Recommendations on the establishment of a well-functioning EU hydrogen GoO system

Grant agreement no.: 633107

Deliverable No. 3.3

"Recommendations on the establishment of a well-functioning EU hydrogen GoO system"

Status:
Final

Dissemination level:
"PU - Public"

version:
January 31, 2016

Authors:

K. Veum (ECN)

M. Londo (ECN)

J.C. Jansen (ECN)

Date: 31 January 2016

Table of Contents

Executive Summary

The CertifHy project develops a roadmap for the implementation of an EU-wide framework for Guarantees of Origin for green hydrogen[1] (Green H_2 GoO), supported by the Fuel Cells and Hydrogen Joint Undertaking (FCH JU) and affiliated partners from industry players in the hydrogen and associated sectors.

The objective of this CertifHy report is to provide recommendations for the establishment of a well-functioning EU hydrogen GoO system. For this, it consists of two elements. First and foremost, it reviews existing platforms for GoOs, in order to yield lessons learned that should be heeded in designing a successful GoO system to facilitate a future green hydrogen market in the EU. It reviews initiatives within the EU to certify the origin of electricity, renewable methane, and biofuels. Focal issues include:

- the process organisation including the roles defined for distinct stakeholders,
- the premium value the system creates for the users of GoOs and the extent to which the system concerned provides an EU-wide platform for exchange of GoOs.

In a smaller second part, it identifies possible interactions between existing energy certification schemes and the envisaged Green H_2 GoO system that occur when energy carriers are converted into each other and GoOs need to follow this conversion. It assesses briefly how undesired interactions can be mitigated. Undesired interactions are defined as those that create barriers to the issuance, transfer or redemption of a GoO and/or lead to market parties´ loss of confidence in GoOs to fulfil a given purpose.

Our overall conclusions are structured along three axis: recommendations for an optimal green hydrogen GoO scheme; key remaining issues from experiences with other schemes; and some initial considerations for a development pathway for the green hydrogen scheme.

Key findings that provide a general basis for designing a Green H_2 GoO scheme are:

- Most importantly, there is an overall functional set-up of GoO systems for various energy carriers. This basic structure can be duplicated for a green hydrogen GoO system. Any claims made by market parties in commercial messages will have to be proven by cancellation of the required GoOs.
- For detailing the system, the Rules and Principles for a European Energy Certificate Systems (EECS), provided by the Association of Issuing Bodies (AIB) are the best basis to start from. While they have not been fully implemented in all Member States, it would be beneficial for a GoO scheme for hydrogen to use these principles from the start[2].
- The GoO system should provide information on the origin of the product. In addition, information could be included which specifies whether the product meets certain qualifications, such as the CertifHy definition of green hydrogen and/or low-GHG

1 In deliverable 2.4 of the project, its objective has been widened to a GoO framework for both Green Hydrogen (renewable and low-carbon) and Low-GHG Hydrogen (non-renewable, low-carbon). Wherever this report refers to green hydrogen, the reader should bear in mind that the GoO scheme will serve both types of hydrogen.

2 An existing system similar to the EECS system is the I-REC Code, for further information see: www.irecstandard.org. With the exception of different their geographical scopes, the EECs and the I-REC systems have very similar rules with regard to the issuance, transfer and redemption of certificates. One important differences is that the I-REC system has one global registry, whereas the EECS system includes national registries.

hydrogen. The 'origin' information part is factual, while the 'qualifications' part may change with developments in policy and green hydrogen definitions over time.

- In order to contribute to a well-functioning internal market and prevent any barriers to international trade, an EU-wide Green H_2 GoO scheme should be developed from the outset, or national registries should preferably use identical data structures. A joint/ central registry, which has been chosen for the I-REC scheme, could also be considered.
- The Green H_2 GoO scheme should cover all possible production routes for green hydrogen, including import and export within the EU and with third countries. It should also be open to all applications using hydrogen, including e.g. transport.
- The main function of the Green H_2 GoO system should be consumer disclosure. Our review indicates that linkages between GoO systems and support schemes should be handled with care. This includes the role of GoOs for renewable energy carriers in sectoral obligations, such as the one for renewable energy in transport. Such linkages could lead to policy redundancy or overstimulation[3]; an effect that policy makers are usually wary of.
- A harmonised GoO scheme for the EU as a whole seems preferable, as this also allows to introduce standard (calculation) rules for conversion. Generally, proper bookkeeping is essential, to prevent double counting effects and safeguard consumer trust. However, there is a trade-off between comprehensiveness of the accounting systems and their administrative burden.
- With potential changes in the external environment of the GoO scheme and its use, a transparent and regular review and update of the system is also important.

At several points, the review has revealed issues that have not (yet) been solved in the currently existing GoO systems, or that are treated differently among them.

- The issue of mandatory use of GoOs for consumer claims is important, since the GoO is not likely to have a 'value' if consumers are free to claim renewable hydrogen consumption without (mandatory) use of the GoO: more in general the issue of 'standards for consumer claims' should be more elaborated on; good examples are the Green House Gas Protocol (GHGP)[4], Climate Disclosure Project (CDP)[5] and RE100[6].
- The issue of additionality, i.e. whether the purchase of a GoO leads to an increase in renewable energy production capacity in comparison to the situation without such purchase. Although additionality is not a requirement for GoOs, better transparency on whether or not additionality is achieved would be beneficial from the perspective of consumers. For example, in the EECS System[7] this is done through the use of Independent Criteria Schemes (ICS), i.e. an organisation can put its label on the GoO when its qualification criteria are met. One of such criteria could be additionality (as e.g. in the EKOenergy label)

[3] Viz. more governmental support for production and/or consumption of green hydrogen than what is needed to overcome the financial gap vis-à-vis fossil hydrogen, for example because the hydrogen and/or its certificate can apply to various support schemes in different countries along its life cycle.
[4] http://www.ghgprotocol.org/.
[5] https://www.cdp.net/en-US/Pages/HomePage.aspx.
[6] http://there100.org/.
[7] http://www.aib-net.org/portal/page/portal/AIB_HOME/EECS.

- The issue of the residual mix: although residual mix calculations as such do not need to be complex, trade, import/export and conversion between energy carriers complicates their calculation and increases the risk of double counting. This risk can be overcome by proper bookkeeping. In the long term, full coverage of all energy sources by the GoO systems could reduce to a minimum and potentially also eliminate the residual mix issue or reduce it to a minimum..
- Another point of attention is the conversion of one energy carrier into another (e.g. from renewable electricity into renewable hydrogen). In principle, proper book-keeping is sufficient to make sure such conversion is correctly accompanied by cancellation of certificates of the original energy carrier and creation of certificates of the new energy carrier. Earlier experiences show, however, that careful design of procedures is essential, in order to take into account conversion efficiencies, and reduce 'information losses in translation'.
- Losses during transport from producer to consumer are not taken into account in current GoO schemes, such as the GoO for renewable electricity[8]. However, there may be issues of energy used during transport (e.g. when this is done by trucks) that need to be taken into account. This deserves further exploration.
- To what extent should production of installations that use both renewable and non-renewable energy be eligible for a renewable or green certificate[9]? And what if the overall CO_2 intensity of such installations is relatively high? Examples of this are biomass co-firing in coal-based power plants, and electrolysis-based hydrogen production systems that partly use renewable and partly non-renewable power. This point requires attention in the definition of green hydrogen. In support, a GoO system could provide information not only about the directly related GHG emissions, but also on the GHG emissions of the production system as a whole.
- Existing GoO systems still encounter challenges with *'virtual trade in renewable attributes'* and the consumer claim. An attribute is always separated from the physical flow. Whilst the GoO as such can be made very reliable, the use of the GoO (meaning consumer claim) is less reliable. In the design of any GoO system, there needs to be alertness on this point. The problem of certificate 'double counting' can be overcome with a robust certificate system like EECS, and the problem of 'double disclosure' is dealt with by decent legislation following e.g. the RE-DISS Best Practice Recommendations[10], but the problem of 'double perception' creates public mistrust. Any approach to handle this problem needs to direct to all involved countries.

[8] AIB is currently considering the treatment of line losses, and whether GoOs for this energy should be cancelled. This is not addressed in the current 2009 RES directive, which does not require GoOs to be issued solely for each MWh of net production; although this is the existing practice - subtracting grid losses from net production would need either strong support or a new Directive. In particular, for the deduction is to be allocated fairly, all production devices would need to be part of the GoO system. This would be a particularly sensitive issue for countries with long transmission lines, which might feel themselves unfairly discriminated against. Also, production devices close to consumers and/or the grid may consider they should lose less GoOs than remote production devices, raising the question whether deductions should be applied to individual plant, or across all plant.

[9] An issue that is covered in the EECS rules (N6.3.2 and N6.4.1), for further details see: http://www.aib-net.org/portal/page/portal/AIB_HOME/EECS/EECS_Rules/EECS%20Rules%20Release%207%20v7.pdf.

[10] http://www.reliable-disclosure.org/upload/3-RE-DISS_Best_Practice_Recommendations_v2.1.pdf.

The lessons learnt and issues identified already set the scene for a development pathway for green hydrogen GoOs, which contains a strategic dilemma. On the one hand, a scheme should be as elaborate as possible from the early beginning, and cover the entire EU from the start. On the other hand, the review also shows significant differences between Member States in how they deal with some elements of their existing GoOs. It may thus be difficult to find EU-wide initial consensus. In a development pathway for a hydrogen GoO, it is probably most effective to start with a system that covers the elements on which the current review shows consistency between Member States. The development of rules how to use the GoO for proper consumer claims would have a high priority in this respect; with proper rules consumer will not start using the GoO. Cooperation with existing 'standards for consumer claims' is an key element for next steps. For its further development, the GoO characteristics on which national positions differ should be further elaborated and discussed, in order to reach a workable compromise.

1 Introduction

1.1 Certification of green hydrogen: the CertifHy project

The CertifHy Project Consortium aims to develop a roadmap for the implementation of an EU-wide framework for guarantees of origin (GoO) for green hydrogen[11,12]. The CertifHy project has been structured in the following Work Packages:

1. Generic market outlook for green hydrogen
2. Definition of “Green Hydrogen”
3. Review of existing platforms for GoO
4. Definition of a new framework of guarantees of origin for "green" hydrogen
5. Roadmap for the implementation of an EU-wide GoO scheme for green hydrogen

This deliverable is the final result of Work Package 3. The main objective of this Work Package was to yield lessons learned that should be heeded in designing a successful GoO system to facilitate a future green hydrogen market in the EU. A review of past and existing initiatives to set up GoO systems is made, including their purposes, the stakeholders involved and their respective roles as well as the uses of the GoOs and functioning of the GoO system concerned. The review encompasses on-going and failed initiatives within the EU to certify the origin of electricity (from renewables-based or high-efficiency CHP generation installations), green gas, and biofuels and, to the extent applicable, green materials, notably for disclosure purposes.

Work Package 3 consisted of four tasks;

Task 1: Review of existing platforms for GoO

Task 2: Interaction between existing certification schemes and the envisaged hydrogen GoO system .

Task 3 Stakeholder interaction to identify what the specific challenges are with regard to certifying green hydrogen and how these can be addressed, building on the experiences gained from certification schemes in other markets.

Task 4 Consolidation of WP3 results into a final WP3 report that will incorporate the results and recommendations obtained from the stakeholder interaction.

