme)
- The current market for gas certificates (i.e., gas Guarantees of Origin) is not very liquid and there is limited price transparency
- Prices (for gas Guarantees of Origin) are still too low and too volatile to materially impact investment decisions at the moment
- Not having a RED II compliant scheme means that UK plants will not be able to sell green gas certificates to EU buyers.

However, there are two well-established UK gas certification schemes for biomethane energy products including the [Green Gas Certification Scheme](#) (GGCS) (please see the Spotlight below for more information) and the [Biomethane Certification Scheme](#) (BMCS) independently run by industry. The lack of Government intervention for the development of these schemes reflects the importance UK market participant's place on the ability to use certification (i.e., GoO) schemes for low carbon gases to:

- Verify the origin of low carbon gases injected into the gas networks
- Enable consumers to make claims of low carbon gas consumption
- Enable low carbon gas producers to associate a premium for the climate value of low carbon gases.

More recent developments (December 2021) from Government on the Green Gas Levy (GGL) included [a published list](#) of “approved biomethane certification schemes” that gas suppliers can use as evidence they have provided at least 95% biomethane (these approved schemes include the [Green Gas Certification Scheme](#) – GGCS and the [Biomethane Certification scheme](#) – BMCS).

While the GGCS and BMCS are not formally Government recognised/backed gas GoO schemes, it is important to note that this recent update does mean the industry led UK biomethane schemes have become legally recognised by Government to fulfill specific functions.



Spotlight on the Green Gas Certification Scheme

The [Green Gas Certification Scheme \(GGCS\)](#) issues, transfers and retires Renewable Gas Guarantees of Origin (RGGOs) that represent biomethane production in the UK. The GGCS is run by Renewable Energy Assurance Ltd, a subsidiary of the Association for Renewable Energy and Clean Technology.

GGCS membership includes producers accounting for approximately 80% of all biomethane injected into the UK's gas networks ([GGCS 2020–2021 report](#)).

How the Green Gas Certification Scheme works

1. A biomethane producer provides information to the GGCS on biomethane injected into the gas network each quarter and for each eligible kWh a Renewable Gas Guarantee of Origin (RGGO) is issued. The RGGO contains information on (not an exhaustive list):
 - i. Identity of producer
 - ii. Location of producer
 - iii. Production technology e.g. Anaerobic Digestion,
 - iv. Biomass used e.g. waste or product (crop)
 - v. When the gas was injected
2. Biomethane producers enter agreements with traders and transfer their RGGOs to accounts operated by those counterparties. Transfers are executed and recorded in an electronic database.
3. Traders can exchange RGGOs between accounts according to the agreements they arrange.
4. Trader agree to sell RGGOs to gas consumers and allocate the RGGOs to them. At the point a RGGO is allocated to a consumer it is retired and can no longer be traded or allocated to any other consumer.
5. Gas consumers are provided with an electronic Retirement Statement which shows that they have been allocated RGGOs.

Payment for RGGOs

It is key to note that the GGCS are solely the administrators of the RGGO registry and are not involved in the commercial (buying and selling) aspects of the RGGO market. The GGCS charges membership fees and a retirement fee per MWh of RGGO.

Payments for RGGOs are completed via private contracts between counterparties (i.e., between producers and traders, traders and traders and traders and consumers). There is no regulated price for RGGOs (or any GoO for that matter), GoOs are traded in a market where buyers and sellers associate the premium for the certificate (please see the [spotlight on Guarantee of Origin pricing](#) for more information).

In the RGGO market, data on RGGO pricing taken from independent anonymous surveys indicates there is a higher premium for waste-based biomethane products and a lower premium on crop-based biomethane products.

Consumer assurance

When consumers are allocated RGGOs it is their guarantee that the kWh's of green gas being represented have not been sold to anyone else (i.e., no double counting) and that they are the only entity who can claim to have been supplied those kWh of biomethane. They are also assured that RGGOs represent gas that has met the GGCS rules i.e. made with a renewable feedstock and having a lower carbon impact than its fossil equivalent. The retirement statement may also indicate that further criteria may have been met such as non-domestic renewable heat incentive sustainability criteria.



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3g. Future of UK gas Guarantees of Origin

Recent and upcoming UK Government publications could change the dial on the future role and recognition of gas Guarantees of Origin in the UK. Two fundamental recent documents include:

Government 2021 Call for Evidence: Designing a Framework for Transparency of Carbon Content in Energy Products

Background to Call for Evidence

Green electricity tariffs have played a hugely important role in the acceleration of the Renewable Energy Guarantee of Origin (REGO) market. When REGOs were first implemented in 2003 ([UKSI](#)), the costs for REGOs were high, and this premium was reflected within green electricity tariffs. However, now the premium for green electricity tariffs has all but disappeared, and there are concerns this is in part due to the falling price of REGOs (along with other factors, including the falling prices of renewable electricity generation).

Green electricity tariffs are seen as an easy step for households to take on the road to decarbonisation, and it is positive to see how much the market and consumer demand for these products has grown. However, there are growing concerns on the transparency of green electricity tariffs and criticisms of 'greenwashing.'

In the 2020 [Energy White Paper](#), Government committed to 'consumers [being] provided with more transparent and accurate information on carbon content when they are choosing their energy services and products', resulting in this Call for Evidence in 2021.

* Key to note, sale prices achieved for REGOs have [increased dramatically](#) from Q3 2021, reflecting that REGO pricing will vary with market forces including demand and supply of REGOs as well as influences from the global market.

Purpose of Call for Evidence

The purpose of this Call for Evidence included to:

- Explore challenges from the role green electricity tariffs play in providing consumers with information on carbon content of energy products
- Seek views and evidence from industry on whether a more transparent (regulatory) framework for carbon content of energy services for consumers is needed, and how such a framework could be designed.

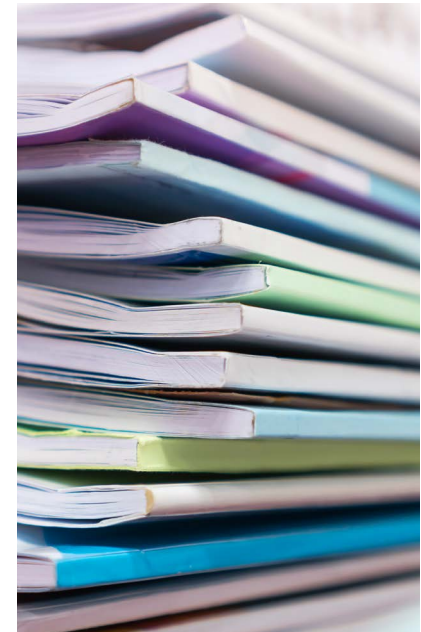
How the Call for Evidence could play a role in shaping the future of UK hydrogen Guarantees of Origin

The focus on green electricity tariffs in this Call for Evidence reflects the current high penetration of renewable electricity, and low penetration of renewable gases in the UK's energy system. For example:

- Renewable electricity currently accounts for 40% of electricity generation in the UK (up from 7% in 2010). When REGOs were first introduced, renewable electricity only made up 2% of the electricity mix ([Call for Evidence](#))
- There are currently approximately 109 biomethane producers connected to gas networks in Great Britain, generating enough biomethane to heat 750,000 homes ([ENA](#))
- Hydrogen accounts for 0% of gas within the UK gas networks (Gas Safety (Management) Regulations limits H2 content to 0.1%) ([GS\(M\)R Schedule 3](#)).

The Call for Evidence notes 'Currently, gas tariffs are not within scope of the green tariff regulatory framework and that suppliers are beginning to market their gas offer as 'green'. We (BEIS) request views and evidence as to whether we should include gas tariffs within the scope of our activity.'

As part of this Hydrogen GMaP project, we explored how a regulated 'green' gas tariff could have an important role in providing transparent information on carbon content to consumers. If 'green' gas tariffs were evidenced by gas



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GoOs in a similar manner to the use of REGOs for 'green' electricity tariffs, then 'green' gas tariffs could play a hugely important role in driving a UK hydrogen and biomethane GoO market. A regulated 'green' gas tariff is an untapped opportunity for the UK's gas industry.

The potential for Government intervention on the development of a regulated framework for gas tariffs would have important implications for the future role of hydrogen GoOs (please see [Section 5C](#) for more information on our recommendation to make UK hydrogen GoOs a statutory mechanism, with a legal basis for functions such as providing evidence to justify 'green' gas tariffs offered to gas consumers).

Government 2021 consultation: Designing a UK Low Carbon Hydrogen Standard

Background to consultation

The UK has set an ambition for 10GW of low carbon hydrogen production capacity by 2030 ([British energy security strategy, 2022](#)). There are different ways to produce hydrogen, and whether this hydrogen is low carbon or not depends on the energy inputs and technologies used. It will be essential to ensure the hydrogen being produced is sufficiently low carbon to help meet the UK's net zero goals.

Purpose of consultation

The aim of this BEIS consultation was to ensure any new low carbon hydrogen that Government supports is sufficiently low carbon to help the UK meet net zero targets. Through the consultation, BEIS sought views on design options for a standard that could define what low carbon hydrogen is, to underpin Government support for hydrogen production. Key requests for input from the consultation included:

- Scope of standard, including its use and coverage across different production methods and geographic location
- System boundary of the standard, chain of custody, purity and pressure, embodied emissions, and global warming potential factors

- Consideration of different primary energy inputs and feedstock emissions
- Greenhouse gas emission methodology and calculation considerations
- A threshold for greenhouse gas emissions
- Delivery and administration of a UK low carbon hydrogen standard.

Informed by responses to the consultation, Government expects future hydrogen producers seeking Government support to meet the resulting low carbon hydrogen standard.

How the consultation could shape the future of UK hydrogen Guarantees of Origin

This consultation is hugely important to a future UK hydrogen GoO scheme, as when considering the development of a hydrogen certification scheme Government expects to build on the principles set out in this standard.

For example, the consultation included that UK Government considered:

'Whether the low carbon hydrogen standard could be developed into a certification / guarantee of origin scheme to underpin deployment of low carbon hydrogen production, giving consumers confidence that the hydrogen they purchase is truly low carbon.'

Government response to consultation

In the response to the consultation, and set out in the [British energy security strategy](#), UK Government has committed to setting up a hydrogen certification scheme by 2025 to underpin deployment of low carbon hydrogen and support future international trade.

This is a very welcome output from the perspective of this Hydrogen GMaP project on hydrogen GoOs. We will await further engagement from Government on the costs, timeline and practical implementation of introducing a UK hydrogen certification scheme.



UK Government has committed to set up a hydrogen certification system by 2025

Section 4: Benefits from developing a UK hydrogen Guarantee of Origin Scheme

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This section explores the benefits that a hydrogen Guarantee of Origin scheme could provide to UK gas market participants including hydrogen producers, transporters, and consumers.