We would like to wholeheartedly thank the CertifHy affiliated partners, GoO experts and other market parties who kindly provided elaborate and constructive comments to the earlier deliverables in this work package that served as the basis for this report. Their names and affiliations have been included in Annex IV.

[11] The project coordinated by Hinicio, brings along the Energy Research Centre of the Netherlands (ECN), Ludwig–Bölkow-Systemtechnik (LBST) and TÜV SÜD, supported by a wide range of key European industry leaders (gas companies, energy utilities, green hydrogen technology developers and automobile manufacturers as well as leading industry associations).

[12] In deliverable 2.4 of the project, its objective has been widened to a GoO framework for both Green Hydrogen (renewable and low-carbon) and Low-GHG Hydrogen (non-renewable, low-carbon). Wherever this report refers to green hydrogen, the reader should bear in mind that the GoO scheme will serve both types of hydrogen.

1.2 Guarantees of origin: context and history

Energy carriers such as electricity and gas are commodities that depend on extensive infrastructure in order to be transported and traded. This creates potential difficulties in setting up dedicated infrastructures for separately trading energy carriers that have specific characteristics (renewable or other sustainability aspects). As a solution, Guarantees of Origin (GoO) systems have been set up, which allow for trade in the specific characteristics of the energy carrier, separated from the physical flow of the energy carrier itself, which is then traded through the conventional infrastructure.

The general set-up of GoO systems is illustrated in Figure 1. Key elements are:

- An accredited issuing body issues GoOs to producers of the energy carrier, and keeps track of them in a registry;
- When an end consumer claims he has consumed energy with the certified characteristics, he should own a corresponding GoO, which is then cancelled;
- Trade of the GoO is administrated in the registry until the GoO is cancelled.

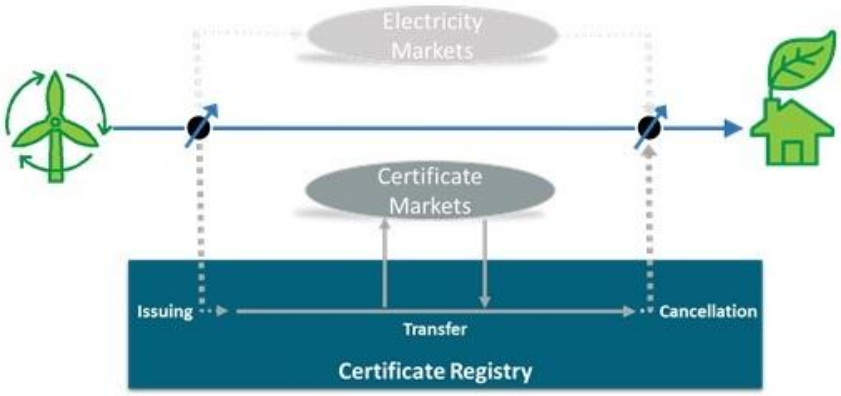

Figure 1: Schematic view of a GoO system, in this case for green electricity (Grexel 2014). This figure is equally applicable for a GoO scheme, and Certificate Markets and Certificate Registry could also be read as GoO Markets and GoO Registry.

The concept of guarantees of origin was introduced in Directive 2001/77/CE, the first directive on renewable electricity. This directive introduced GoOs as proof of origin for renewable energy, thereby facilitating trade in renewable energy and increasing transparency for the consumer's choice between renewable and non-renewable energy. Later, GoOs were introduced for electricity from CHPs (in the European CHP directive (2004/8/EC)), and today, GoO systems also exist for renewable heating and cooling, biofuels and methane from renewable sources. Further details are presented in Chapter 2 and 3. GoOs are one of several tracking systems that have been developed over the past years. Box 1 provides a brief description of the distinction between GoOs and other tracking schemes, such as renewable energy certificates (RECS) and labelling schemes. RECS holds important credit for setting up an EU wide tradeable certificate system. However, since 1/1/2015 no more RECS certificates are issued, as all attributes on them are now integrated in the GoO certificates. A new certificate system focusing on markets outside Europe is the I-REC certificate system[13].

[13] See: www.irecstandard.org.

Box 1: Understanding different tracking systems

In addition to the Guarantees of Origin system, there are a number of other tracking instruments for the same or similar purposes, such as renewable energy certificates and energy labels.

Renewable energy certificate (RECS): This is a more generic term for all tradable certificates for renewable energy. RECS International, a non-profit-making European association of market players trading in renewable energy certificate, distinguishes systems for the voluntary market and for the target compliance market. In the voluntary market, GoOs and RECS certificates have in principle fulfilled the same function, and as of 1 January 2015, no more RECS certificates are issued, as the attributes on them are now integrated in the GoOs. Where they differed initially, however, is that a GoO is required under EU Directives which are obligatory in all Member States of the European Union (for more details see section 2.1). RECS certificates were issued as a voluntary initiative by energy companies, as such the issuing body was appointed by market players. The issuing bodies of GoOs on the other hand are appointed by national governments.

Labelling systems: GoOs should not be confused with green electricity labels. Both provide consumers with more information about their energy (transparency). However, labelling systems often go further by requiring, for example, additionality. Whilst labelling schemes, such as OK-Power (DE) and Naturemade (CH) are private initiatives, GoOs arise from European regulations. Green electricity quality labels, such as the Eugene Green Energy Standard or EKOenergy labelling scheme, are issued to products that meet certain criteria (sometimes subjective) set by a so-called Labelling Body. Such criteria may show a preference for certain renewable energy sources and exclude other sources. Quality label information is different from the 'disclosure' regulation, which requires an objective display of information regarding the electricity provided without attaching any value judgement to the disclosed information (Burger et al. 2004).

Table 1: Most relevant types of electricity tracking systems in Europe. (Source: Timpe and Sprongl 2009).

	Legal Basis in EU Directive	Usage by market actors	Applicable to		
			RES-E	HE-CHP-E	other generation
Guarantees of Origin for RES-E	(2001/77/EC) 2009/28/EC	optional	X		
Guarantees of Origin for HE-CHP-E	2004/8/EC	optional	(X)	X	
RECS certificates	(none)	optional	X		
"Disclosure certificates"	(none)	optional	X	X	X
National calculation schemes for electricity disclosure	2003/54/EC	optional (mandatory)	X	X	X
Green Power Quality Labels	(none)	optional	X	(X)	

1.3 Objective and structure of this report

This report consists of two main sections; firstly, a section covered in chapters 2 – 4 that seeks to derive lessons relevant for a green hydrogen GoO system that can be learned from experience gained with guarantees of origin of other energy carriers. The emphasis is on GoO systems of renewable electricity (RES-E GoO), in chapter 2. Furthermore, systems for guarantees of origin and certificate systems for renewable heating and cooling, green gas and biofuels are discussed in chapter 3. A second section covers the key interactions between existing certification schemes and the envisaged Green H_2 GoO scheme. This is covered in chapter 4. Key conclusions are summarised in chapter 5.

2 Renewable electricity GoO systems

2.1 Introduction: Purpose and legal basis

Purpose

The purpose of an electricity guarantee of origin (GoO) system is to provide a proof of the renewable origin of electricity (RES-E). A prime driver for the establishment of a RES-E GoO system has been a market for 'green power', where consumers can buy electricity generated from renewable energy sources and pay a premium for this (Grexel 2014). A GoO scheme facilitates **electricity disclosure** and enables consumers to make informed choices about the electricity they buy based not only on price but also, for example, on the type of generation and related environmental effects (Boardman et al. 2003). In addition to serving the disclosure purpose, a GoO scheme can also serve the purpose of supporting the management of a support mechanism (as is the case, for example, in the US and in the Dutch SDE+ scheme). Use of GoOs for national target accounting purposes has also been discussed in the literature (Timpe and Sprongl 2009), however, this latter purpose is not allowed by the RES Directive, as will be described in more detail below. The different interpretation of the purpose of the GoO also proved to be one of the major obstacles towards their transferability across borders.

Legal basis

The GoO as defined by the EU directives is the only tracking system with a clear legal basis at EU level. The GoO concept was first introduced in the Directive on the promotion of renewable electricity from renewable energy resources[14] (hereafter referred to as "2001 RES-E Directive"). The provisions concerning the GoO scheme have been updated in the Directive on the promotion of renewable energy sources[15] (hereafter referred to as "2009 RES Directive").

The 2001 RES-E Directive pointed out that the GoO had to be distinguished from tradable green certificates, i.e. it indicated that it was the prerogative of a Member State to decide as to whether or not a GoO implied a right to benefit from the pertinent national support scheme. It stipulated that a guarantee of origin shall:

- specify the energy source from which the electricity was produced, specifying the dates and places of production, and in the case of hydroelectric installations, indicate the capacity;

[14] Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market, OJ L 283, 27.10.2001, pp. 33-40.
[15] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (Text with EEA relevance), OJ L 140, 5.6.2009, p. 16–62

- serve to enable producers of electricity from renewable energy sources to demonstrate that the electricity they sell is produced from renewable energy sources within the meaning of this Directive.

The 2009 RES Directive provides further clarity on the purpose and functionality of the GoO. It does so by defining the GoO instrument in more detail and more consistently (Timpe and Sprongl 2009). With the 2009 RES Directive, it was made clearer that the sole purpose of the GoO system is electricity disclosure. Furthermore, it requires one electronic registry for the issuance, transference and cancellation of GoOs to be operated by a single competent body per geographical region. The 2009 RES Directive states that the guarantee of origin shall have no function in terms of a Member State's compliance with Article 3 (which relates to the mandatory national targets for the share of RES).. Furthermore, the directive requires that that the GoO system must be "accurate, reliable and fraud-resistant, and that Member States shall accept GoO from other Member States for disclosure purpose".

In addition to the EU directives covering GoOs for renewable energy, the Internal Electricity Market (IEM) Directives[16] require Member States to introduce "electricity source disclosure" schemes for all electricity sold to final consumers. The IEM Directives do not require a specific GoO, but instead that certain information concerning the electricity generation is provided to final consumers as a part of their electricity bill. This information includes the contribution of each energy source to the overall fuel mix of the supplier, and information on the environmental impacts (such as CO_2 emissions and radioactive waste related to the power generation).

The disclosure requirement was implemented for the first time by the Directive 2003/54/EC on the functioning of the internal electricity market (hereafter referred to as the "2003 IEM Directive"). The regulation on electricity disclosure has later been revised in the Energy Market Directive 2009/72/EC (hereafter referred to as the "2009 EM Directive"), which had to be implemented by EU Member States by March 2011 (Timpe and Sprongl, 2012). Whilst the 2009 RES Directive refers to the purpose of disclosure, the 2009 EM Directive does not refer to GoOs.

EU legislation also provides for GoOs for electricity generated from high-efficient cogeneration of heat and power. The respective regulations on high-efficient cogeneration of heat and power are now included in the Energy Efficiency Directive 2012/27/EC.

2.2 Key actors and their roles

The key actors are a function of the purpose(s) of RES-E GoOs and the institutional embedding of RES-E GoO tracking systems, as envisaged in relevant EU legislation and its transposition

[16] Directive 2009/72/EC of the European Parliament and of the Council (and its predecessors Directives 1996/92/EC and 2003/54/EC).

into national legislation of the Member States. In principle, the following actors play an important role:

- The national regulatory agency (or designated competent body) that is responsible for the regulatory framework, and which has to oversee the operator of the national tracking system and the functioning of the national RES-E GoO market.
- The operator of the national RES-E GoO tracking system (operators of national/sub-national tracking systems), often referred to as the registrar or issuing body.
- The Association of Issuing Bodies, representing the operators of national GoO systems, including notably RES-E GoO systems.
- Relevant EU-level trade/branch associations, i.e. RECS International, Eurelectric, Europex and EFET.
- Relevant bodies of the European Commission overseeing proper implementation of EU legislation regarding RES-E GoOs by the Member States: the DGs for energy (ENER), competition (COMP) and health and consumers (SANCO).
- Generators of renewable electricity, requesting issuance of GoOs.
- Electricity infrastructure operators: the national distribution system operator (DSOs) and transport system operators (TSOs), measuring RES-E generated per reporting period (e.g. day, month).
- Certification and auditing companies of RES-E installations and, when applicable, bio-degradable fractions.
- Electricity suppliers offering eco power tariffs or green deliveries by using GoOs.
- Businesses and other actors using GoOs for cancellation as proof of green environmental impact claims in annual CSR (corporate social responsibility) reports and commercial communications, advertisements, etc. and their representative bodies. Examples include the GHG Protocol, RE100, and WeMeanBusiness.
- Other final electricity customers, notably households, buying specialty ("green") electricity products and their representative bodies, such as BEUC and national consumer associations.

2.3 Key design features of a GoO scheme for RES-E

As mentioned above, the 2009 RES Directive sets the requirements for implementation of the GoO as a tracking and disclosure tool for RES-E in Member States. Whilst Annex I in this report provides a full overview of the detailed requirements, this sub-chapter highlights key design features of the GoO.

The Functioning: Cradle-to-grave

The set-up of a RES-E GoO scheme follows the general structure as explained in section 1.2 and Figure 1. The 2009 RES Directive requires a GoO to be issued by a national competent body at the request of a producer, thus, on a voluntary basis for the producer. A standard size

is defined: 1 GoO per MWh. The GoO has a validity of maximum 1 year, must be registered electronically, and cancelled upon use. The Directive does not provide any clarification on what is actually meant by 'use'. It can, however, be understood, in the context of the Directive, that a GoO must be cancelled by suppliers for each MWh of RES-E supplied by them, in conformity with the "green power" product they sell to final consumers. Following the 2001 RES-E Directive and the subsequent 2009 RES Directive, most Member States have established national GoO schemes, with relevant national legislation and regulations covering roles and responsibilities (e.g. competent issuing body), procedures and rules for accreditation of eligible power generation plants, rules for the issuance and cancellation of GoOs, etc., and in some countries also rules for the transfer of GoOs. Elementary is the fact that each GoO has an End of Life, as illustrated in the figure below.

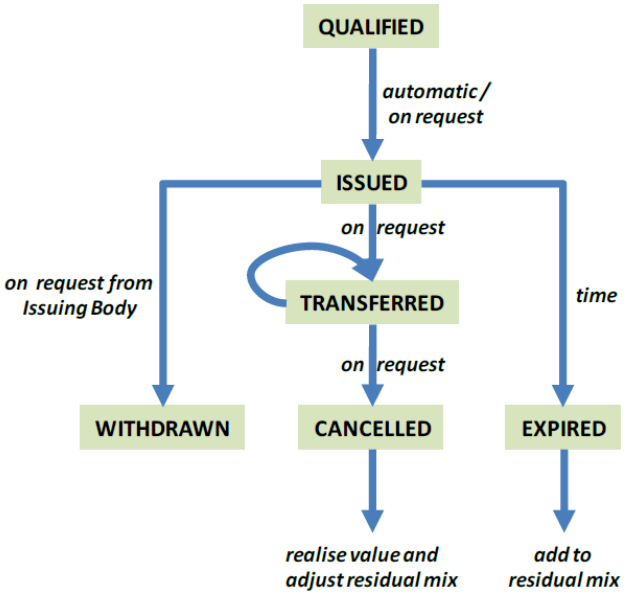

Figure 2: Life cycle of a GoO. Source: AIB (2015a)

Information included in the GoO

In accordance with the 2009 RES Directive, a RES-E GoO shall specify at least:

- the energy source from which the energy was produced and the start and the end dates of production;
- whether it relates to electricity, or to heating or cooling;
- the identity, location, type and capacity of the installation where the energy was produced;
- whether and to what extent the installation has benefited from investment support, whether and to what extent the unit of energy has benefited in any other way from a national support scheme, and the type of support scheme;
- the date on which the installation became operational; and
- the date and country of issue and a unique identification number.

Ensuring reliability, accuracy and fraud-resistance

Reliability, accuracy and fraud-resistance are crucial for market confidence. If these criteria are not ensured, market parties will have little or no confidence in the actual instrument and the instrument will not be able to serve its purpose. For example, from the perspective of the RES Directive, reliability relates to the question: How to ensure that the information about the source of the electricity supplied can be trusted by the electricity customer? There are a few EU legislative requirements pertaining to the GoO aimed at addressing the reliability, accuracy and fraud-resistance issues. These include, among others:

- Only one GoO is to be issued for a MWh of renewable electricity generation.
- All GoOs are to be registered electronically, and issued by a designated competent body, whereby the designated bodies do not have overlapping geographical responsibilities, and be independent of production, trade and supply activities.
- Validity period of maximum 1 year, and GoO shall be cancelled once it is used.

Guarantees of Origin and renewable electricity support schemes

While GoOs have the main objective of stimulating renewable electricity development through consumer disclosure, all EU Member States also have renewable energy targets and governmental support schemes for renewables. One of the RE-DISS II[17] project good practice recommendations (RE-DISS II 2015a) is to use GoOs only as a tool for disclosure, and not as an instrument for target disclosure or as a support instrument.

In practice, Member States have different approaches towards the co-existence of GoOs and national support schemes (RE-DISS II 2015b):

- In countries with a quota obligation as the key policy instrument, such as the UK, Sweden, Italy, Poland and Belgium, each unit of renewable electricity produced is eligible for a tradeable certificate in the context of that obligation (e.g. ROCs in the UK, Elcerts in Sweden and Norway) *and* for a separate GoO for consumer disclosure. These two types of certificates are usually traded and administered separately. Important is that the certificate itself clearly identifies the purpose it serves, so that both purposes cannot be mixed.
- In most countries with a feed-in payment scheme, GoOs are banned or discouraged for supported production. In Germany, GoOs cannot be issued for production under the feed-in tariff scheme, the well-known Energie Einspeisegesetz (EEG). In France, revenues earned by a producer through the sale of a GoO from feed-in-supported electricity need to be paid back to the government. And in Spain, selling a GoO obliges the producer to invest part of the revenues in environmental actions, and pay back the governmental support they received for the energy to which the GoO relates. The Netherlands and Austria have less discouraging rules on GoOs in their feed-in support

[17]: The RE-DISS projects (I and II) aim at improving the reliability and accuracy of the information given to consumers of electricity in Europe, with a focus on GoOs. Details see www.reliable-disclosure.org.

schemes. In the Netherlands, a producer of renewable electricity can receive both feed-in support and a renewable GoO. In Austria, GoOs of supported production can be used for domestic disclosure but are not allowed to be traded internationally.

The difference in GoO treatment between quota and feed-in payment systems follows a certain logic. In quota systems, the additional costs of renewable electricity that producers face are usually transferred to the end consumers. If specific consumer groups are willing to pay for 100% renewable consumption, a producer can reduce the cost transfer to his consumers by selling a GoO. In feed-in payment systems, related costs are generally brought up by either the government (via taxes) or transferred to end consumers via an additional tariff on their energy bill. It seems defendable that the tax or tariff payer should benefit from the GoO as well, e.g. by having a corresponding renewable share in their standard electricity consumption (Germany) or by a transfer of GoO sales benefits back to the government (France).

Cross-border trade arrangements

Whilst the 2009 RES Directive requires individual Member States to recognise GoOs from other Member States, there are no legal requirements covering the transfer and trade of GoO between countries. The details on how such recognition could take place, and which reasons might justify a refusal to recognise a given GoO, are not clearly defined in the 2009 RES Directive, and therefore both national competent bodies as well as market participants are currently in an unclear situation on how to handle this (RE-DISS, 2015). Although trade in GoOs actually takes place, it is assumed by most experts that a lack of clarity of these and other important issues play a role in hampering cross-border trade.

Following the 2001 RES-E Directive and the subsequent 2009 RES Directive, most countries implemented GoO schemes as national systems which were not well designed for cross-border transfers (Timpe and Sprongl, 2009). To facilitate cross border transfers, the current shape of the European Energy Certificate System (EECS) was established in 2005 by the Association of Issuing Bodies (AIB) (however AIB has facilitated cross border certificate transfers since 2002, and cross-border GoO transfers since 2004). The EECS supports the issuing, transfer and cancellation of various types of GoOs, including RES-E GoOs, and has an established electronic hub which facilitates cross-border transfers of GoOs. The EECS provides for an EU-wide standard encompassing GoOs for RES-E as well as GoOs for high efficiency CHP, RECS certificates (see Box 1 – until 31 December 2015) and other generic disclosure certificates. Furthermore, the EECS Rules formed the basis of the CEN/CENELEC GO standard for energy. Today, many countries make use of this hub for international trade in GoOs. The 2009 RES Directive does not require Member States to accept the EECS system. However, many countries integrated the EECS scheme into their national GoO scheme or are operating their national GoO schemes and the EECS scheme in parallel.

GoO impacts on the environmental profile of other electricity consumed: the residual mix

Electricity consumption for which a renewable electricity GoO is cancelled can be claimed as being renewable. As a consequence, a consumer who uses grid electricity without the cancellation of a GoO certificate is consuming electricity with the environmental characteristics of the residual mix. The residual mix has the environmental profile of the power production that is not allocated to a specific individual or end-consumer. Practically, this means that the environmental profile of the residual mix needs to be corrected when a GoO is cancelled from the national registry, because of domestic final use, conversion into another energy carrier, or export of the GoO. The national GoO issuing body or a delegate is the logical party to annually calculate the national residual mix, but this is not done in all GoO systems (see below).

Additional features/issues:

A few countries already allow for the issuance of GoOs for all types of electricity generation (nuclear, coal, etc.). Studies, such as RE-DISS[18], are addressing possible extensions, such as the inclusion of information related to fair-trade, CO_2 statistics, and additionality[19].

There is some information in the public domain[20] on the cost of tracking schemes, including the GoO. The E-Track study stipulates a wide cost range for tracking systems, with the highest cost estimate reaching 0,2% of the wholesale price of baseload electricity (Ritter et al. 2007).

The study stipulates, furthermore, that a key driver for the large differences in costs is the requirements resulting from more policy integration (Ritter et al. 2007). An example of policy integration is when GoOs are used to support scheme payments, as is the case in the Netherlands. However, the size of the market segment for the GoO is also a cost driver for a tracking scheme. The larger the market for GoOs, or similar tracking schemes, the more the unit costs will decrease, since the total costs can be distributed among more participating market parties. Thus, the Dutch GoO is relatively cheap in 'per MWh' terms as the total system costs are spread over a large market segment.

Costs of a tracking scheme typically include development and operational costs. Development costs include the development of a registry, including system specifications, software development, development of the interface to a hub, and testing. Operational costs are mainly dependent on how the procedures are set up and on how the system is used. Operational costs would typically include costs related to issuing (such as plant certification and auditing, collection and verification of data concerning plants and production of electricity at the plants). Costs can be reduced if there are already procedures (for auditing, data acquisition, etc.) in place that can be used directly for tracking (Ritter et al. 2007).