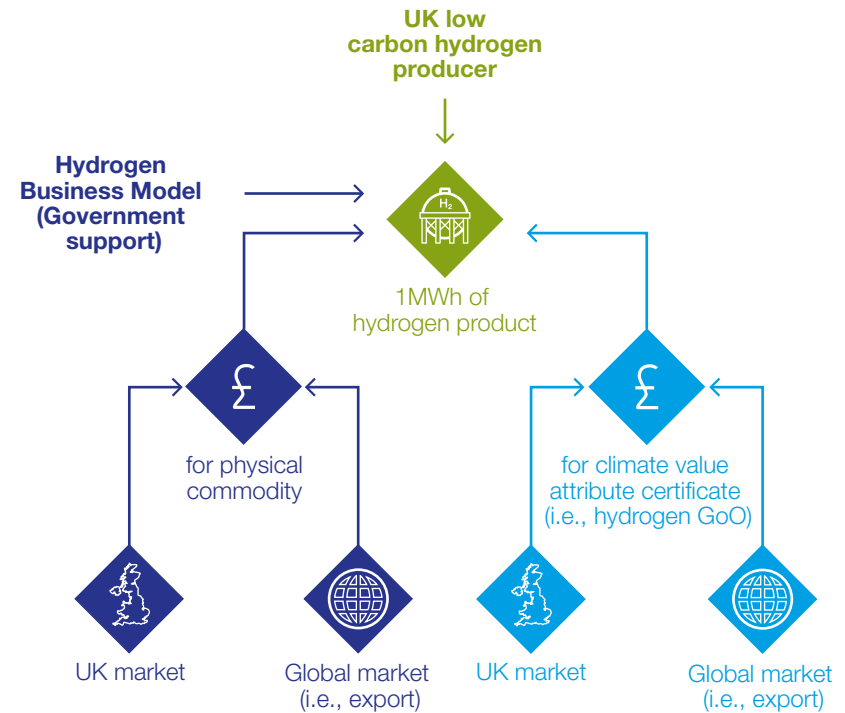
4a. Benefits of a UK hydrogen GoO scheme to hydrogen producers

Hydrogen GoOs could provide an additional revenue stream for hydrogen producers, to maximise the climate value attributes of their low carbon energy product.

Hydrogen GoOs, as illustrated in Figure 10, could be sold by hydrogen producers as a tradeable instrument independent from the physical hydrogen commodity. In this way, GoOs could generate an additional revenue stream for hydrogen producers, beyond remuneration for the sale of the physical hydrogen energy product.

The sale of hydrogen GoOs could also enable hydrogen producers to gain valuable information on consumer appetite for their product, which could provide evidence and positive market signals to justify expanding their hydrogen production facilities to meet consumer demand. In this manner, hydrogen GoOs can be seen as an important market mechanism to incentivise low carbon hydrogen production and thus support the UK's overarching goal of decarbonisation.

Figure 10: Hydrogen GoOs as an additional revenue stream for hydrogen producers



Ultimately, there is a need to support UK hydrogen producers.

A hydrogen GoO scheme could enable UK gas consumers (i.e., in addition to Government support for the hydrogen commodity through the [Hydrogen Business Model](#) mechanism) to generate an additional long-term revenue stream for low carbon hydrogen producers.

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It is key to emphasise that hydrogen GoOs could provide a market mechanism for low carbon hydrogen producers to gain a premium for their low carbon product, through the sale of GoO certificates. If decarbonisation is the key driver for developing a UK low carbon hydrogen industry, then it will be essential for hydrogen producers to gain a climate value for their product*.

Consider the scenario of hydrogen blending. When gas molecules are injected into the gas system, it is impossible to know where the molecules go and at consumer meters it is likewise impossible to differentiate the origin of gas molecules received. Therefore, without a system such as a GoO scheme, there would be no method to verify claims of low carbon hydrogen consumption, and no means to attribute an additional climate value of injecting (low carbon) hydrogen molecules into the existing (high carbon) natural gas network. It is likely that the establishment of a system such as a hydrogen GoO scheme will be essential to developing effective market mechanisms to incentivise the injection of hydrogen into the existing natural gas networks.

Even in the scenario of full (100%) hydrogen pipelines, a GoO scheme will be essential to differentiate and associate a climate value premium between different hydrogen products. Different hydrogen production technologies generate different emissions, therefore a system such as GoO scheme will be essential to attribute a climate value premium for the lowest emission hydrogen products.

In summary, a hydrogen GoO scheme could be used by hydrogen producers to trade the value of low carbon energy characteristics, generate price signals on low carbon energy products and provide signals for investment in developing further low carbon hydrogen production facilities.

* Key to note, a hydrogen GoO scheme alone would likely be insufficient to drive market behaviours to accelerate a UK hydrogen transition in the timescale required for achieving net zero targets. Intervention from a Government perspective is therefore likely required to support the development of a UK hydrogen market in the desired timeframe.

4b. Benefits of a UK Hydrogen GoO scheme to hydrogen transporters

A UK hydrogen GoO scheme could benefit hydrogen transporters such as networks, as GoOs enable virtual trade ahead of physical change.

To illustrate this point, we know that over [400](#) councils and cities in the UK have set ambitious carbon reduction targets, many setting targets for achieving carbon neutrality by 2030. For example, [Edinburgh council](#) set a target of achieving net zero by 2030, [London](#) aims to be a zero carbon city by 2030, and [Nottingham city](#) aims to be carbon neutral by 2028.

Considering the options that the above councils and cities have, electrification may seem the easiest method to reducing emissions and achieving net zero. For example, it is possible to buy and install solar panels and wind turbines today to generate renewable zero carbon electricity, with relative ease and minimal disruption to consumers.

However, a local low carbon gas option, such as hydrogen production, may not be so easy to deliver, even by 2030. As outlined in the Government's [UK Hydrogen Strategy](#), there are a range of challenges to overcome in order to produce and use hydrogen at scale in the UK. Challenges include the cost of hydrogen, technology uncertainty, policy and regulatory uncertainty, need for enabling infrastructure, need for supply and demand coordination, and the need for 'first of a kind' investment and deployment.

Near-term decarbonisation goals provide a key example of where hydrogen GoOs could support decarbonisation ambitions, by enabling virtual trade ahead of physical change. For example, consumers could procure hydrogen GoOs from hydrogen producers or suppliers injecting and blending hydrogen into the UK gas networks, even if the hydrogen producers are located geographically distant and the consumer is not receiving 100% hydrogen. By purchasing the hydrogen GoOs, the consumer would still be demonstrating their commitment to decarbonising.

Even in the scenario of full (100%) hydrogen pipelines, a GoO scheme will be essential to differentiate and associate a climate value premium between different hydrogen products

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For example, below we have illustrated a city in the Midlands with a 2030 net zero target. Figure 11 below illustrates the location of this example city in the Midlands in relation to (relevant to spring 2022 publication date) proposed large scale UK hydrogen production facilities (please note, this example is based on the assumption hydrogen blending is permitted within the UK gas networks).

Looking at Figure 11, it is clear to see the city in the Midlands is not located close to current planned significant sources of low carbon hydrogen production, limiting the ability for the city to directly connect to bulk hydrogen production and thereby decarbonise their gas consumption in time for their near-term (i.e., 2030) carbon zero target.

However, gas users within the Midland city could procure GoOs from hydrogen producers (located beyond the remit of the city) injecting and blending hydrogen into the UK's gas network system, and thereby demonstrate their commitment to decarbonise their gas use.

Through buying GoOs (please see Figure 12), gas users in the Midlands city could use a market mechanism to provide an additional revenue stream to support UK hydrogen producers, demonstrate their appetite for low carbon hydrogen products, which could in turn potentially justify the expansion of UK low carbon hydrogen production injecting hydrogen into the UK gas network.

Although buying hydrogen GoOs would not influence the physical delivery of hydrogen to gas users in the Midlands city (as it is impossible to trace molecules once injected into the gas system), hydrogen GoOs could provide an important mechanism for consumers in the city (that are not located close to hydrogen supplies) to reap the benefits of gas network decarbonisation, even if they are in a region that has not yet (100%) transitioned to hydrogen.

Figure 11: Map of example Midlands city in relation to proposed (large scale) UK hydrogen production*



* Please note, this figure is by no means an exhaustive illustration of potential UK hydrogen production, and is not drawn to scale

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Criticisms to the approach of buying hydrogen GoOs could include that gas consumers would not have to change their energy behaviour, i.e., consumption of gas. However, if consumers cannot use market mechanisms to demonstrate commitment to decarbonisation, what could be the potential time, cost, and disruption implications of waiting for 100% renewable physical energy delivery?

In summary, hydrogen transporters will play a key role in facilitating a UK hydrogen GoO market through connecting hydrogen producers to hydrogen consumers and enabling market participants to develop a GoO scheme to place additional value on low carbon hydrogen products injected into the gas system.

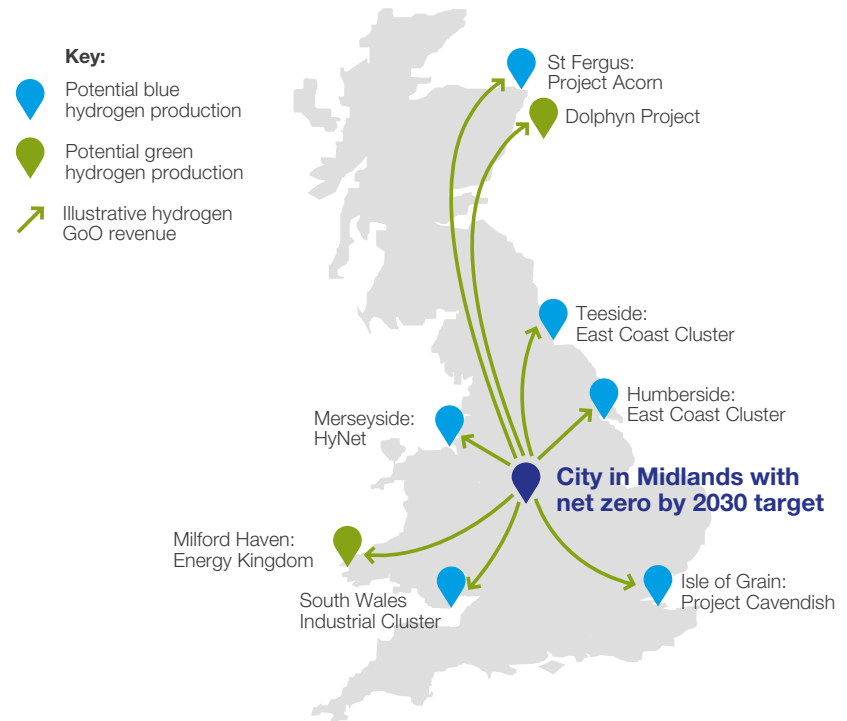
4c. Benefits of a UK hydrogen GoO scheme to hydrogen consumers

GoOs could be a key tool to empower consumers to engage in a UK hydrogen market, through enabling consumers to indicate their preference for hydrogen energy products.

Enabling consumers to purchase hydrogen GoOs would generate a market 'pull' force for low carbon hydrogen products. Consumers could then play an active role in contributing to further hydrogen production, through generating revenue for hydrogen producers achieved through the sale of hydrogen GoOs.