[18] IBID.

[19] Additionality usually refers to an additional environmental effect over and above the status quo or business-as-usual development, which is related to the consumption of a green electricity product. (Seebach, 2014).

[20] See: http://www.vreg.be/sites/default/files/statistieken/groenestroom/20151002_-_heb_-_go_transacties.pdf for the average market price of a RES-E GO traded within Flanders-Belgium (in Dutch).

2.4 Key issues and lessons learned

Table 2 summarises key (non-exhaustive) issues and concerns pertaining to the specific EU legislative requirements and to the design of the GoO schemes. Most of these issues and concerns have been raised by stakeholders and presented through various projects, such as E-TRACK and RE-DISS. The table also presents proposed solutions. Table 3 summarises additional issues and concerns which largely relate to lack of EU legislation covering renewable energy, the internal electricity market, and high efficiency cogeneration and energy efficiency.

Key summary points

EU RES Directives have played a key role in facilitating the development of RES-E GoO schemes. The provisions of the Directives provide for a basic 'cradle-to-grave' GoO tracking system. The electronic tracking system features could also be used for GoO systems for other energy carriers, such as green hydrogen.

A key weakness of the RES-E GoO prescriptions by the 2009 RES Directive is that RES-E GoOs are to be applied for disclosure purposes only, while in several countries, links exist between GoO systems and national support schemes, some of them with their own tradable certificate systems. Unless carefully regulated, this risks creating diversity in the degree of additionality, a risk of policy redundancy, and general confusion of RES-E GoO systems from the perspective of environmentally concerned consumers. A second weakness hampering reliability in the case of cross-border trade is the absence of comprehensive coverage of all forms of electricity generation. In general, the 2001 RES-E Directive has lacked sufficient prescription, giving leeway to differing implementation in Member States. This has particularly been problematic for cross-border exchange.

Furthermore, lack of coordination between relevant EU RES Directives and EU IEM Directives creates problems with respect to credibility.

Another point of concern is the residual mix. Not all countries do residual mix calculations, and such calculations become more and more complex when international trade and electricity conversion into another energy carrier grow further.

Accountability of a specifically low emission factor particularly for RES-E has become a major driver for voluntary markets for RES-E for non-household consumers. However, there is no requirement to include relevant information on this aspect within the current GoO requirements of the 2009 RES Directive.

Table 2: Issues and concerns specifically on the design of GoO relating to the requirements and implementation of the EU RES Directives, or lack thereof. Sources: AIB (2015b), RE-DISS II (2015a, 2015b), Raimundo (2015), RE-DISS (2012), Timpe and Sprongl (2009).

Issues and concerns	Possible solutions considered
Trading of GoOs proceeds bilaterally, leading to cumbersome price discovery and (unwanted) market segmentation, e.g. based on source (e.g. biomass versus solar) and location (Dutch versus Norwegian hydropower).	Central trading platforms have been developed to overcome this. This can improve price discovery possibilities. Yet, market actors may feel a commercial need to introduce distinctive green electricity products into the market. Hence, complete transparency would seem elusive. For new markets, such as Green Hydrogen, a solution might be to have a unified GoO system from the very beginning.
The credibility of the use of the GoO is questioned	For ensuring consumer empowerment and reliability from the consumer's perspective, including the mitigation of double counting problems, an integrated approach is required. This would imply that for proving a defined profile of the energy carrier at stake, e.g. the renewable or the low-carbon origin, only GoOs are allowed to be used for whatever commercial purpose. Then it is ensured that consumers can influence the supply profile of the energy carrier concerned. Concerning cross-border exchange, countries should set up clear and publically transparent criteria for the recognition of imported GoOs.
2009 RES Directive defines a GoO's validity of 12 months after production of the generation, but does not regulate whether GoOs that represent generation attributes of one year should be eligible for 'electricity disclosure' use in another year. Nor does the 2009 RES Directive define what "use" means.	Art. 3(9)a) of the 2009 EM Directive mandates disclosure of the supplier's fuel mix in the preceding year, i.e. 12 months. It does not mandate the use nor define what is meant by "use" of GoOs for the RES part of this mix, but allows for it. It would improve transparency of the consumer's choice to mandate ex ante disclosure of the fuel mix for the current accounting year with mandatory use of GoOs.
Current information on GoOs is not sufficient to allow for consumer carbon footprint calculations. Some companies currently use reference values for the associated fuel for this, but this ignores certain aspects of carbon emission calculations. The AIB has raised the issue that this should be harmonised with a common approach linking GoOs with carbon emissions (AIB, 2015b).	GoOs could include the basic information that is needed to calculate the emitted carbon and generated radioactive waste arising from the underlying electricity production and when societal need is identified also information on (other) pollutants. Arguably, GoOs already does so, in that they contain information about the production technology, country of production, producing plant, and fuel source. The addition of plant efficiency might improve this. For all fossil fuel, a currently mandatory EECS field on each GoO is CO2 emissions. For trustworthy use of GoO for carbon footprint calculations, the use of GoO to convey emissions (CO2, NOx, SOx, etc.) should be regulated.
Currently, an array of different rules for compliance with the IPCC rules for greenhouse gas emissions monitoring (GHG Protocol) exists in Europe.	Implement of standards for consumer claims. Ref point above, standards for consumer claims including those related to emissions should be regulated.
2009 RES Directive does not include requirements for cross-border coordination and transfer of GoOs between countries. This creates a barrier for cross-border exchange and/or cross-border cancellation.	The AIB has developed the EECS system which facilitates cross-border transfers applicable to AIB members. AIB allows non-EECS members to access the EECS Hub under the condition that certain harmonisation measures are implemented and a contract is concluded with the AIB, allowing for cross-border GoO exchange for non-AIB member countries. However, currently, only one Hub user has opted for such an arrangement, UBA of Germany. Another solution could be to establish a single European registry for the electricity market. Then there would be no technical restrictions regarding transfer. Given the interfaces with national systems for measurement of energy production, support and so on, this will be challenging. Therefore a compromise will likely have to be sought.

Table 3: Issues and concerns concerning GoOs relating to the lack of coordination between relevant EU legislation. Sources: AIB (2015b), RE-DISS II (2015 a, 2015b), Raimundo (2015), RE-DISS (2012), Timpe and Sprongl (2009).

Issues and concerns	Possible solutions considered
Whilst EECS is providing for harmonised rules for GoOs in many European countries, the rules for electricity disclosure still differ from country to country, creating market barriers, arbitrage, loss of disclosure information and (most importantly) double-counting of renewable energy.	One first step in solving this point would be to start registering all energy generated, also the energy from fossil resources, and thus making GoOs a universal tool for fuel source disclosure.
Lack of a Residual Mix calculation remains the major weakness in the majority of schemes implemented. In GoO systems with significant trade, import/export and conversion of energy carriers, correction of the residual mix upon cancellation of GoOs becomes very complex.	This problem could be addressed by very clear and proper bookkeeping of the GoOs in the processes of trade, import/export and conversion. Ultimately, residual mix calculations would become unnecessary with comprehensive coverage by GoOs of the whole supply by the energy carrier(s) in the jurisdiction in which GoOs are traded.
Additionality: to what extent does the purchase of a GoO lead to additional renewable production, compared to the situation without the purchase[21]?	Perspectives on this issue vary between countries and stakeholders. In some GoO systems it is essentially neglected, in others additionality is actively safeguarded, e.g. by excluding renewable electricity under a feed-in payment scheme from eligibility for a GoO. The RE-DISS best practice recommendation on this point is to provide information to the end consumer on the degree the GoO can be considered additional, but this recommendation has not yet been implemented in most schemes.
Leakage of attributes and/or arbitrage, an error that occurs when different national GoO tracking systems are not coordinated.	Better harmonisation, mandatory implementation of the EECS system.
In the case of inter-modality and "netting" it is essential to do a full supply chain analysis: e.g. can coal-based electricity used for hydro pumping be labelled "green" when the stored hydropower is later discharged?	'Proper bookkeeping' should be sufficient to do the job: keeping explicit what electricity was used for pumping, and making sure that later discharged power gets the original tag back[22].
Policy redundancy or overstimulation: particularly when certificates are traded internationally, the corresponding production could receive both production support (e.g. a feed-in tariff) and end-use support (e.g. a consumer tax exemption). This will be considered undesired by some governments.	Inclusion of policy support in the GoO information setup is already obligatory under the 2009 RES Directive. Whilst at present, the AIB labels GoOs with whether or not they have received investment support, production support, both or none of these, or "not known", full transparency of the 'extent of' support received has proven to be difficult to accommodate. In international trade, such information should ideally be provided on the GoO, in a recognisable way for buyers, then it would be up to the buyer whether he considers any double incentives a problem or not. Given the inherent difficulties in providing fully transparent information on the 'extent of' support provided, a compromise should be sought.

[21] AIB is currently working on the development of an advice to the Commission on the treatment of CO2e emissions with Core Theme 5 (CT5) of the CA-RES II, the concerted action on the RES Directive.

[22] AIB is currently enhancing its regulations in this respect, such that any uncertainties act against the issue of GoOs – any errors or unknowns in the process lead to GOs not being issued.

3 Other GoO systems

3.1 Renewable heat GoO systems for renewable heating (and cooling)

3.1.1 Introduction

The 2009 RES Directive (Article 15) transfers the concept of the GoO to the RES – Heating and Cooling (H/C) sector by stipulating that *"Member States may arrange for guarantees of origin to be issued in response to a request from producers of heating and cooling from renewable energy sources"*. Although not obliged to, Member States can introduce a GoO scheme for RES-H/C.

3.1.2 Key design features

In principle, the same rules apply to GoO for RES-H/C as to those for RES-E. However, as mentioned above, Member States can decide freely whether they want to provide for the issuance of GoOs for RES-H/C, and if they do so, the issuing can be restricted to installations above a certain capacity threshold.

These regulations might have been added to the 2009 RES Directive due to an uncertainty of whether a true market will emerge for RES-H/C GoOs, because renewable heating and cooling, in contrast to renewable electricity, cannot be transferred in trans-European networks but are rather limited to local consumption or local distribution networks for heat (and possibly cooling) (Timpe and Sprongl, 2009).

Box 2: RES H/C GoO in the Netherlands

On 1 May 2013, the Dutch issuing body CertiQ issued the first GoOs for heat produced in the Netherlands by renewable sources. CertiQ issues these certificates for every megawatt-hour (MWh) of heat produced by renewable energy sources, e.g. from biomass in thermal boilers or from geothermal energy. The first heat-producing installation for which GoOs were issued was the wood-fired plant operated by Bio Forte in Marum, in the Groningen province, north in the Netherlands.

Source: http://www.certiq.nl/en/news/2013/05/press-release.html

The Netherlands is currently the only EU Member State with an operational scheme for the issuance of RES H/C GoOs, see Box 2 (above) for a brief description. The scheme for RES H/C GoOs mimics the RES-E GoO scheme, i.e. the technical-administrative set-up of the RES H/C scheme is more or less identical to that of the RES-E scheme. There are, however, two important distinctions. Firstly, there is no international market for cross-border trade in RES H/C, and secondly, there are local networks for distributing heat as opposed to a nation-wide

grid infrastructure with cross-border connections to neighbouring countries as in the electricity sector. Issues related to the latter are briefly discussed in section 3.1.4 below.

3.1.3 Key actors and their roles

As for RES-H/C GoO scheme, key actors include the issuing body, producers, auditors, traders, and end consumers.

The current issuing bodies for RES-E GoO are typically transmission system operators (TSOs) or regulators from the electricity sector. Many are reluctant to expand their activity into the areas of RES H/C, biofuels, bioliquids and biogas as these are usually beyond their sector (Timpe and Sprongl, 2009). However, in the Netherlands, the TSO (Tennet) has created a subsidiary company, CertiQ, which is responsible for GoO schemes for both electricity and heating and cooling.

In addition, in the Netherlands, companies which are involved in conducting various tasks within the RES-E GoO scheme are typically also engaged to conduct similar tasks within the RES H/C GoO scheme, for example metering companies and accountants for measurements and verification.

3.1.4 Key issues and lessons learned

As mentioned above, an important difference between the heat and electricity sector is the geographical coverage of the grid infrastructure. Whilst electricity is transported in a national grid network with cross-border connections, heat is transported in local grid networks. In the Netherlands, the issue is being addressed concerning whether or not it is acceptable to use a 'book and claim'[23] approach for RES H/C GoO when different parties are not connected to the same heat grid.

[23] A "book and claim" system can be understood as a system in which e.g. electricity producers can register or book (in a database) how much they have produced, when they have produced it and how they have produced it, and electricity sellers and electricity consumers can use the same databases to "claim" that a specific type of electricity is theirs. For electricity GoOs, book and claim is the current practice in Europe, but for GoO systems for liquid and gaseous fuels, a 'mass balance' approach is needed (see section 3.2.4)

3.2 Renewable methane certification systems

3.2.1 History

Certificates for renewable methane (biomethane and methane from other renewable sources) have a shorter history than those for electricity. However, in the past years, initiatives in various EU countries have led to several GoO systems for renewable methane (Gasunie 2013). It seems that the GoO systems of the Netherlands, Germany and the UK are the most advanced.

- Some countries such as the Netherlands have started with an elaborate GoO system from the start, with a fully-fledged set of information on the GoO and an elaborate supporting ICT system. Other countries such as Denmark have started with a very simple certificate system that was further developed and extended over the course of time.
- Some key characteristics of the various current GoO systems for green gas can be found in annex I.

3.2.2 Actors

As for GoO systems, key actors include the issuing body, producers, auditors, traders, and end consumers.

The issuing body hands out the tradable certificates and owns the accompanying registry. In some countries, the issuing body has been appointed by the government, in others it has merely originated from a private sector initiative. Producers report their production to the issuing body, including the required attributes and characteristics, in order to receive a certificate tailored to the quality of renewable methane. This certificate, which proves the green nature of the production, can be traded separately from the physical flow of the methane produced. The information producers provide and their monitoring procedures are checked regularly by auditors, who work according to the standards that the issuing body provides. The certificates can be bought by traders or suppliers. Finally, they are bought by suppliers who offer gas products to end consumers. Large end consumers can buy the certificates directly in order to prove the greenness of their gas consumption. After the consumption of the gas product, the certificate is cancelled in order to exclude any kind of double marketing.

3.2.3 Current purposes and definition

All certificate systems allow for consumer disclosure: an end consumer who wants to claim that the gas he/she consumes is green can do so by buying and cancelling a proportional number of certificates.

In some countries, such as Germany, Sweden and the Netherlands, certificates also play a role in policy support for green methane. For example:

- In the Netherlands, the data in the renewable methane certificates is used as proof for calculation of the production in the feed-in premium scheme for renewable methane, the SDE+ (although the certificate does not need to be handed in to receive the support). Besides, renewable methane certificates that meet certain conditions can be converted into 'renewable fuel units', the tradable certificates in the context of the biofuels blending obligations.
- In Germany, the bio-methane GoOs are accepted as a proof for receiving feed-in support for the produced electricity from bio-methane (but not for the conditioned and fed-in methane itself).
- In Sweden, bio-methane certificates are used in the transport sector to apply for exemption of various (fuel and vehicle) taxes.

3.2.4 Key issues and lessons learned

Start-up strategies

In general, GoO systems in different countries can vary: consistency between Member States was not on the agenda at the start of many GoO systems. However, as trade of green gas certificates is considered increasingly interesting, there is more interest in harmonisation, including some pilots for international trade in certificates.

Book-and-claim setups and international trade

The most common set-up for green gas GoO systems follows a book-and-claim approach: the produced methane and its GoOs can be traded entirely separately. However, the EU 2009 RES directive and the fuel quality directive only recognise international trade in certified liquid and gaseous biofuels when this is done through a mass balance approach: the certificate trade must be coupled to the physical transfer of the related energy carrier. In practice, this also means that international trade of renewable methane GoOs should be done through a mass balance approach, and there must be a physical connection between the countries in which supplier and consumer are located, although the produced methane can be blended with non-certified methane. Pilot activities have been started to couple certificates with international transport nominations (proofs of physical gas trade between countries) to allow imports/exports. An essential condition for such trade is that the green methane is recognised

in the GoO system of the receiving country (and corresponding certificates are issued) and that in parallel, the same amount of certificates is cancelled in the registry of the exporting country (Van Pijkeren and Pol 2015).

Linkage of biomethane GoOs with support schemes

As mentioned in the introduction, GoOs mainly serve the purpose of consumer disclosure but can also serve support scheme management. However, the latter is not without complexities, as policy makers are usually wary of combining support schemes that in total lead to policy redundancy or overstimulation[24]. In the Netherlands, overstimulation could occur by combining a feed-in premium with incomes from tradable certificates in the context of the renewable transport fuels obligation, but this is prevented: Renewable methane certificates can only be converted into the renewable fuel certificates for the renewable transport obligation if the green gas production has not received feed-in support. However, when international trade of certificates is to be introduced, this check on possible overstimulation would require detailed information on the types of support the biomethane has received, and their impact on the business case. As already mentioned in Table 3, this will be difficult if not impossible, which illustrates that any linkages between GoOs and policy instruments should be handled with care.

Credibility of the green certificate

For any new certificate, it is vital that the stated environmental claims are considered trustworthy by the users of the certificate. For private consumers this may mean that the environmental benefits of the certified green methane should be beyond dispute. When the GoO system is used for governmental regulations, all relevant information that an authority needs for checking compliance with the regulation requirements shall be in the GoO system.

Some examples regarding credibility from the Dutch setting (Van Pijkeren and Pol 2015):

- Vertogas, the Dutch issuing body of renewable methane GoOs, has been relatively strict in its definition of green gas. For example, it was based on net green methane production even when for Dutch and EU regulations, gross production would also have been acceptable.
- Some "missed opportunities" of the new regulations on green gas GoOs are:
  - No introduction of green gas labelling, which additional information on origin and nature of the product would have been better for product transparency, relevant for consumer's choice and demand creation.
  - No introduction of a of book and claim approach in cross-border trade, due to conditions in EU legislation (2009 RES Directive and FQD). This still needs to be done on the basis of mass balancing. This is relevant as the separation of physical

[24]Here, we define overstimulation as governmental support that structurally provides more financial compensation than what is needed to overcome the 'financial gap'; the difference between production costs and product sales revenues.

trade and GoO trade will actually contribute to more market liquidity, while tying physical and GoO trade stifles market liquidity.

- There is no EU-wide harmonised regulation on whether the issuance of a certificate requires biogas to be conditioned in a way that it can be fed into the "public" grid.
- In the Netherlands, CertiQ is the issuing body of electricity and heat GoOs, while Vertogas is the issuing body for renewable methane. The fact that energy carriers can be converted into each other (e.g. natural gas into electricity and hydrogen, hydrogen into electricity and vice versa) argues in favour of the operation of GoO systems by one neutral organisation: The administrative system needs to be fully consistent throughout the "energy transformation life cycle".

3.3 Renewable transport fuel certification

3.3.1 Context and objectives

The 2009 RES Directive also contains a specific target for renewable energy in transport of 10% in 2020, mostly to be met through liquid and gaseous biofuels. In most EU countries, this target has been translated into a biofuels quota system (on an energy basis), in which fuel suppliers must prove that a given share of their fuel sales consists of biofuels.

In most cases, this quota obligation is accompanied by a system that allows for trade between market players, often through a dedicated certificate system. These certificates must also contain the relevant information to serve several purposes:

- Prove that the biofuels involved are compliant with the various conditions in the 2009 RES Directive on inter alia greenhouse gas emissions and feedstock origin;
- Contain the relevant information to check whether the related biofuels are allowed to count twice against the target (depending on the feedstock used);
- Allow for certificate trade between different fuel suppliers under the quota obligation.

Strictly speaking, such tradable certificate systems are not a GoO system, as they allow for trade in a concrete support scheme (a quota obligation), and do not have the purpose of consumer disclosure.

3.3.2 Other features

In terms of *actors*, biofuels quota systems are not different from the other GoO systems discussed in this paper. One specific feature of the biofuels quota schemes is that each EU country has to implement the RED criteria by itself and is therefore allowed to apply its own approach to comply with the RED criteria including an own system for safeguarding of biomass sustainability. However, there is also a huge number of voluntary certification schemes accredited by the European Commission ensuring compliance with the criteria set out in the RED for the entire fuel life-cycle. Although the EU biofuel target is not internationally tradable (all Member States need to meet the 10% target individually), the related certificate systems for the biomass to be used for it do allow for international trade.

3.3.3 Issues and lessons learned

One issue that was encountered in the Netherlands regarding biofuels quota relates to possible double incentives. As renewable methane use in transport also counts towards the EU transport target, a green gas certificate can also be converted into a renewable fuel unit, the certificate under the transport quota system. However, production of biomethane can also receive a feed-in premium that essentially covers the full cost gap for its production. In order to avoid the double incentive of production-subsidised renewable methane and quota system, the government has taken the following measures, which can be easily copied to green hydrogen as well:

- The information on the green gas certificate includes whether or not it received the feed-in premium.
- The renewable fuel obligation certificate system blocks the conversion of a green gas certificate into a renewable fuel unit if this certificate reports that a feed-in premium was received.

Key summary points

In comparison to the RES-E GoO scheme, very few efforts have been made to put in place GoO schemes for renewable heating and cooling. An important reason is the uncertainty of whether a sufficiently liquid market will emerge for renewable heating and cooling.

In recent years, initiatives in various EU countries have led to several GoO systems for renewable methane. These schemes vary considerably from very simplistic (Denmark) to a scheme with fully-fledged information (e.g. Netherlands). Their features and lessons are generally consistent with those for renewable electricity GoOs.

There is an increasing interest in trade of green gas certificates, resulting in more attention for harmonisation, including some pilots for actual trade.

4 Interactions between a Hydrogen GoO and existing GoO schemes

4.1 Why do we want to address interactions?

In this report, we define interaction as an *"action that occurs when two or more objects, or in this case certification schemes, have an effect upon one another"*. The idea of a two-way effect is essential in the concept of interaction, as opposed to a one-way causal effect.

A GoO provides evidence of the energy source of a given energy carrier, such as electricity. For example, the GoO for renewable electricity (RES-E GoO) proves that the electricity is generated from renewable energy sources. The primary role of the RES-E GoO is to serve as a basis or tool for disclosure, i.e. informing consumers about what kind of electricity they are purchasing. Currently, there are GoO schemes in place not only for electricity from renewable energy sources (RES), but also for green gas, energy efficiency, and renewable heat, and existing European Union legislation also encourages the issuance of GoOs for non-renewable energy. In addition, certification (e.g. green and/or white certificates) and labelling schemes have been established which cover similar objectives to that of GoO schemes, i.e. information to consumers on what energy sources the energy carrier is based on.