Shifting (some) of the costs of hydrogen production to energy consumers who actively wish to purchase hydrogen GoOs could also provide an efficient solution to driving down the costs of subsidisation for hydrogen products. This is an especially elegant solution when one considers that consumers could play a role in increasing low carbon hydrogen production (through buying hydrogen GoOs), without having to pay for the full amount of support needed to develop a nascent hydrogen market.

Figure 12: Illustrative view of GoO revenue to UK hydrogen producers*



* Please note, this figure is by no means an exhaustive illustration of potential UK hydrogen production, and is not drawn to scale

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To provide some helpful further context, we know that energy users in the UK consume significant quantities of gas. For example approximately 40% of power generation is fuelled by gas fired combined cycled generators ([Energy in Brief, 2021](#)) and 85% of households are connected to the gas networks for heat and cooking needs ([ENA](#)). Focusing on domestic energy consumers, domestic consumers use on average four times as much gas as electricity per annum ([UK power](#)).

As discussed previously, there are legal provisions in place enabling electricity suppliers to offer regulated 'green' electricity tariffs to electricity consumers. These tariffs are backed up by REGOs (Renewable Energy Guarantees of Origin) and are seen as an easy step for electricity consumers to take on the transition to decarbonisation. However, there is no regulated framework for 'green' gas tariffs.

As part of this Hydrogen GMaP project we recommended that a regulated framework for 'green' gas tariffs could help to put electricity and gas tariffs on equal footing and enable gas consumers to take an important step towards decarbonising their energy use. In a regulated framework, hydrogen GoOs could have a legal basis to be used as evidence for 'green' gas tariffs offered to consumers, in the same way REGOs are used to evidence 'green' electricity tariffs offered to consumers (please see [section 5D](#) for more details on our recommendation for the role of UK hydrogen GoOs within market frameworks).

However, even if no regulated framework were developed for 'green' gas tariffs, gas suppliers could still develop green gas energy products evidenced by hydrogen GoOs, in a similar manner to existing green gas products evidenced by biomethane RGGOs. It is key to note that the only difference between a regulated 'green' gas tariff versus a 'green' gas product is that the former is led by Government appointed organisations and the latter is led by industry. It would not negate the robustness of a hydrogen GoO scheme if hydrogen GoOs were led by industry, however it would mean that a hydrogen GoO market would be driven by market forces alone (as a voluntary mechanism), and

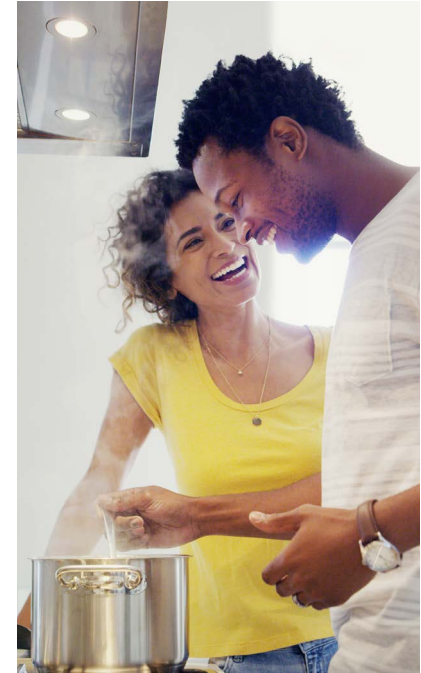
therefore less able to accelerate a hydrogen market at the rate required to deliver a 2050 net zero target, as well as raising risks of creating inefficiencies with interactions with the range of existing UK climate value market mechanisms, as well as the risk of missing opportunities to trade hydrogen GoOs with the EU and global market.

The ability for consumers to purchase 'green' gas tariffs or products evidenced by hydrogen GoOs (please see the spotlight below on GoO pricing) would enable gas consumers to have a route to engage in a UK hydrogen market and could provide many benefits to gas consumers including:

- Raise consumer awareness on low carbon hydrogen products
- Enable consumers to indicate their preference for specific low carbon hydrogen products
- Enable consumers to provide an additional revenue source for low carbon hydrogen producers, incentivising increased production of low carbon hydrogen
- Enable consumers to verify claims of hydrogen use and demonstrate commitment to decarbonise.
- Enable organisations to verify claims of hydrogen use to generate goods, using GoOs to evidence carbon reduction goals*
- Send market signals on consumer appetite for low carbon hydrogen products.

In summary, hydrogen GoOs could be used to evidence 'green' gas tariffs or products offered to consumers, enabling consumers to indicate their preference and verify claims of low carbon hydrogen use, thereby generating a market pull force for a UK low carbon hydrogen industry.

* There are clear examples of powerful initiatives resulting from the provision of carbon reduction information to end users. For example, [RE100](#) has brought together hundreds of businesses committed to 100% renewable electricity consumption, where the renewable electricity can be claimed through providing evidence of purchasing electricity Guarantees of Origin, including from the UK REGO scheme.





Spotlight on Guarantee of Origin pricing

Energy consumers pay for GoOs to match the volumes (i.e., MWhs) of energy consumed. For example, REGOs are issued per 1 MWh of eligible renewable electricity product, and are then matched with the electricity used by consumers in a retrospective, average, annualised process.

Currently, the UK GoO market can be described as an illiquid market. While there is a lot of demand for GoOs (both electricity and biomethane), the GoO market is illiquid because the risk of selling GoOs is asymmetric. Because energy suppliers do not want to be 'short', GoOs tend to be bought by market participants and held onto until needed. To provide a case study:

- There is a discrete amount REGOs (Renewable Energy Guarantees of Origin) backed up by compliant volumes of renewable electricity. Currently, energy suppliers purchase REGOs and keep them for the annual [Fuel Mix Disclosure](#) (FMD) process. The FMD is where suppliers are required to disclose to their customers the mix of fuels in their fuel supply (i.e., nuclear, gas fired, renewable etc). Electricity suppliers do not want to be 'short' on REGOs (i.e., where consumers use more electricity than suppliers have REGOs to match with), as insufficient REGOs would mean electricity suppliers would not be able to offer 'green' or '100% renewable' electricity tariffs to consumers.

Currently, the pricing of GoOs is not transparent or well reported. The only means to ascertain prices of GoO transactions is through anonymous price reporting surveys, such as through Cornwall Insights. Insight from industry reporting indicates:

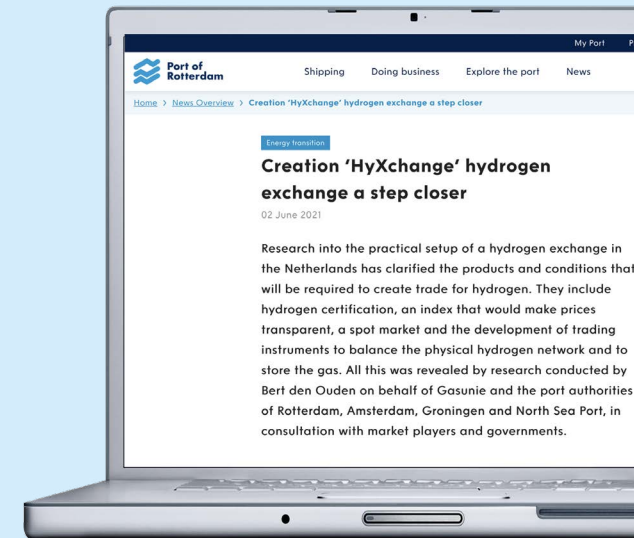
- In the case of REGOs, renewable technologies (wind, solar, hydro) typically achieve the highest REGO values ([Cornwall Insights](#)). REGO pricing tends to be based on different merit orders including:
 - Highest premium: Electricity produced from renewable sources (unfuelled REGOs)
 - Lower premium: Electricity produced from biomass/ landfill gasses (fuelled REGOs)
- In the case of GoOs for biomethane products (i.e., industry led schemes), biomethane produced from waste (i.e., food or agricultural) typically achieve the highest premium ([Green Gas Certification Scheme](#)). Biomethane GoO pricing tends to be based on different premiums associated with different feedstocks including:
 - Highest premium: waste based biomethane production
 - Lower premium: Energy crop based biomethane production (i.e., energy crops grown for the purpose of green gas production).

Naturally, the price of GoOs corresponds with ever changing supply and demand levels as well as influences from the global market. To find further information on current prices for GoOs, the following organisations have a range of market information: [Argus Media](#), [Cornwall Insight](#) or [Greenfact](#).

Although there is currently not a high level of transparency surrounding price transparency of GoOs, the energy industry has experience of this with other, nascent energy markets. A natural progression could include a transition from price reporting agencies publishing anonymous survey results on values being attached to bilateral GoO trades, to developing a wholesale independent traded market with more transparent GoO price information. To accelerate this progression, hydrogen producers could be encouraged to

be transparent with GoO prices and to declare GoO prices on an anonymous basis, to begin to develop confidence in the development of a hydrogen GoO market.

An exciting development in the hydrogen Guarantee of Origin pricing space is the [HyXchange project](#). This project, based in the Netherlands, is exploring the creation of a hydrogen exchange to trade hydrogen products and hydrogen certificates. This project is conducting further analysis on the development of a virtual trading platform – HyXchange.



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The following section outlines six key recommendations for implementing a UK hydrogen Guarantee of Origin scheme, developed through the Hydrogen GMaP project. It is key to note that the following recommendations capture our exploration of this topic, recognising that the route to a UK hydrogen GoO scheme could take a variety of different paths.

5a. Timeline for a UK hydrogen Guarantee of Origin scheme

Key recommendations

- There is an urgency to design and develop a UK hydrogen GoO scheme to align with upcoming UK low carbon hydrogen production
- A UK hydrogen GoO scheme should be piloted with initial low carbon hydrogen production (see section 5F)
- UK industry should take steps to keep up to date with EU hydrogen GoO developments to maximise compatibility.

UK Government hydrogen ambitions as set out in the [British energy security strategy](#) include '10GW of low carbon hydrogen production capacity by 2030.'

Through this Hydrogen Gas Market Plan project, we explored several options for how a UK hydrogen GoO scheme could emerge, and below we have outlined our baseline and accelerated timelines.

Context for a UK hydrogen GoO timeline

The UK has an ambitious timeline of upcoming hydrogen milestones, including commitments from Government and proposals from industry.

Please see Figure 13 below for an indicative overview of the timeline of current UK hydrogen ambition.

As seen in Figure 13, there is a significant pipeline of large-scale UK hydrogen production projects, involving a range of hydrogen production technologies.



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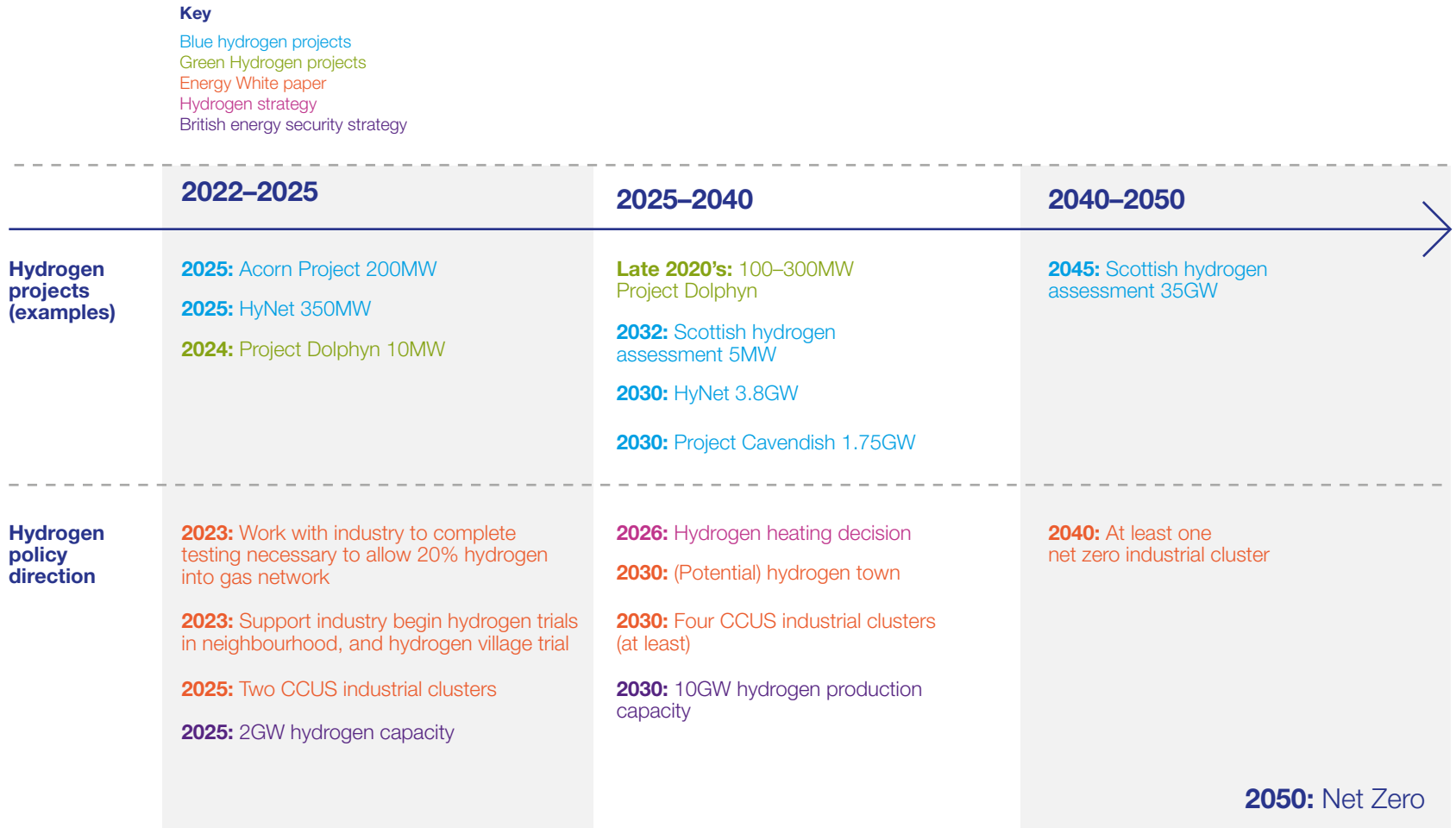
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Figure 13: Timeline of UK low carbon hydrogen ambition



- Key**
- Blue hydrogen projects
 - Green Hydrogen projects
 - Energy White paper
 - Hydrogen strategy
 - British energy security strategy

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Baseline scenario for development of a UK hydrogen GoO scheme

Summary of baseline approach: From a baseline perspective, hydrogen production and development of a hydrogen market should emerge first, followed by the implementation of a UK hydrogen GoO scheme that can be tailored to meet the needs of a UK hydrogen market.

Timeline>>	Present day–2025	2025–2030	2030–2040	2040–2050
UK Government (Hydrogen Strategy)	<p>2022: UK Low Carbon Hydrogen Standard finalised</p> <p>2023: UK Government decision on hydrogen blending in the gas networks</p> <p>2025: 2GW of low carbon hydrogen production capacity</p>	<p>2026: UK Government decision on role of hydrogen in heating</p> <p>2030: 10GW of low carbon hydrogen production capacity</p> <p>2030: Potential 100% hydrogen town</p>	<p>2040: Hydrogen demand increasing rapidly</p>	<p>2050: 250–460TWh of hydrogen could be needed across the economy</p>
Hydrogen GMaP project recommendation: (Baseline) UK hydrogen GoO development	<p>2025: Finalise UK hydrogen GoO scheme (i.e., process and functionality of scheme, eligibility, requirements, administration etc)</p>	<p>2026: Hydrogen GoOs begin to be used by hydrogen market participants</p>	<p>2030: Growing use of UK hydrogen GoOs in alignment with increasing UK hydrogen production. UK hydrogen GoO scheme become a statutory mechanism.</p> <p>2035: Initial cross-border hydrogen GoO trade</p>	<p>2040: Widespread use of UK hydrogen GoOs as hydrogen economy accelerates.</p> <p>2045: Global hydrogen GoO trade emerges.</p>
Reasoning behind Hydrogen GMaP (Baseline) UK hydrogen GoO development	<p>In this baseline scenario, in the early phases of UK hydrogen development hydrogen GoOs would not be required for two key reasons:</p> <ol style="list-style-type: none"> 1) Support for First-of-a-Kind (FOAK) low carbon hydrogen production would be provided by the Government Hydrogen Business Model mechanism. While other revenue streams such as a GoO scheme will be important to hydrogen producers, they would not be enough to justify investment into a FOAK low carbon hydrogen production facility. 2) It is likely that most initial low carbon hydrogen producers will be directly connected to their hydrogen consumers. Considering that the Hydrogen Business Model aims to provide a mechanism to support FOAK low carbon hydrogen producers to offer their hydrogen products at the same price as the reference natural gas price, it is likely initial hydrogen customers will not want to pay an additional premium for hydrogen GoOs, especially as initial customers will likely be directly connected to the hydrogen production itself. <p>However, while the role and value of a hydrogen GoO is less clear when there is direct delivery of hydrogen, there would still be value, and indeed an urgency, to design and develop a UK hydrogen GoO scheme to align with hydrogen production, due to the length of time it could take to design, develop and agree a UK hydrogen GoO scheme. For example, as a reference, the EU funded EU hydrogen GoO scheme CertifHy was founded in 2014 and is still in the process of refining the scheme.</p> <p>In addition, key to note, if directly connected customers are only partly fuelled by hydrogen, then a certification scheme such as a GoO scheme would be essential to verify claims of hydrogen use.</p>	<p>In this baseline scenario, when the UK hydrogen industry had been initiated for several (i.e., ~3 years), hydrogen GoOs become an increasingly important market mechanism to associate a premium for low carbon hydrogen products, especially hydrogen products increasingly blended into the existing natural gas networks.</p>	<p>With an accelerating UK hydrogen industry (i.e., ~ 5 years of hydrogen market initiation), hydrogen GoOs become an increasingly important tool both to differentiate low carbon hydrogen products blended into the existing natural gas networks, and also to differentiate and associate a premium for different low carbon hydrogen products within 100% hydrogen pipelines.</p> <p>Reflecting an increasing penetration of low carbon gases on the gas networks, a regulated green gas tariff framework could emerge, where green gas tariffs could be backed up or evidenced by hydrogen GoOs (i.e., use of hydrogen GoOs as a statutory mechanism).</p> <p>In addition, in this scenario initial cross-border hydrogen GoO trade emerges with the EU in the early to mid-2030's.</p>	<p>In this baseline scenario, when low carbon hydrogen is close to or has achieved cost parity with natural gas (without subsidy), hydrogen GoOs become an essential revenue stream for low carbon hydrogen producers, due to the premium placed on GoOs for different hydrogen production technologies. The premium should benefit the lowest carbon emission technologies.</p> <p>As a global hydrogen economy emerges, an internationally recognised hydrogen GoO standard would be needed to facilitate the global trade (import and export) of hydrogen GoOs. UK industry would seek to ensure that UK hydrogen GoOs are compatible to benefit global hydrogen GoO trade.</p>

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Accelerated scenario for development of a UK hydrogen GoO scheme

Summary of accelerated approach: From an accelerated perspective, a UK hydrogen GoO scheme should be developed in advance of hydrogen production, to be implemented in time to associate a premium for initial low carbon hydrogen production and use.

Timeline>>	Present day–2025	2025–2030	2030–2040	2040–2050
UK Government (Hydrogen Strategy)	<p>2022: UK Low Carbon Hydrogen Standard finalised</p> <p>2023: UK Government decision on hydrogen blending in the gas networks</p> <p>2025: 2GW of low carbon hydrogen production capacity</p>	<p>2026: UK Government decision on role of hydrogen in heating</p> <p>2030: 10GW of low carbon hydrogen production capacity</p> <p>2030: Potential 100% hydrogen town</p>	<p>2040: Hydrogen demand increasing rapidly</p>	<p>2050: 250–460TWh of hydrogen could be needed across the economy</p>
Hydrogen GMaP project recommendation: (Accelerated) UK hydrogen GoO development	<p>2022: Design and develop UK hydrogen GoO scheme</p> <p>2023: Pilot UK hydrogen GoO scheme</p>	<p>2025: UK hydrogen GoOs embedded into UK market frameworks as statutory mechanism</p> <p>2025: Initial implementation of cross border hydrogen GoO trade</p>	<p>2030: Widespread cross-border and global hydrogen GoO trade</p> <p>2030: Continued refinement and development of a UK hydrogen GoO scheme</p>	<p>2040: Development of single GoO system for all energy vectors</p>
Reasoning behind Hydrogen GMaP (Accelerated) UK hydrogen GoO development	<p>In this accelerated scenario, a UK hydrogen GoO scheme would be designed, developed and agreed by UK industry in advance of physical hydrogen flows. UK industry would take immediate steps to further cooperation and facilitate learnings with EU hydrogen GoO schemes, to benefit future cross-border hydrogen GoO compatibility and trade.</p> <p>A pilot UK hydrogen GoO would be trialled in alignment with initial low carbon hydrogen production. A pilot scheme would trial the functionality of a UK hydrogen GoO scheme, and also gain customer insight into information that GoO customers find valuable, essential as bilateral trades will likely dominate initial UK hydrogen GoO trade.</p> <p>Any gap between low carbon hydrogen production and lack of a GoO scheme could generate market uncertainty, for example, uncertainty on claims from gas consumers on hydrogen consumption, the emissions associated with the hydrogen etc.</p>	<p>In this accelerated scenario, hydrogen GoOs would have a legal basis as a statutory mechanism and be implemented within wider UK market frameworks.</p> <p>For example, UK hydrogen GoOs could be used to evidence a regulated 'green' gas tariff framework.</p> <p>Hydrogen GoOs would also seek fungibility with GoO schemes from a range of energy products, such as biomethane and electricity GoO schemes. In addition, hydrogen GoOs could also be used as evidence for compliance with other climate value market mechanisms, such as to reduce the need to buy Emissions Trading Scheme credits.</p> <p>UK hydrogen GoOs would incentivise the market to shift to increasingly lower emission hydrogen production technology, by placing a premium on the lowest emissions hydrogen production technology.</p> <p>Importantly, with an increasing penetration of low carbon hydrogen on the gas networks, initial cross-border hydrogen GoO trade would emerge with the EU by mid-decade.</p>	<p>As the global hydrogen economy emerges in this scenario, an internationally recognised hydrogen GoO standard would facilitate the global trade (import and export) of hydrogen GoOs.</p> <p>UK industry would seek to ensure that UK hydrogen GoOs were compatible to benefit global hydrogen GoO trade. Key to note, a UK hydrogen GoO will require continuous refinement and improvement to gather and provide the information on hydrogen products customers find valuable and improve functionality to better enable trade and implementation within wider market frameworks.</p>	<p>In this accelerated scenario, the ultimate ambition would involve the development of a single GoO instrument that could be used:</p> <ul style="list-style-type: none"> – Independently from physical commodities – Provide information on any/ all energy vectors (hydrogen, electricity, biomethane, natural gas) – Be fully fungible (i.e., mutually interchangeable) – Generate price signals on low carbon energy products. <p>If the over-arching goal of GoOs is to act as a financial tool to aid low carbon energy producers, a GoO market should strive for liquidity and harmonisation, which could be in the form of a single GoO instrument to track, account and associate a premium for all (low carbon) energy products.</p>