It has been pointed out that the existence of these multiple schemes could jeopardize the trustworthiness of any of these existing schemes. In order for these schemes to be *'trustworthy'* and create consumer confidence, they must be designed to facilitate *'reliability, accuracy and fraud-resistance'*. If consumer confidence in a Green H_2 GoO would not be met, the purpose of the scheme would be undermined. As such, any new GoO scheme should be designed such that proper *'book keeping'* can be insured. This is important not only for issuance-transfer-redemption for a particular energy carrier, but also in the transformation from one energy carrier to another.

In summary, the most important and relevant pathways for transformation of energy carriers, which include hydrogen, include

- Electricity → gas
- Electricity → gas →electricity
- Electricity → gas → electricity & heat *(cogeneration)*
- Renewable methane →hydrogen

Hydrogen is very versatile in its applications, sometimes involving one or more transformations from one energy carrier to another. Hydrogen produced from electrolysis can be stored (either as a gas (under high pressure) or as liquid (at low temperatures)) and later converted to electricity or used as raw material in industrial processes. Future applications include the potential to power internal combustion engine vehicles that run on hydrogen. Electricity can be stored as hydrogen, and later be converted back into electricity. Alternatively, hydrogen can be converted to methane using a methanisation reaction, and fed into the natural gas infrastructure.

Understanding the interactions between new and existing GoO schemes for different energy carriers is important, particularly when there is transformation of energy carriers from one

form to another, firstly from the perspective of ensuring trustworthiness, and secondly, to avoid unnecessary *'system costs'*, i.e. costs that would be imposed or carried by producers and/or consumers. High system costs could jeopardize the supply and demand of GoOs, and undermine the interest of *'participating'* in a GoO scheme.

4.2 Scope and limitations

We only focus on hydrogen from electrolysis (because Green H_2 is based on RES-E share of electricity used in the electrolysis process), with an eye on hydrogen produced through Steam Methane Reforming (SMR) with (certificates for) renewable methane as a feedstock.

The green or "premium" hydrogen may be used to comply with different regulations or policies put in place to promote green hydrogen. For example, a Green H_2 GoO could be used to comply with certain emission reduction requirements and/or for possible subsidy allocation. This could have implications for the type of interactions that should be addressed. However, we do not have a clear picture of future policy requirements. In addressing interactions, we therefore limit the objectives of the Green H_2 GoO scheme to that of disclosure, i.e. proof of renewable origin and to low emission content.

4.3 Brief description of the uses of hydrogen and drivers for Green H_2 GoOs

In order to identify the possible interactions between a new Green H_2 GoO scheme and existing GoO schemes it is important to have a clear understanding of the various applications of hydrogen and the drivers for these.

Deliverable 1.3 of the Certfihy project gives an overview of the (future) demand for hydrogen in sectors and drivers for hydrogen. Generally, the sectors are divided into three categories with subsequent sub-segments[25]. The three categories include industry, mobility and power-to-gas. Whilst industrial sector represents more than 90% of today's hydrogen consumption, the two latter sectors are still very small and under development. The mobility sector is potentially one of the key sectors that may generate substantial growth and demand for green hydrogen.

Demand for Green H_2 GoOs in the different industries are likely to be driven by (summarised from deliverable D1.3 of the CertifHy project)[25]:

[25]: Fraile, D., A. Torres, A. Rangel, and P. Maio (2015): Generic estimation scenarios of market penetration and demand forecast for "premium" green hydrogen in short, mid and long term. CertifHy Deliverable 3.2, Hinicio.

Refineries industry

- **Substitution of conventional hydrogen by renewable-based hydrogen and/or low-carbon hydrogen, e.g for target compliance, such as 10% transport target in RED, 6% target of FQD.**
- **Substitution of conventional hydrogen by low-carbon hydrogen to profit from the CO2 market under the EU ETS.**

Chemical industry

- **Reducing the businesses carbon footprint.**
- **Moving towards a more sustainable business due to increased environmental pressures.**
- **Corporate Social Responsibility and image.**

Other industries (glass manufacturers, semiconductor industry, food industry)

- **Hydrogen purity, some industry players will demand hydrogen from electrolysis as it can supply higher purity.**
- **Corporate Social Responsibility and image.**

In some cases, hydrogen is produced as a by-product from certain industrial processes.

4.4 Overview of undesired (negative) interactions and measures to mitigate

GoOs are electronic certificates issued for a given energy carrier, enabling the producer to document the energy input of the energy carrier, e.g. energy from renewable sources. A well-designed GoO scheme requires a set of rules and regulations concerning a number of different aspects; the eligibility and accreditation of a producer or plant, the issuance of the GoO, the transfer of the GoO, and the redemption of a GoO. In addition, rules will cover the information content of a GoO, its size (e.g. 1 MWh) and validity. Furthermore, responsibilities have to be defined, such as who should be in charge of ensuring a proper functioning of the scheme. Supra-national legislation, such as the 2009 Renewable Energy Directive dictates a set of requirements that the member states must follow.

A well-functioning Green H_2 GoO scheme will need to be based on a similar set.

The most important and relevant interactions between existing GoO scheme and a newly established Green H_2 GoO scheme will occur when one energy carrier eligible for a GoO is transformed into another energy carrier which is eligible for a GoO under another scheme.

Here, we could encounter a number of interactions. The interactions can be classified as undesirable or negative when they are seen to create barriers to the issuance, transfer or redemption of a GoO and/or when market parties are not confident using GoOs to fulfil a given purpose, e.g. to document a company's carbon footprint.

Table 4 below lists the most important undesired interactions and measures which could be implemented to mitigate these. Barriers to the issuance-transfer-redemption of GoOs could include unnecessary or complicated administrative procedures, including complicated conversion calculations, or high costs for in the conversion of GoOs from one scheme to another. These barriers could best be mitigated by introducing harmonised rules across the

relevant GoO schemes, and by keeping conversion rules and calculation methodologies simple. On the issue of consumer confidence, which is crucial if one wishes to create a critical mass (and allow for lower unit costs), transparency in the design and implementation of rules and calculation methodologies for conversion from one GoO to another will be crucial.

Table 4: Overview of undesired (negative) interactions and measures to mitigate these

Undesired interactions:	GoO characteristics needed to prevent this:
Administrative barriers for conversion of GoOs (from one energy carrier to the other)	Harmonized rules for conversion, EU-wide. Use the same registration system for all types of GoOs.
High administrative costs for conversion	As simple as possible procedure. Large scale to create critical mass.
Loss of credibility and consumer trust in certificates due to conversion	Transparent and proper bookkeeping e.g. on conversion efficiencies, cancellation of converted certificates and residual mix calculation.
Double use of GoOs (certificates) for different purposes through conversion	General point of attention in certificates, also in conversion. For example, in the Netherlands, Green gas certificates can be translated into Renewable Fuel Units (RFU), as long as they have not been produced under the SDE, the feed-in premium scheme that supports production and grid feed-in of biogas. Ensure the cancellation of a GoO at the time of conversion into another (type of) GoO
Complex calculation rules for conversion	Keep calculation rules as simple as possible, e.g. with 'default' data and the option to submit motivated deviations.
Illegal conversion of GoOs (conversion of GoOs without physical conversion of the energy carrier, leading to shortage of GoOs in the disclosure system of the originating energy carrier)	Clear rules and transparent control mechanisms.

Key summary points

The specific assessment of implications of interactions between a hydrogen GoO and existing GoO schemes indicates several potential undesired interactions and options to mitigate them, which are consistent with the earlier analysis of existing GoO schemes. The analysis also shows that there is a trade-off between the comprehensiveness of the accounting systems (providing maximum safeguards against undesired interactions)for conversion and the administrative burden of it (reducing overall effectiveness of the GoO scheme).

5 Conclusions: Implications for a (green) hydrogen certificate system

On the basis of the review material in chapters 2, 3 and 4, we draw conclusions on the following elements:

1. Recommendations for an optimal green hydrogen GoO scheme, based on lessons learned from existing schemes (sub-chapter 5.1);
2. Key issues from experiences with other schemes, relevant to hydrogen (sub-chapter 5.2);
3. Recommendations for a development pathway for the scheme (sub-chapter 5.3).

On the basis of material in chapter 4, we draw conclusions on the implications for a green hydrogen GoO scheme with regard to mitigating undesirable interactions (sub-chapter 5.4).

5.1 Key lessons learnt and recommendations for an optimal scheme

The review provides some robust general insights for designing the green hydrogen GoO scheme:

- First, the overall set-up of GoO systems is successful, with the RES-E GoO system being the most developed. The functional system, with clear roles for producers, traders, consumers and an issuing body, in which certificates are issued, traded and finally cancelled, has proven its value in other energy domains. This basic structure can be transferred to a green hydrogen GoO system.
- Any claims with respect to renewable origin of hydrogen consumed made by market parties in commercial messages will have to be proven by cancelation of the required hydrogen GoO.
- For detailing of the system, the AIB Rules and Principles for a European Energy Certificate Systems (EECS) are the best basis to start from. While they have not been fully implemented in all Member States, it would be beneficial for a GoO scheme for hydrogen to use these principles from the start.
- An optimal scheme should not create any barriers for international trade and should allow the European internal market to function well. This means that a single European registry should be established from the start, or that national registries should preferably use identical data structures, or procedures for international certificate transfer should be developed that maintain all relevant information.
- The GoO scheme should cover all possible production routes for green hydrogen, including import and export within the EU and with third countries.
- The GoO system should be open to all applications for hydrogen. While initially, industry may be the main end user, it should already be prepared for the entrance of hydrogen distributors for transport applications.
- A key element of the GoO system should be the separation of information on the origin of the product on the one hand, and the part that specifies whether the product meets

certain qualifications, such as the CertifHy definition of green hydrogen, or the 2009 RES Directive qualifications for renewable transport fuels. The information part is factual and neutral, while the qualifications part may change with developments in policy over time. Obviously, the factual database needs to contain all relevant data needed to check the products in the qualifications part, and in the course of time, additional types of information may need to be added for this.

- Initially, the function of the GoO system should be consumer disclosure. Our review indicates that linkages between GoO systems and support schemes should be handled with care. This includes the role of GoOs for renewable energy carriers in sectoral obligations, such as the one for renewable energy in transport. Such linkages could lead to policy redundancy or overstimulation.
- A harmonised GoO scheme for the EU as a whole seems preferable, as this also allows to introduce standard (calculation) rules for conversion. Generally, proper bookkeeping is essential, also to prevent double counting effects, and to safeguard consumer trust. However, there is a trade-off between comprehensiveness of the accounting systems for conversion and their administrative burden.
- With potential changes in the external environment of the GoO scheme and its use, a transparent and regular review and update of the system is also relevant. Such an update could include the inclusion of new attributes in the 'factual' section of the GoO, and updates of the qualifications section if definitions of 'green' or 'sustainable' hydrogen have been set up.

5.2 Key issues of existing schemes relevant to hydrogen

At several points, the review has revealed issues that have not (yet) been solved in the currently existing GoO systems, or that are treated differently among them.