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Summary of Hydrogen GMaP recommendations on a timeline for development of a UK hydrogen GoO scheme

Overall, the Hydrogen GMaP project recommended that due to the benefits a hydrogen GoO scheme could provide to a developing UK hydrogen market, a UK hydrogen GoO scheme is needed as soon as possible. UK industry should begin work as a priority on designing, developing, and agreeing a UK hydrogen GoO scheme. A pilot hydrogen GoO scheme should also be considered to align with initial low carbon hydrogen production, to test the functionality of a UK hydrogen GoO scheme and gain insight on what information within GoOs customers value.

As stated previously, this Hydrogen GMaP project welcomes the recent Government response to the consultation on The UK Low Carbon Standard, including the commitment to set up a hydrogen certification scheme by 2025 to underpin deployment of low carbon hydrogen and aligns with both our baseline and accelerated UK hydrogen GoO timelines.

Finally, we recommend that UK industry take positive steps to keep up to date with EU hydrogen GoO scheme development, to benefit future hydrogen GoO scheme compatibility and cross-border trade.



5b. Information to include within UK hydrogen Guarantees of Origin

Key recommendations

- UK hydrogen Guarantees of Origin should contain mandatory data fields, such as:
 - Evidence of meeting UK low carbon hydrogen standard
 - Compatibility with cross-border GoO scheme requirements.
- UK hydrogen Guarantees of Origin should also contain supplementary or optional data fields, such as:
 - Granular information consumers may attribute additional value to (geographic, temporal, carbon etc).

Context to information to include within a UK hydrogen Guarantee of Origin

As part of this Hydrogen GMaP project, when considering information to include within a UK hydrogen GoO we began by focusing on two complex areas, including the debate on the 'colours' of hydrogen and emissions information, as outlined below.

1) 'Colours' of hydrogen

A key point of complexity with developing a hydrogen GoO scheme includes how to manage the debate on different 'colours', or production technologies, of hydrogen (please see Figure 14 below).

...the Hydrogen GMaP project recommended that due to the benefits a hydrogen GoO scheme could provide to a developing UK hydrogen market, a UK hydrogen GoO scheme is needed as soon as possible

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Key questions on the colours of hydrogen and a GoO scheme include:

- Should UK hydrogen GoOs be labelled according to the ‘colours’ of hydrogen production technologies? For example, if some market participants only want to trade ‘green hydrogen’ GoOs?
- What could be the impact of added complexity from colour labels?
- Instead of colours, could hydrogen GoO products be labelled according to fuel input, to identify renewable or non-renewable fuel input?

While the debate on hydrogen colours is a valid one, as a UK hydrogen GoO database would be capturing this information anyway (i.e., hydrogen production technology), ‘colour’ labels of hydrogen are not necessary for hydrogen GoOs. As long as hydrogen GoOs contain sufficient information so that a consumer can buy the specific energy product they wish to, there is likely no need for ‘colour’ labels. In addition, there is a risk that ‘colour’ labels could lead to further market fragmentation and impact liquidity within a nascent hydrogen GoO market.

A further reason why hydrogen ‘colour’ labels may not be necessary is that GoOs should be incentivising hydrogen producers to reduce emission intensity to gain the highest market premium, and the means to achieving emissions reduction should be technology agnostic.

2) Emissions information

Arguably, the most important information to be captured within hydrogen GoOs will be information on emissions. GoOs could be a key tool to demonstrate the emissions footprint of hydrogen products, and also provide an incentive to reduce hydrogen production emissions to gain higher GoO premiums.

Figure 14: Examples of hydrogen production technologies



Blue hydrogen Natural gas reformation with Carbon Capture Usage and Storage

Green hydrogen Electrolysis of water, powered by wind energy

Yellow hydrogen Electrolysis of water, powered by solar energy

Pink hydrogen Nuclear power driven hydrogen production

The emissions intensity information to be captured within a UK hydrogen GoO scheme (i.e., eligibility emissions threshold, emissions system boundary (i.e., upstream, midstream, downstream) (etc)) will build upon principles developed as part the finalised [UK low carbon hydrogen standard](#).

Key to note, while some market participants will be interested in gaining the most granular information possible on emissions data, other market participants may find this level of information unnecessary, and may prefer evidence that an emission threshold was met. We recommended that some emission information could be mandatory, and other information supplementary. For example, it could be mandatory to meet an emissions threshold to be eligible for a UK hydrogen GoO, while the granular emissions data could be included within supplementary data fields.

Finally, while we have recommended that it will be essential to include emission information within hydrogen GoOs, this does represent a divergence from current REGOs. REGOs do not include emission information and are instead classified as 100% renewable (0g of carbon emissions).

Below we have outlined a baseline and an accelerated approach to the development of information to include within a UK hydrogen GoO scheme.

As long as hydrogen GoOs contain sufficient information so that a consumer can buy the specific energy product they wish to, there is likely no need for ‘colour’ labels

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Baseline scenario for information to include within a UK hydrogen Guarantee of Origin scheme:

Summary of baseline approach

- A UK hydrogen GoO scheme should begin with the aim of simplicity and evolve in complexity as the hydrogen GoO market develops.

Developing, agreeing and implementing a Guarantee of Origin scheme takes time. As an example, [CertifHy](#) has been developing an EU hydrogen GoO scheme for implementation since 2014. In a baseline scenario, keeping mandatory information within a new UK hydrogen GoO scheme as simple and minimal as possible, could help to accelerate the process of implementing a UK hydrogen GoO. Examples of mandatory information within a 'simple' UK hydrogen GoO scheme would likely include evidence of meeting the UK's low carbon hydrogen standard eligibility criteria.

In this baseline scenario, an initial UK hydrogen GoO scheme would seek simplicity and to avoid segregation of hydrogen GoO products, considering the lack of liquidity in the hydrogen GoO market. As the UK and global hydrogen and hydrogen GoO market developed, liquidity and market signals would emerge, whereupon the UK hydrogen GoO market could look to develop further segregation of hydrogen GoO products and associate premiums for different information held within a hydrogen GoO.

Over time, the UK hydrogen GoO scheme could evolve from containing minimal information in as simplified a format as possible, to evolve into a more complex format containing further information. This approach would allow hydrogen producers to provide more granular information within GoO schemes as the hydrogen market developed, to support the development of more sophisticated energy products.

Risks with this baseline approach include that a lack of transparency in initial hydrogen GoO schemes may lead to 'greenwashing' criticisms. In addition, there is a risk that a simplified initial UK hydrogen GoO scheme may create complexity as the GoO market develops in sophistication, or reduce the ability for the UK to trade with the EU or global hydrogen GoO market.

Accelerated scenario for information to include within a UK hydrogen Guarantee of Origin scheme:

Summary of accelerated approach

- A UK hydrogen GoO scheme should be developed with the capability to store as much information as possible, from initiation.

In this accelerated scenario, from initiation a UK hydrogen Guarantee of Origin would include multiple data options for mandatory and supplementary information. This extensive information capability could provide, in the long term, a more flexible and cost-effective UK hydrogen GoO scheme.

Designing the IT infrastructure for the UK's first hydrogen GoO scheme with built-in optionality could mitigate the time and cost investment implications of agreeing and implementing additional data fields as the hydrogen GoO market develops. For example, it can be expected that over time as a UK hydrogen market develops, a UK hydrogen GoO scheme would be required to contain increasingly granular information on temporal, geographic or greenhouse gas emission data.

Including multiple data options within a UK hydrogen GoO scheme from initiation could include mandatory data fields, and also a range of optional / supplementary information fields. The list of obligatory information could be kept simple initially (with an emphasis on meeting UK low carbon hydrogen standard criteria, as well as achieving compatibility between the EU and the UK), where any additional information that consumers may associate a value to could be included within supplementary data fields.

Keeping mandatory information within a new UK hydrogen GoO scheme as simple and minimal as possible, could help to accelerate the process of implementing a UK hydrogen GoO

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Benefits from the ability to include extensive information from initiation within a GoO would enable a greater ability for suppliers and/or traders to carve out sophisticated energy products that consumers may find valuable. As an example of a sophisticated energy product, vegan electricity products are currently available to UK consumers ([Ecotricity](#)). Because it is impossible to anticipate what consumers will value in a UK hydrogen GoO scheme in the near term and also out to the future, the ability to gather as much information as possible would enable energy traders or suppliers to aggregate this information in anticipation of consumer demand for particular products.

Finally, it is key to note that while some consumers may value the granularity of information provided in this accelerated UK hydrogen GoO scenario, the optionality suggested also means that this information would not have to be used or recognised to generate energy products, if consumers did not value this (granularity of) information.

Summary of Hydrogen GMaP recommendations on information to include within a UK hydrogen GoO Scheme

In summary, we recommended that a UK hydrogen GoO schemes should have the capability to include:

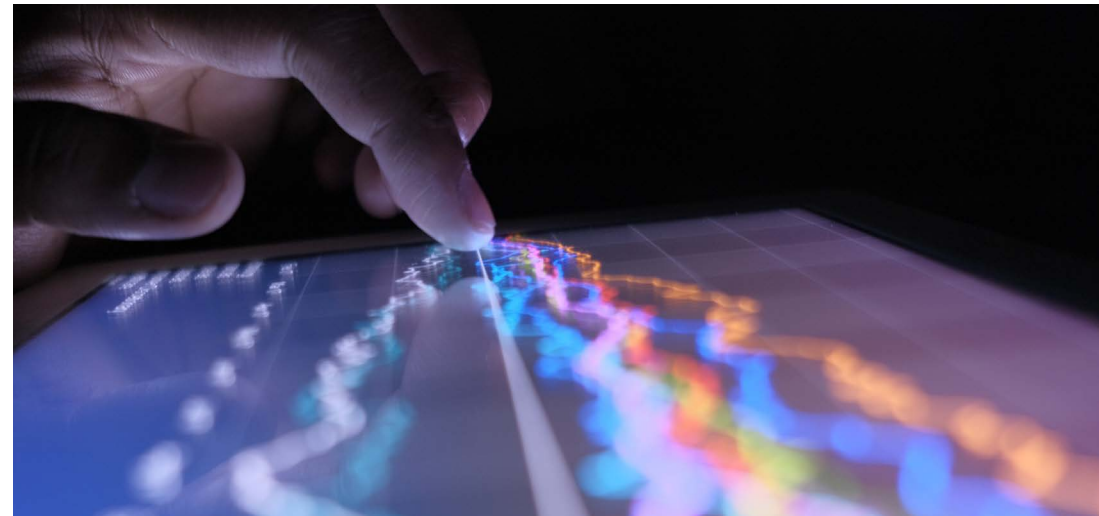
- Mandatory information that would be obligatory to disclose
- Supplementary information that would be optional to disclose.

It is key to note that using a single scheme to capture (a comprehensive range of) information on hydrogen products will make it easier for market participants to trade the climate value attributes of hydrogen.

When deciding on information to include within a GoO, there is always a risk to developing a scheme that segregates products, is overly complicated or has too stringent information requirements that could fragment the market, limit how the hydrogen GoO market could develop and reduce the ability of smaller market players to participate.

A mitigation to the above risk we explored as part of this H2 GMaP project, would be to develop a UK hydrogen GoO scheme with an extensive capability to store information, including mandatory information as well as a range of supplementary information. Over time, as a hydrogen GoO market develops, mandatory information could expand to include some of the original supplementary information. In this way, a UK hydrogen GoO scheme could accelerate in a staged approach from a 'basic' scheme to a more 'sophisticated' scheme, without the need to invest in time or cost to adapt the IT infrastructure of a hydrogen GoO system.

Benefits from extensive information available within a GoO would include a greater ability for suppliers and/or traders to carve out sophisticated energy products that consumers may find valuable



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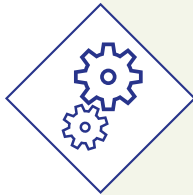
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5c. Role of UK hydrogen Guarantees of Origin within wider UK market frameworks



Key recommendation

- A UK hydrogen GoO scheme should seek to become a statutory mechanism to fulfil legally defined purposes
 - For example, hydrogen GoOs could be used as a market mechanism to evidence regulated ‘green’ gas tariffs offered to consumers and/ or used as evidence to demonstrate compliance towards climate value mechanisms and obligations.

Through this Hydrogen GMaP project we explored several options for the role a UK hydrogen GoO scheme could play within wider UK market frameworks, below we have outlined our baseline and accelerated scenarios.

Baseline scenario on role of UK hydrogen GoOs within wider market frameworks

Summary of baseline approach

- A UK hydrogen GoO scheme could (initially) be developed as a voluntary mechanism solely for the purposes of consumer disclosure.

Using hydrogen GoOs solely as a tool for consumer disclosure would follow the example of the [EU Renewable Energy Directive](#), where GoOs cannot be used as evidence for meeting legally obligated emissions reduction targets.

Benefits of baseline scenario

Benefits to using hydrogen GoOs solely for consumer disclosure include that a hydrogen GoO scheme, could provide an important avenue for consumer engagement and participation in driving a UK hydrogen market, by providing consumers with the opportunity to show preference for specific hydrogen products through buying hydrogen GoOs.

As a mechanism for consumer disclosure, a UK hydrogen GoO scheme or schemes could be set up and run by independent industry led bodies, such as the current role of the industry-led schemes for biomethane GoO products.

The benefits of this approach include it is likely an independent scheme/s would be able to get off the ground in a relatively short amount of time, in comparison to the time required for Government intervention in recognising a hydrogen GoO scheme with legal functions to fulfil.

Risks of baseline scenario

The risks of this approach include reduced consumer confidence if hydrogen GoO schemes are solely for the purpose of consumer disclosure.

A further risk with this voluntary approach is that it relies on eco-minded consumers willing to pay a premium for low carbon gas GoOs. A hydrogen GoO scheme solely for the purpose of consumer disclosure would likely be insufficient and have limited powers to drive market behaviours to accelerate a UK hydrogen transition in the timescale required for achieving net zero targets. Intervention from a Government perspective is therefore likely required to support the development of a UK hydrogen market in the desired timeframe.

Finally, an additional risk from a voluntary, industry-led approach would include that an industry-led scheme could add further complexity to the UK’s range of existing climate value market mechanisms.

In contrast, a government recognised hydrogen GoO scheme from the outset would have greater leverage to drive efficiency in interactions between existing UK climate value mechanisms. For example, a government recognised hydrogen GoO scheme could integrate a hydrogen GoO scheme with existing hydrogen policies and wider climate value market mechanisms. ‘Retrofitting’ a hydrogen GoO scheme into those initiatives at a later date will likely be a complex process, and could mean missed opportunities and efficiencies that a hydrogen GoO scheme could provide to support a nascent UK hydrogen market.

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Accelerated scenario on role of UK hydrogen GoOs within wider market frameworks

Summary of accelerated scenario

- In an accelerated scenario, UK hydrogen GoOs would be a statutory mechanism from initiation, i.e., a Government recognised tool led by a Government appointed organisation, to fulfil legally recognised purposes (such as providing evidence for regulated green gas tariffs for consumers and/or evidence to meet criteria for existing climate value mechanisms).

Benefits of accelerated approach

The benefits of developing hydrogen GoOs as statutory mechanism from initiation, with legal basis for both the purpose of consumer disclosure and compliance towards existing climate value mechanisms, would likely include reduced administrative burdens for market participants by streamlining the climate value market.

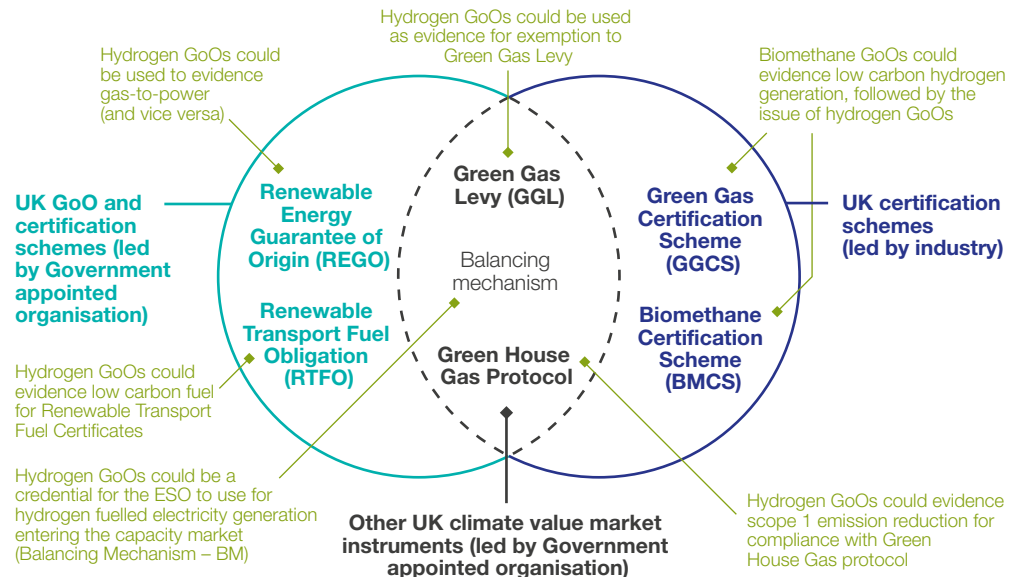
To illustrate this benefit, hydrogen GoOs could be used as evidence for consumer disclosure to back up a regulated 'green' gas tariff. A regulated 'green' gas tariff could generate an obligation on suppliers to source hydrogen GoOs, in the same manner that electricity suppliers currently source REGOs (Renewable Energy Guarantees of Origin) to provide 'green' electricity tariffs to consumers. Developing a regulated 'green' gas tariff framework could help to accelerate a UK hydrogen GoO market in the same way that green electricity tariffs played a pivotal role in developing the REGO market (please see the Call for Evidence on [Designing a Framework for transparency of Carbon Content in Energy Products](#) for further information on the development of the REGO scheme). It is key to note that developing a regulated

green gas tariff would require Government intervention, as currently it is [Electricity Supplier License Condition, 21D](#) that enforces the use of REGOs to evidence fuel-mix disclosure and conditions for marketing claims for green electricity tariffs.

In addition, as a Government recognised tool with legal purposes to fulfil, hydrogen GoOs could also be used as evidence for compliance with a range of existing UK climate value obligations and/ or mechanisms. There are a number of climate value mechanisms that would align closely with a hydrogen GoO scheme, we have outlined a few examples of how these mechanisms could interact in Figure 15 below:

Developing a regulated 'green' gas tariff framework could help to accelerate a UK hydrogen GoO market

Figure 15: Range of climate value instruments in the UK and potential interaction with a hydrogen



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To provide a more detailed example, hydrogen GoOs could be used as evidence to comply with the obligatory carbon targets set by the UK Emissions Trading Scheme (UK ETS). Sectors that must be compliant with the UK ETS include energy intensive industries, power generation and aviation. As not all market participants affected by the UK ETS could install low carbon production sources on site to reduce emissions, market mechanisms such as GoOs could play a critical role in supporting these sectors demonstrate their commitment to decarbonise.

Figure 16 below illustrates how the ETS and GoOs currently do not complement each other.

Risks of accelerated approach

Hydrogen GoOs as a statutory mechanism with legal basis to fulfil climate value mechanisms would require a UK hydrogen GoO scheme to be well-designed and robust to prevent misuse of GoOs, such as double-counting.

A risk from this role of GoOs is that the range of UK climate value schemes perform different purposes and include different governance processes and compliance criteria, and this could mean that enabling hydrogen GoOs to be used as compliance evidence for existing climate value mechanisms could be a complex process to deliver.

Summary of Hydrogen GMaP recommendation on role of UK hydrogen GoOs within wider market frameworks

Given the opportunity to start a UK hydrogen GoO scheme from scratch, we recommended that a UK hydrogen GoO scheme should aim to become a statutory mechanism, with legal basis for the purposes of consumer disclosure, evidence to support a regulated 'green' gas tariff and as evidence to contribute towards compliance with climate value mechanisms.

Figure 16: Correlation between UK ETS and GoOs

UK Emissions Trading Scheme	vs	Guarantees of Origin
<p>The Emissions Trading Scheme (ETS) operates as a Cap-and-trade system. Emission credits are provided to large UK carbon emitters, however every year the scheme provide less credits to the UK emitters. This creates scarcity, and eventually it will become too expensive to buy carbon credits, and cheaper to decarbonise to emit less carbon.</p> <p>The ETS scheme essentially 'punishes' fossil fuel users for emitting carbon.</p>		<p>Guarantee of Origin schemes reward producers of low carbon energy. Energy producers are able to sell GoOs (independent, tradeable certificates evidenced by low carbon energy production) to attribute a premium to low carbon energy products.</p>

Currently, it is not possible to purchase GoOs to reduce ETS credits.