- The issue of additionality, i.e. whether the purchase of a GoO leads to an increase in renewable energy production capacity in comparison to the situation without such purchase. Whilst existing EU legislation does not require GoOs to facilitate additionality, better transparency, i.e. information included in a GoO on whether or not additionality is achieved, would be beneficial from the perspective of consumers wishing to influence the environmental profile of the energy supply as a whole.
- The issue of the residual mix in the electricity sector: although residual mix calculations for electricity as such do not need to be complex, trade, import/export and conversion of one energy carrier into another complicates their calculation and increases the risk of double counting. This risk can be overcome by proper bookkeeping, and activities are ongoing to improve practice in this field. Whilst on the one hand, it can be argued that in the long-term, a comprehensive coverage of the full diversity of all energy sources by the GoO systems would eliminate the residual mix issue, it can also be argued that e.g. non-green H_2 producing plants should not be

eligible for GoOs. In the long-term, compromise on the full scope of a GoO scheme will have to be sought.

- Another point of attention is the issue of conversion of one energy carrier into another (e.g. from renewable electricity into renewable hydrogen, or vice-versa). In principle, proper book-keeping is sufficient to make sure such conversion is correctly taken care of; earlier experiences show, however, that careful design of procedures is essential.
- Losses are not taken into account in current GoO schemes, such as the GoO for renewable electricity. This is due to the fact that current EU legislation requires a GoO to be issued upon request by a producer, e.g. to give proof of the origin of electricity produced from renewable energy sources (which takes place before the electricity is transported by the grid). However, there may be issues of energy losses that need or should be taken into account with regard to energy transformations involving (green) hydrogen. This point may therefore require attention.
- How should production be treated of installations that use both renewable and non-renewable energy be eligible for a renewable or green certificate? And what if the overall CO_2 intensity of such installations is relatively high? Examples of this are biomass co-firing in coal-based power plants, and electrolysis hydrogen production systems that partly use renewable and partly non-renewable power. This point requires attention in the definition of green hydrogen. In support, a GoO system could provide information not only about the directly related GHG emissions, but also on the GHG emissions of the production system as a whole.
- In general, the fact that the renewable attribute of an energy carrier is separated from its physical trade makes a GoO inherently less 'fool-proof'. Existing GoO systems still encounter challenges with this type of *'virtual trade in renewable attributes'*, e.g. in terms of general consumer confidence. In the design of any GoO system, there needs to be alertness on this point. . In this context, it is also important to stress that any linkages between GoO systems and support schemes should be handled with care. This includes the role of GoOs for renewable energy carriers in sectoral obligations, such as the one for renewable energy in transport.

5.3 Initial thoughts on a development pathway for a hydrogen GoO scheme

The lessons learnt and issues identified already set the scene for a development pathway for green hydrogen GoOs. However, there seems to be some strategic dilemma in the development of a green hydrogen GoO scheme. On the one hand, a scheme should be as elaborate as possible from the early beginning in order to serve a variety of users and accommodate e.g. trade and conversion in a reliable manner. Also, such a scheme would preferably be Europe-wide from the start, with a top-down development, in order to have a harmonised set of rules and also to provide one standard GoO. On the other hand, the review also shows significant differences between Member States in how they deal with some elements of their existing GoOs. It may thus be difficult to find EU-wide consensus from the start. Besides, the initial market for green hydrogen will be small, and relative administrative

costs per unit of green hydrogen traded may be high when a fully-fledged European GoO scheme is to be introduced from the outset.

In our view, it is essential to have a general European GoO scheme for green hydrogen. This review already shows robust elements among GoO schemes that can be used for its shaping, and points where there are differences between countries and between energy carriers. In a development pathway for a hydrogen GoO, it is probably most effective to start with a system that covers the robust parts. For its further development, the GoO characteristics on which national positions differ should be further elaborated and discussed, with the aim to reach a workable compromise that can then be used to further develop the GoO scheme. Further details of a green hydrogen GoO scheme will be developed in CertifHy Work Package 4. The development pathway will be further detailed in the road mapping part , Work Package 5.

References

AIB (2015a): European Energy Certificate System (EECS): Principles and rules of operation. Association of Issuing Bodies.

AIB (2015b): AIB reflection paper on the forthcoming RES Directive. AIB-2015-WGIA-RP01. June 2015. Association of Issuing Bodies.

Boardman, Brenda, J. Palmer, A. Arvidson, V. Bürger, J. Green, K. Lane, J. Lipp, M. Nordstrom, H. Ritter, C. Timpe, D. Urge-Vorsatz (2003): 4CE Final Report, Prepared as part of the IEE project 'Consumer Choice and Carbon Consciousness for Electricity (4CE)'. http://www.electricitylabels.com/downloads/4CE_Final_Report.pdf

Bürger, V., F. Rivero Garcia, J. Green, J.C. Jansen, N.H. van der Linden, C. Timpe, M.A. Uyterlinde, C. Vrolijk, S. White, G.P. Yerro (2004): Guarantees of Origin as a Tool for Renewable Energy Policy Formulation – RE-GO phase 2 report.

E&E Advies (2013): International trade in biomethane: Options for trade of biomethane between EU and non-EU countries. E&E Advies for Gasunie. Groningen 2013.

Gasunie (2013): An overview of the biogas and biomethane market; set of national factsheets for Austria, Denmark, France, Germany, the Netherlands, Poland, Sweden, Switzerland and the UK. Gasunie, Groningen 2013.

Grexel (2014): Energy Certificate Systems Introduction – What are Energy Certificates? http://www.grexel.com/sites/grexel.com/files/energycertificates.pdf.

Jansen, J.C. and M. Londo (2015): Briefing Paper on the regulatory context for defining green hydrogen and its certification. EU-co-financed project CertifHy. Deliverable No. 2.1. Petten/Amsterdam 2015.

Raimundo, C. (2015): Qualitative Assessment of Disclosure and GO system; Monitoring Report (Draft). Deliverable 2.2 of Work Package 2 from the RE-DISS II project. http://www.reliable-disclosure.org/upload/203-Monitoring_Assessment_RE-DISS_II_V07.1.pdf, site consulted on October 12, 2015.

RE-DISS (2012): Final Report from the project "Reliable Disclosure Systems for Europe (RE-DISS)". Őko-Institut e.V. Freiburg, December 2012.

RE-DISS II (2014): Electricity Disclosure and Carbon Footprinting: Effects and incentives resulting from different approaches to account for electricity consumption in carbon footprints. Deliverable 6.2 of the RE-DISS II Project. December 2014.

RE-DISS II (2015a): Best Practice Recommendations For the implementation of Guarantees of Origin and other tracking systems for disclosure in the electricity sector in Europe. Version 2.3, 31st July 2015. http://www.reliable-disclosure.org/upload/183-RE-DISS_Best_Practice_Recommendations_v2.3_Final_31-07-15.pdf

RE-DIS II (2015b): Country profiles and summaries of national legislation. See http://www.reliable-disclosure.org/documents/, site consulted on October 12, 2015.

Ritter, H., T. Riess, C. Timpe, C. Pooley (2007): Assessment of the Cost of a European Tracking Scheme. E TRACK Work Package 5 report. http://www.e-track-project.org/E-TRACK_WP5_Report_v1.pdf

Timpe, C. and H. Sprongl (2009): Long term developments and integration of energy-related certification schemes. WP6 report of the E-TRACK II project (Deliverable 9), 30 November 2009.

Van der Lee, J. and M. Lenzen (2015): Personal communication in an interview on RES-E Guarantees of Origin and the role of CertiQ. CertiQ, Arnhem, March 20, 2015.

Van Pijkeren, G. and D. Pol (2015): Personal communication in an interview on green gas certificates and the role of Vertogas. Vertogas, Groningen, March 16, 2015.

Annex I: Directive 2001/77/EC on the concept of Guarantee of Origin

Preamble 10 states: "This Directive **does not require** Member States to recognize the purchase of a guarantee of origin from other Member States or the corresponding purchase of electricity as a contribution to the fulfilment of a national quota obligation. However, **to facilitate trade in electricity produced from renewable energy sources and to increase transparency for the consumer's choice between the electricity produced from non-renewable and electricity produced from renewable energy sources, the guarantee of origin of such electricity is necessary.** Schemes for the guarantee of origin do not by themselves imply a right to benefit from national support mechanisms established in different Member States. It is important that all forms of electricity produces from renewable energy sources are covered by such guarantees of origin. Preamble 11 adds: "It is important to distinguish guarantees of origin clearly from exchangeable green certificates."

The main text sets out in Article 5 the legal meaning of a "Guarantee of origin of electricity produced from renewable energy sources" according to Directive 2001/77/EC, viz.:

1. Member States **shall**…ensure that the origin of electricity produced from renewable energy sources can be guaranteed as such within the meaning of this directive according to objective, transparent and nondiscriminatory criteria laid down by each Member State. They shall ensure that a guarantee of origin is issued to this effect in response to a request.
2. Member States **may** designate one or more competent bodies, independent of generation and distribution activities, to supervise the issue of such guarantees of origin.
3. **A guarantee of origin shall:**
    - **specify the energy source from which the electricity was produced, specifying the dates and places of production, and in the case of hydroelectric installations, indicate the capacity;**
    - **serve to enable producers of electricity from renewable energy sources to demonstrate that the electricity they sell is produced from renewable energy sources within the meaning of this Directive.**
4. Such guarantees of origin, issued according to paragraph 2, **should** be mutually recognized by the Member States, **exclusively as proof of the elements referred to in paragraph 3**. Any refusal to recognize a guarantee of origin as such proof, in particular for reasons relating to the prevention of fraud, must be based on objective, transparent and non-discriminatory criteria. In the event of refusal to recognize a guarantee of origin, the Commission **may** compel the refusing party to recognize it, particularly with regard to objective, transparent and non-discriminatory criteria on which such recognition is based.
5. Member States or the competent bodies **shall** put in place appropriate mechanisms to ensure that guarantees of origin are both accurate and reliable and they shall outline … the measures taken to ensure the reliability of the guarantee system.
6. After having consulted the Member States, the Commission **shall**….consider the form and methods that Member States could follow in order to guarantee the origin of electricity produced from renewable energy sources. **If necessary**, the Commission **shall** propose to the European Parliament and the Council the adoption of common rules in this respect.

Moreover, in the third footnote to indicative targets for year 2010 in the Annex of Directive 2001/77/EC an implicit remark is made on target accounting: "The percentage contributions of RES-E in 1997 and 2010 are based on the national production of RES-E divided by the gross national electricity consumption. **In the case of internal trade of RES-E (with recognized certification or origin registered) the calculation of these percentages will influence 2010 figures by Member State but not the Community in total.**

Directive 2009/28/EC on the concept of Guarantees of Origin

Whilst its precursor leaves some room for other purposes such as target accounting, the RED stipulates consumer disclosure as the only function of a "renewables guarantee of origin" (RE-GoO). Some relevant parts of the RED for the purposes of the CertifHy project are highlighted below.

Preamble 52 states that **Guarantees of Origin (GoO) issued for the purpose of this Directive have the sole function of proving to the final customer that a given share or quantity of energy was produced from renewable sources**. A GoO can be transferred, independently of the energy to which it relates, from one holder to another….Double counting and double disclosure of GoO should be avoided…Energy from renewable sources in relation to which the accompanying GoO has been sold separately by the producer **should not** be disclosed or sold to the final customer as energy from renewable sources. It is important to distinguish between green certificates used for support schemes and guarantees of origin. Preamble 53 adds that MS **should …be able** to require electricity suppliers who disclose their energy mix to final customers in accordance with Article 3(6) of Directive 2003/54/EC to include a minimum percentage of GoO from recently constructed installations ….. In repetition of preamble 11 of its predecessor, preamble 56 of the RED states that GoO do not by themselves confer a right to benefit from national support schemes.