Although both the ETS and GoOs are policies designed with the aim of helping the energy industry achieve net zero, they take opposing routes.

There is opportunity to explore how alignment could be achieved between these climate value mechanisms, including how the role hydrogen GoOs (as a statutory mechanism) could be used to reduce the need for energy intensive sectors to purchase ETS credits for emissions compliance.

However, if a hydrogen GoO scheme is developed within a well-defined framework, hydrogen GoOs could evolve from a voluntary tool to a compliance tool. Key to note, the role of a Government recognised UK hydrogen GoO as a statutory mechanism would need to be clearly defined (i.e., defined interaction with existing UK climate value mechanisms and obligations). As stated previously, this Hydrogen GMaP project welcomes the Government commitment to set up a hydrogen certification scheme by 2025. We will await further engagement from Government on the practical implementation of introducing a UK hydrogen certification scheme.

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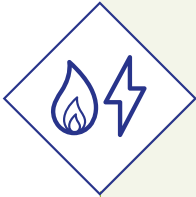
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5d. Interoperability of UK hydrogen Guarantees of Origin with range of energy products



Key recommendations

- GoO IT systems should enable interoperability of Guarantees of Origin, to facilitate transfer of renewable attributes between different energy products
- GoO IT systems should enable Guarantee of Origin scheme interoperability, within a robust method in place to prevent double counting of GoOs.

Context to interoperability of Guarantee of Origin schemes

The topic of interoperability, to enable the transferal of renewable attributes between GoOs is complex, below we have outlined benefits as well as challenges to enabling interoperability of GoO schemes.

Benefits to GoO interoperability

Whole system thinking will be essential to decarbonising the UK's energy system. The [2021 Future Energy Scenarios document](#) articulates this need as:

'Whole system thinking helps decarbonisation. The net zero target requires a more comprehensive way of thinking about the way we use energy Policy, market, and regulation decisions needed to meet net zero must take the whole system into account, and quickly, to maximise benefits. The UK energy system is complex and interconnected and, if support is given to one area, it must consider impacts right across markets, infrastructure and consumers.'

Considering the need for whole system solutions to achieve net zero, and considering hydrogen is a uniquely cross-cutting energy carrier that can interact with electricity, biomethane and natural gas, this Hydrogen GMaP project recommended that GoO IT systems should be put in place to enable interoperability between electricity, hydrogen, biomethane (and other energy product) GoOs to benefit a whole system approach to achieving net zero.

For example, in the case of power-to-gas (P2G), we recommended it should be possible for 'green' electricity GoOs to generate 'green' hydrogen GoOs, where the REGO for the power should be able to transfer its renewable attributes into the generated hydrogen GoO (and vice versa in the case of gas to power). If, as an industry, we believe that GoOs are a credible instrument to evidence the generation of energy products, then it follows that GoOs should be used as credible evidence (or at least, part of the evidence, such as alongside a PPA in the case of power-to-gas) to allow the transfer of renewable attributes between energy products.

Furthermore, enabling GoO systems to facilitate interoperability between GoO energy products and vectors is important from a first principle basis, considering:

'The first law of thermodynamics states that energy can neither be created nor destroyed, only altered in form (i.e., converted from one form of energy to another)' ([Science Direct](#)).

Challenges to GoO interoperability, and potential mitigations

To begin with, any GoO IT system that enables interoperability should ensure as a priority that the risk of double counting between energy products is eliminated. For example, a REGO should not be used as evidence to generate both a hydrogen GoO as well as being sold to a consumer as a REGO. Robust systems will need to be put in place to enable interoperability between GoOs and avoid double counting.



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The key challenge to enabling interoperability between GoOs of different energy products is how to design the IT system to facilitate this. Challenges include:

- How to record chains of information on the interoperability between GoOs of different energy products
 - The more interoperability between energy products, the more information or chains of information may be required to generate GoOs and monitor accurate emission intensity values.
- How to align with the EU on system / process changes to enable interoperability
- Mitigating ‘greenwashing’ (please see the [spotlight on greenwashing](#) for more information) criticisms from interoperability between GoO schemes
- Defining limits or rules for interoperability between GoO energy products
- Temporal and geographic considerations
 - For example, for power-to-gas (electrolysis), temporal and geographic factors will influence the emissions of the hydrogen produced. To be truly ‘green’, it will be necessary to match times of low emission intensity on the electricity network with electrolytic hydrogen production (connected to the electricity networks).

Furthermore, a key issue that will need to be addressed in the interoperability arena is the concept of additionality. The concept of additionality can be defined as the need to generate additional capacity for renewable energy. As an example, in the case of power-to-gas, additionality would require new-build renewable electricity to be developed prior to electricity being used as a fuel for hydrogen generation.

A recent study exploring the impact of additionality on green hydrogen prices in Germany, (commissioned by [RWE](#)) indicated that additionality would harm the market ramp-up of green hydrogen supplies and increase costs.

Nevertheless, the case for additionality has growing momentum in the EU ([Montel](#)), amid concerns that as renewable electricity has a growing demand base (i.e., electric vehicles, increasing uptake of heat pumps etc), diverting renewable electricity supplies for hydrogen generation could increase the carbon content of electricity networks as fossil-fuel based electricity generation may need to increasingly come online to support electricity users as well as grid connected electrolytic hydrogen producers.

Through this Hydrogen GMaP project, we recognised the above concerns and case for additionality. We also recognised that the UK will likely need to manage increasing renewable loads on the electricity networks in the transition to net zero. For example, the Government has set ambitious targets to connect 50GW of offshore wind power capacity by 2030 ([British energy security strategy](#)). Generating electrolytic hydrogen at times of excess renewable electricity generation could benefit both electricity and gas networks (manage the electricity network and generate low carbon gas) and demonstrate an effective whole system solution. GoOs could be used as an effective tool to evidence interoperability (i.e., converting from one form of energy to another) between energy products such as in the case of power to gas. Considering the above, we welcomed the statement ‘we will not be adopting an additionality requirement for hydrogen production to meet the standard’ included within the Government response to the consultation on the [Design of the UK low carbon hydrogen standard](#).

However, clearly it will be essential not to proliferate the use of electricity grid connected electrolysers at times of high carbon intensity on the electricity network. For more information on additionality and the role of GoOs, as well as proposals to enable effective whole system solutions for interoperability between hydrogen and electricity products, please see the [Consultation on the Design of the UK Low Carbon Hydrogen Standard](#).

Considering the above context, there are several means of achieving GoO interoperability, and below we have outlined two options in a baseline and accelerated scenario.



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Baseline scenario for hydrogen GoO interoperability

Summary of baseline approach

- Current IT system functionality would be used to enable interoperability of GoO schemes, involving the cancellation of one GoO to generate another.

In a baseline scenario, GoOs from one energy product would be cancelled before a new GoO could be issued for the generated energy product.

For example, (please see Figure 17 below), in the case of power to gas, the REGO would be cancelled followed by the issue of a hydrogen GoO. The hydrogen GoO would contain information on the energy source used to generate the hydrogen product (i.e., information on the electricity GoO, captured within the cancelled REGO).

Accelerated scenario for hydrogen GoO interoperability

Summary of accelerated approach

- Future IT system functionality would enable GoO scheme interoperability through 'transforming' or 'converting' GoOs to reflect energy transformations.

In an accelerated scenario, GoO IT systems could enable interoperability through 'transforming' or 'converting' GoOs themselves. In this future possibility, GoO IT systems could have the flexibility and capability to track interoperability (i.e., energy transformations) between energy products, and keep chains of information of energy product transformation (including geographic information, use of different networks, temporal considerations etc).

For example (please see Figure 18 below), in the case of power to gas, a GoO could be 'transformed' from a REGO to a hydrogen GoO within the GoO IT system.

Figure 17: Power to Gas – Baseline scenario example

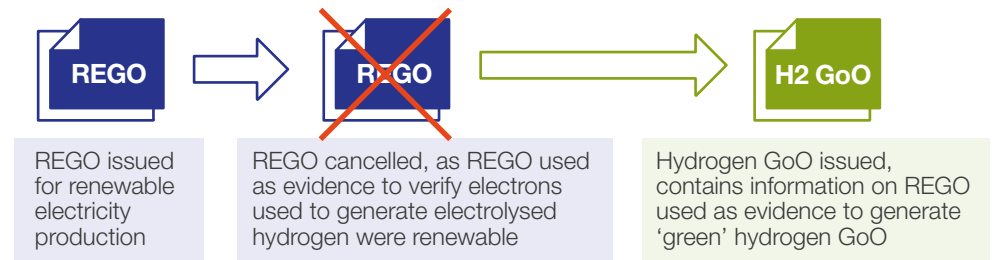
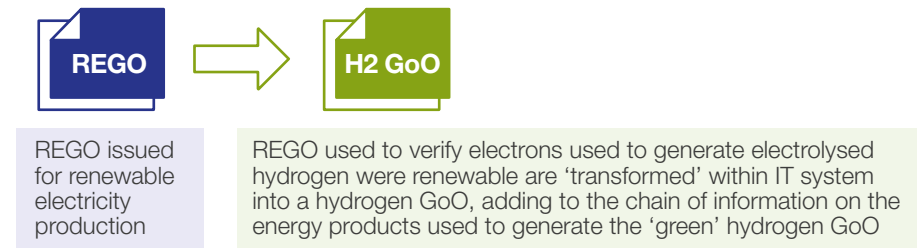


Figure 18: Power to Gas – Accelerated scenario example



Summary of Hydrogen GMaP recommendation on interoperability

In summary, we recommended that GoO IT systems should develop the capability to enable interoperability between energy products, to allow for the transfer of renewable attributes between GoO schemes.

We recommended existing IT systems should be used to enable initial GoO interoperability, with an evolution towards a more flexible and sophisticated process to enable GoO interoperability as the GoO market emerges.

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5e. Cross-border hydrogen Guarantee of Origin trade



Key recommendations

- UK should seek alignment and reciprocal trade arrangements with EU hydrogen GO schemes as a priority due to locality and shared infrastructure.
- Note: In the EU, Guarantees of Origin are referred to as GOs.
- In the medium to long term (as a secondary priority), the UK should seek to develop alignment with the global hydrogen GoO market, as a global hydrogen market emerges.

Context to cross-border hydrogen GoO trade

As hydrogen markets emerge, hydrogen GoOs will play an increasingly important role in certifying low carbon hydrogen products to facilitate hydrogen trade. Benefits of cross-border hydrogen GoO trade, focusing on the UK GoO market, will include increased market liquidity, increased GoO supply resilience, ability to service additional GoO demand, and more competitive GoO pricing for UK GoO consumers. Cross-border hydrogen GoO trade would enable the UK hydrogen industry to expand beyond the domestic hydrogen GoO market, where increasing consumers competing for UK hydrogen GoOs would benefit UK hydrogen producers through the potential to increase the sale and price of UK hydrogen GoOs.

Currently, international GoO trade plays an important role in the Renewable Energy Guarantee of Origin (REGO) and Renewable Gas Guarantee of Origin (RGGO- biomethane) markets. For example, data from industry surveys indicates

that in 2019 – 2020 the UK imported 38% of total electricity GoOs from the EU ([Greenfact](#)). Similarly, industry surveys indicate approximately 15% of UK Renewable Gas Guarantees of Origin (RGGOs) issued by the GGCS for biomethane were exported to the EU in 2020 – 2021 ([2020 – 2021 Green Gas Certification Scheme annual report](#)).

Exploration of cross-border hydrogen GoO trade

As part of this Hydrogen GMaP project we explored several scenarios for enabling hydrogen GoO cross-border trade including:

Scenario	Benefits	Challenges
1. UK seeks compatibility with EU hydrogen GOs	<p>In this scenario, the UK hydrogen industry would seek from initiation to enable reciprocal hydrogen GoO trade with the EU GO market.</p> <p>Due to shared infrastructure and locality, it is likely that initial cross-border hydrogen GoO trade will be with the EU hydrogen GO market.</p>	<p>Currently, there is not a reciprocal trade arrangement in place for UK and EU GOs. This is currently an area of uncertainty, as several obligations would be required to be met (due to the UK being a non-EU member) to facilitate UK and EU GO reciprocal trade (please see Section 3A for more information).</p> <p>In addition, there are risks with seeking compatibility with EU criteria for hydrogen GOs, due to potential future EU revisions to GO eligibility criteria that could impose additional complexity and cost for UK hydrogen market participants to adhere to.</p>
2. UK accepts hydrogen GoOs that meet UK hydrogen GoO eligibility criteria	<p>In this scenario, UK market participants could accept any imported hydrogen GoOs from the EU GO or global GoO market that meet UK hydrogen GoO eligibility criteria.</p>	<p>Risks with this approach include uncertainty on reciprocal hydrogen GoO trade arrangements (this reflects the current state of play with the EU not accepting UK REGOs, with the UK market still able to accept EU electricity GOs).</p>

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Achieving cross-border hydrogen GoO trade should be a key consideration for UK hydrogen market participants in order to participate in a global traded hydrogen GoO market, where compatibility with the EU should be considered as a priority considering shared infrastructure and proximity. Through this project, we recommended that UK market participants seek to take steps to understand the required criteria in order to trade with the EU, including seeking further information on the [Union Database](#) (a monitoring and reporting tool) that is proposed in the EU as part of [RED III](#) to trace the production of renewables (including hydrogen) as well as their life-cycle emissions.

Considering the priority of developing compatibility with EU hydrogen GO schemes to facilitate cross-border trade, a further recommendation from this Hydrogen GMaP project included that required information for cross-border hydrogen GoO trade should be developed with the aim of simplicity to facilitate initial trade. As the hydrogen GoO market develops, increasing complexity could be introduced to cross-border trade.

In addition, we recommended that while the UK should strive for compatibility to enable cross-border hydrogen GoO trade with the EU, that does not mean the UK should necessarily strive for an equivalent (i.e., the same) hydrogen GoO scheme. Risks with implementing an equivalent hydrogen GoO scheme as the EU include that potential revisions to GO eligibility criteria from the EU could impose additional complexity and cost for UK hydrogen market participants to adhere to. Instead, we recommended the UK hydrogen GoO market should strive for compatibility, while ensuring that UK hydrogen GoO market needs are met.

While compatibility with EU hydrogen GO schemes should be considered as a priority, criteria to enable global cross-border hydrogen GoO trade should be enshrined in intergovernmental agreements as a global hydrogen market emerges.

It will also be important to anticipate that large net importers of hydrogen and corresponding hydrogen GoOs will likely emerge. For example, the [EU Commission](#) set out new ambitious hydrogen targets as part of the proposed plan to make the EU independent of Russian fossil fuels well before 2030, starting with gas, due to Russia's invasion of Ukraine. Hydrogen producers will need to ensure that their product is viable for the market they intend to export to, including seeking compatibility with hydrogen GoO eligibility criteria. Hydrogen GoO eligibility criteria from large net importers could generate a ripple effect that shapes eligibility criteria from other, global, hydrogen GoO schemes. If different regions globally have different hydrogen GoO eligibility criteria, this could pose challenges to facilitating cross-border hydrogen GoO trade. Clearly, it will be important to seek global hydrogen GoO compatibility to facilitate a global hydrogen GoO market.

Ultimately, to enable cross-border hydrogen GoO trade a balance will need to be achieved between added complexity and cost for compliance, and suitability with the UK's hydrogen GoO scheme and market.

Finally, a further key consideration for facilitating cross-border hydrogen GoO trade (beyond the information required to be captured within the GoO), is the technical format of GoOs. Technical format of GoOs includes how information is positioned within the GoO digital document. We recommended that a standard technical format of hydrogen GoOs would facilitate ease of cross-border trade.

Summary of Hydrogen GMaP recommendation on enabling cross-border trade for hydrogen GoOs

As hydrogen markets emerge, hydrogen GoOs will play an increasingly important role in certifying low carbon hydrogen products to facilitate hydrogen trade. It will be essential for the UK hydrogen industry to seek compatibility with EU and global hydrogen GoO markets to benefit cross-border hydrogen and hydrogen GoO trade.



A standard technical format of hydrogen GoOs would facilitate ease of cross-border GoO trade

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5f. Pilot UK hydrogen Guarantee of Origin scheme

Key recommendation

- UK gas industry participants should consider, as a priority, a pilot UK hydrogen GoO scheme in alignment with physical low carbon hydrogen production.

Context to developing a UK hydrogen GoO pilot

There is an urgency to pilot a UK hydrogen GoO scheme as any gap between physical low carbon hydrogen production and a hydrogen GoO scheme could lead to market uncertainty, concerning how to verify claims of hydrogen consumption.

In addition, there is an urgency to pilot a hydrogen GoO scheme due to the length of time it could take to develop and implement a hydrogen GoO scheme. For example, the EU funded hydrogen GoO project '[CertifHy](#)' was founded in 2014, where work is ongoing to implement a EU hydrogen GoO scheme. Reasons as to why it can be a lengthy and at times controversial process to develop and implement a GoO scheme include:

- Agreement on information / data required to be captured within a GoO
- Agreement on methodology for capturing information / data
- Eligibility criteria for participation within GoO scheme
- Numerous market players involved where a range of concerns will need to be addressed before a GoO scheme can be agreed and subsequently implemented.

Considering the time it could take to develop, agree and implement a UK hydrogen GoO scheme, the sooner the process is initiated, the sooner a hydrogen GoO scheme can be implemented to benefit the development of a UK hydrogen market.

A pilot trial of a UK hydrogen GoO scheme could begin to tackle some of the difficult questions surrounding a hydrogen GoO scheme and outline further areas that may need to be considered as part of a UK hydrogen GoO.

Benefits of a pilot UK hydrogen GoO scheme include insight into what information within hydrogen GoOs that consumers may find valuable. A trial of a UK hydrogen GoO could also provide valuable insight on how IT systems could be developed to facilitate a UK hydrogen GoO scheme. A pilot hydrogen GoO scheme could trial the processes and functionality of GoO IT systems and identify key learnings to take forward.

Summary of Hydrogen GMaP recommendations on a UK hydrogen GoO pilot

We recommended that the sooner work begins on developing and trialling a UK hydrogen GoO scheme with the relevant market participants, the sooner a GoO scheme can be agreed and implemented in the UK. We recommended that UK gas industry should consider as a priority developing a UK hydrogen GoO to align with physical low carbon hydrogen production.



Section 6: Key conclusions

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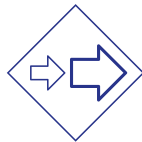
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After considering the benefits a UK hydrogen Guarantee of Origin (GoO) scheme could provide to hydrogen producers, transporters and consumers, it is clear that a hydrogen GoO scheme will have an essential role to play in driving a UK hydrogen market.

The overarching recommendations we developed as part of this Hydrogen GMaP project included:



1. Timeline: A UK hydrogen GoO scheme should be developed to align with physical hydrogen production.



2. Information to include: A UK hydrogen GoO scheme should be designed with the capacity to include a variety of information, including mandatory information necessary to verify meeting low carbon criteria and enable cross-border GoO trade, as well as the option for including additional supplementary information that consumers may find valuable.



3. Role within wider market frameworks: UK hydrogen GoOs should aim to become a statutory mechanism, with legal basis to support their function within wider frameworks. For example, hydrogen GoOs could be used as evidence to back up regulated 'green' gas tariffs offered to gas consumers. Hydrogen GoOs could also be used as evidence to comply with existing UK climate value mechanisms, such as compliance with the Emissions Trading Scheme.



4. Interoperability: A UK hydrogen GoO scheme should seek interoperability to facilitate transfer of renewable attributes between different energy products. For example, a renewable electricity GoO should be able to transfer the renewable attributes of the electricity GoO to a hydrogen GoO in the case of power-to-gas, and vice versa.



5. Trade: A UK hydrogen GoO scheme should seek compatibility with EU hydrogen GoO schemes as a priority, due to locality and shared infrastructure, and seek compatibility with the global hydrogen GoO market as global trade emerges.



6. Pilot scheme: A pilot UK hydrogen GoO scheme should be developed as a priority to trial the process of a hydrogen GoO scheme and gain learnings on what information consumers may find valuable within GoOs.

Short term (immediate, low regret) recommendations for UK industry to consider taking forwards to implement a UK hydrogen GoO scheme include:

1. Create (or use an existing) forum to continue discussions on the development of a UK hydrogen GoO.
2. Explore how a statutory hydrogen GoO scheme could interact (i.e., complement) with existing climate value market mechanisms.
3. Seek membership to EU hydrogen GoO working groups to drive compatibility for cross-border hydrogen GoO trade.
4. Explore how to enable hydrogen GoO interoperability (i.e., transferring renewable attributes from one energy product to another).
5. Deliver a hydrogen GoO pilot in alignment with initial physical hydrogen production.

Spotlight on a vision for Guarantees of Origin



Looking beyond the development of a UK hydrogen GoO scheme, a vision for future GoO schemes could involve the use of a single GoO instrument to fulfil a variety of purposes.

A single GoO mechanism could be:

- Traded independently from physical energy products (i.e., book and claim system)
- Used to maximise the climate value attributes of energy products.
- Act as a fully fungible traded entity (i.e., mutually interchangeable with all energy products) to generate price signals on low carbon energy products.

The driver for a single GoO mechanism is that the more un-alike GoO instruments become, such as the development of separate GoO schemes for hydrogen, biomethane, electricity, natural gas (etc), the more fragmented the GoO market, the lower the liquidity of a traded GoO market.

If the over-arching goal of GoO schemes is to act as a financial tool to support the lowest carbon energy producers, a GoO market should ultimately strive to develop a harmonised, liquid, and competitive market. A single, fully fungible mechanism could be the goal to deliver a future harmonised GoO market.



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