Article 15 of the main text of the RED expands on the role of RE-GoO. It states the following:

For the purposes of proving to final customers the share or quantity of energy from renewable sources in an energy supplier's energy mix in accordance with …Directive 2003/54/EC, MS **shall** ensure that the origin of electricity produced from renewable energy sources can be guaranteed as such within the meaning of this Directive, in accordance with objective, transparent and non-discriminatory criteria. To that end, MS **shall** ensure that a GoO is issued in response to a request from a producer of electricity from renewable energy sources. MS **may** arrange for GoO to be issued in request from producers of heating and cooling from renewable energy sources. Such an arrangement **may** be made subject to a minimum capacity limit. A GoO **shall** be of the standard size of 1 MWh. No more than one GoO **shall** be issued in respect of each unit of energy produced. MS **shall** ensure that the same unit of energy from renewable sources is taken to account only once. MS **may** provide that no support be granted to a producer when that producer receives a guarantee of origin for the same production of energy from renewable sources. The GoO **shall** have no function in terms of (target accounting). Any use of a GoO **shall** take place within 12 months of production of the corresponding energy unit. A GoO **shall** be cancelled once it has been used. MS or designated competent bodies **shall** supervise the issuance, transfer and cancellation of GoO. The designated competent bodies **shall** have non-overlapping geographical

responsibilities, and be independent of production, trade and supply activities. MS or the designated competent bodies **shall** put in place appropriate mechanisms to ensure that GoO **shall** be issued, transferred and cancelled electronically and are accurate, reliable and fraud-resistant. A GoO **shall** specify at least:

a) the energy source from which the energy was produced and the start and the end dates of production;
b) whether it relates to electricity, or to heating or cooling;
c) the identity, location, type and capacity of the installation where the energy was produced;
d) whether and to what extent the installation has benefitted from investment support, whether and to what extent the unit of energy has benefited in any other way from a national support scheme, and the type of support scheme;
e) the date on which the installation became operational; and
f) the date and country of issue and a unique identification number.

An electricity provider **may** prove the share or quantity of energy from renewable sources in its energy mix for disclosure purposes (Directive 2003/54/EC) by using its GoO.

MS **shall** recognize GoO issued by other MS…exclusively (for disclosure purposes). It **may** only refuse to do so when it has well-founded doubts about its accuracy, reliability or veracity. The MS **shall** notify the Commission of such a refusal and its justification. If the Commission finds that such refusal is unfounded, the Commission **may** adopt a decision requiring the MS in question to recognise the GoO concerned.

A MS **may** introduce — in conformity with Community law — objective, transparent and non-discriminatory criteria for the use of GoO in complying with disclosure obligations (Ref: Directive 2003/54/EC, Art. 3(6)). Where energy suppliers market energy from renewable sources to consumers with a reference to environmental or other benefits of the energy from renewable sources, MS **may** require those energy suppliers to make available, in summary form, information on the amount or share of energy from renewable sources that comes from installations or increased capacity that became operational after 25 June 2009.

Annex II: Factsheets of various GoO systems for renewable natural gas

This annex contains some structured information on several GoO systems for (green) electricity, (green) heat, (green) methane and biofuels. Source: Gasunie (2013), and web sites of the issuing bodies.

GoO Name	Biogasregister Deutschland
Working area	Germany
Energy carrier	Biomethane
Issuing body	Deutsche Energieagentur (DENA)
Tracking mechanism	Mass Balancing
Attributes registered	Extensive list of 50 attributes, including: • Applied feedstocks • Installation production capacity • Several process conditions
Tradeable internationally?	Yes
Current applications	Several governmental support schemes: • Renewable energy feed-in tariff (EEG) • Renewable heat support (EEWärmeG) • Biofuels support (BioKraftNachV)

GoO Name	GvO hernieuwbaar gas
Working area	The Netherlands
Energy carrier	Renewable methane
Issuing body	Vertogas
Tracking mechanism	Book & Claim
Attributes registered	Various attributes, including: • Applied feedstocks • Relevant (feedstock) sustainability information • Whether the installation receives feed-in premium (SDE) • Installation production capacity • Several process conditions
Tradeable internationally?	For international trade, a declaration can be made to allow for trade on a Mass Balance basis
Applications	• Consumer disclosure • The renewable energy in transport obligation

GoO Name	Renewable Gas Guarantee of Origin (RGGoO)
Working area	United Kingdom
Energy carrier	Renewable methane
Issuing body	Renewable Energy Association
Tracking mechanism	Book & Claim
Attributes registered	Various attributes, including: • The technology by which it was produced (biogas from AD, landfill gas, 'syngas' from gasification) • The predominant feedstock from which it was derived (sewage sludge, food, agricultural activities, industrial waste water treatment, municipal solid waste, other feedstocks and a combination of these feedstocks) • The month and year in which it was produced • The country in which it was produced (England, Wales, Scotland, N. Ireland) • The registered producer • The kWh number, or sequence or range of kWhs relating to that producer's green gas.
Tradeable internationally?	Not yet (2011), ambition to align the system in order to allow for trade
Applications	• Consumer disclosure

GoO Name	Green Gas Principle
Working area	Sweden
Energy carrier	Biomethane
Issuing body	Energimyndigheten, the Swedish Energy Agency
Tracking mechanism	Book and Claim
Attributes registered	• Not found
Tradeable internationally?	No
Current applications	Several governmental tax exemptions (partial or full): • Energy tax • Carbon dioxide tax • Vehicle tax • Company car tax

GoO Name	Registre des Garanties d'Origine Biomethane (RGoO)
Working area	France
Energy carrier	Renewable methane
Issuing body	Gaz Réseau Distribution France (GrDF)
Tracking mechanism	Book & Claim
Attributes registered	• Production site • Key characteristics
Tradeable internationally?	Not yet (2011)
Applications	• Consumer disclosure • Eligibility for a compensation fund

GoO Name	Naturemade Star
Working area	Switzerland
Energy carrier	Renewable methane, other renewable energy carriers
Issuing body	Association for environmentally compatible energy
Tracking mechanism	Book & Claim
Attributes registered	• Not found
Tradeable internationally?	Not found
Applications	• Consumer disclosure

GoO Name	Tradable certificates of origin system
Working area	Poland
Energy carrier	All energy carriers
Issuing body	Not found
Tracking mechanism	Book & Claim
Attributes registered	• Feedstock • Production technology
Tradeable internationally?	No
Applications	• Fulfilment of the renewables quota system

GoO Name	‘Bionatural gas’ certificates
Working area	Denmark
Energy carrier	Biomethane
Issuing body	Energimet.dk
Tracking mechanism	Book & Claim
Attributes registered	• Not found
Tradeable internationally?	No
Applications	• Consumer disclosure

Annex III: Brief description of the energy carrier characteristics

Purpose of this chapter is to briefly compare key characteristics of energy carriers, and to identify features that are important for a Green H_2 GoO scheme.

As shown in Table 5, we can see that the characteristics of the energy carrier affects the structure of a GoO scheme in the following ways:

- ***diversity in production options (technology, scale)***; more diversity makes it more challenging to design a GoO in general. Hydrogen has some similarities to renewable electricity in this respect, at least on the generation side as there are a number of different technologies and renewable sources that can be used to generate RES-E.
- ***diversity in end consumers (e.g. demand size)***; this issue relates to the drivers behind the demand for a GoO. Diversity in end consumers could increase the number of different drivers for the GoO scheme. Drivers for green hydrogen are similar to those of e.g. renewable electricity, these being proof of substitution from conventional based energy to low-carbon energy, corporate social responsibility and image, reducing carbon footprint, making businesses more sustainable due to increasing environmental pressures.
- ***(expected future) market size***; important particularly from a unit cost perspective, costs can be reduced with larger number of participants (supply and demand).
- ***hybrid systems with combination of RES/non-RES based generation***; on this point, there is a clear similarity between hydrogen from electrolysis (which can be fed by a combination of renewable and non-renewable power.

Table 5: Comparison of energy carrier characteristics, and implications for a hydrogen GoO system.

Characteristic	Relevance for a GoO system	Energy carrier				Key issues/consequences for hydrogen GoO scheme
		Electricity	Heat	Methane	Hydrogen	
Diversity in production options (technology, scale)	More diversity makes it more challenging to have a GoO system useful for all options; think of administrative burden	High	High	High	High	Designing a hydrogen GoO system will need to take into account this diversity, just as other GoO systems have done so.
Diversity in end consumers (e.g. demand size)	More diversity makes it more challenging to have a GoO system useful for all options; think of different purposes	High	High	High	High	Designing a hydrogen GoO system will need to take into account this diversity, just as other GoO systems have done so.
Ease of direct storage of the energy carrier	Required GoO lifetime	Low	Low	High	High	GoO lifetime for hydrogen should be sufficiently long to allow for storage. This is a potential difference with RES-E GoOs
Ease of storage through conversion	Required GoO lifetime, risk of greenwashing (think of pumped hydro)	Moderate	Moderate	N.R.	N.R.	None
Conversion possibilities to other carrier	Importance of proper bookkeeping while converting, risks of double counting	Heat, **hydrogen**	-	**Electricity**, **heat**	**Electricity**, heat	Proper bookkeeping is important for a hydrogen GoO, as further conversion can take place.
Means of physical transport	Need for a GoO system: important with large infra, less with small-scale transport	Grid infra (trans) national	Pipe infra local	Pipe infra long-dist. shipping	Trucks, pipe infra	GoOss will be mostly relevant for transport through pipes. So on a bit longer term
Losses during transport	Importance of dealing with losses (or neglecting them)	Moderate	High	Low	Low	Losses are not the most critical point for a hydrogen GoO.
Diversity in product specs.	Diversity in specs may require diversity of GoOs	Low	High	Moderate	Low	This is not a critical issue for a hydrogen GoO
Current RES market size	Current market for GoOs, start a full-blown GoO system	High	Moderate	Moderate	Low	A hydrogen GoO system might need to start small and simple…
Expected future RES market size	outlook for GoOs, develop a full-blown GoO system	High	High	Moderate	Moderate	… but can definitely grow into a full/fledged system.
RES-non-RES hybrid systems?	Issue of 'dirty' hybrids, more GHG-intensive than reference	Moderate, Co-firing bio/coal	Low, Co-firing bio/coal	None	High, RES/coal power	This is a relevant point for a hydrogen GoO. Learn from biomass co-firing?

Annex IV: Stakeholders and experts that provided comments to the draft material

The following stakeholders and experts provided input to this report, through interviews, general comments and/or specific 'tracked changes' comments:

Person	Affiliation	Role
Cautaerts, Jonas	Colruyt group	Affiliated partner
Lafond, Dominique	EDF	Affiliated partner
Lee, Jan van der	CertiQ	GoO expert
Lenzen, Michael	CertiQ	GoO expert
Kerschbaum, Markus	OMV	Affiliated partner
Moody, Phil	Association of Issuing Bodies	GoO expert
Niermeijer, Peter	RECS International	GoO expert
Pijkeren, Gerard van	Vertogas	GoO expert
Pol, Daniel	Vertogas	GoO expert
Sandberg, Joost	AkzoNobel	Affiliated partner
Schiller, Christoph	Linde Gas	Affiliated partner
Schnitzeler, Frank	Air Products	Affiliated partner
Verwimp, Katrien	VREG	GoO expert