The interaction between existing certification systems and a new hydrogen GoO system

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1 Introduction

1.1 Task description

The CertifHy Project Consortium aims to develop a roadmap for the implementation of an EU-wide framework for guarantees of origin (GoOs) for green hydrogen (Green H_2)[1]. The substantive part of the CertifHy project has been structured in the following Work Packages:

1. Generic market outlook for hydrogen (H_2)
2. Definition of (Green) "H_2"
3. Review of existing platforms for GoOs
4. Definition of a new framework of Green H_2 GoOs
5. Roadmap for the implementation of an EU-wide GoO scheme for Green H_2

This specific deliverable is the result of the second task in Work Package 3: An exploration of interactions between existing certification schemes and the envisaged hydrogen GoO system. Specifically, this task consists of

- Identifying possible interactions between existing energy certification schemes and the envisaged Green H_2 GoO system.
- Analysing under which conditions desired interactions will occur and how undesired interactions from the perspective of the functioning of the envisaged Green H_2 GoO system can be mitigated.

This memo should be read in combination with the result of task 3.1: A review of past and existing GoO systems[2]. Task 3.2, if which this report is the result, will be followed by:

Task 3.3	Stakeholder interviews to identify what are the specific challenges with regard to certifying green hydrogen and how these can be addressed, building on the experiences gained from certification schemes in other markets.
Task 3.4	Consolidation of Work Package 3 results into a final report that will incorporate the results and recommendations obtained from the stakeholder interviews.

[1] 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). Further details see www.certifhy.eu.

[2] Veum, K., M. Londo and J. Jansen (2015): A review of past and existing GoO systems. CertifHy Deliverable 3.1, ECN.

1.2 Why do we want to address interactions?

In this memo, 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.

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 and/or used to power internal combustion engine vehicles that run on hydrogen[3]. 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.

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

[3] Use of hydrogen to power fuel cell vehicles is expected to come into the market in the next decade.

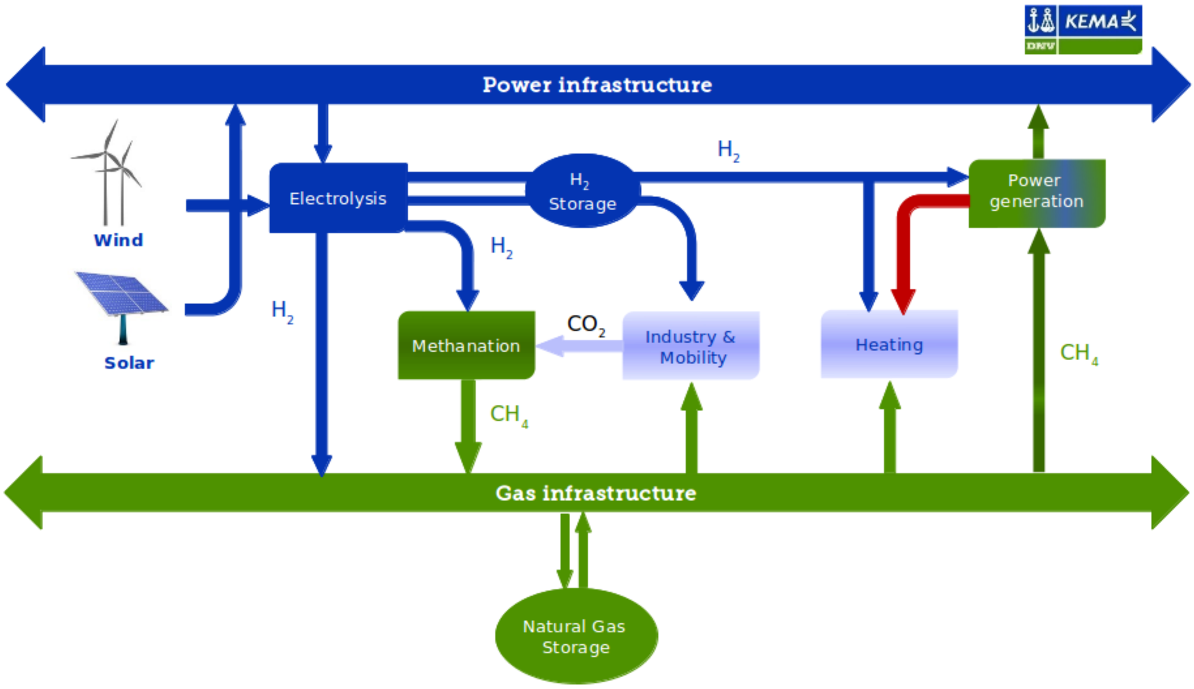

Figure 1: Transformation opportunities involving hydrogen. Source: http://www.europeanpowertogas.com/about/power-to-gas

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.

1.3 Scope and limitations

We only focus on hydrogen from electrolysis (because Green H2 is based on RES-E share of electricity used in the electrolysis process), as well as 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.

1.4 Structure

In the following chapters, we firstly focus on a brief description of energy carrier characteristics and implications for a (hydrogen) GoO system (Chapter 2). In Chapter 3, we focus on the interactions (potential and existing). In addition to what are the (potential) undesired interactions. In Chapter 4, we draw up conclusions on key interactions and what key actions to undertake to do to avoid/reduce undesirable/negative interactions, particularly from the perspective of a Green H_2 GoO.

2 Brief description of 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 1, 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 1: 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 pro-duction 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?

3 Interactions

3.1 Brief description of the relevant transformation options

In the introductory section, we briefly mentioned the possible pathways for transformation of energy carriers, which include hydrogen. These include:

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

Table 2: Pathways and conversion efficiencies. Source: Own table with input from Sterner et all.[4].

Pathway electricity → gas		
• Hydrogen	54-77%	Partly dependent on required pressure of product
• Methane	49-65%	Partly dependent on required pressure of product
Pathway electricity → gas → electricity		
• Hydrogen	34-44%	With 80 bar compression of intermediate gas
• Methane	30-38%	
Pathway electricity → gas → electricity & heat		
• Hydrogen	48-62%	With 80 bar compression, electricity/heat for 40/45%
• Methane	43-54%	
Pathway renewable methane → gas (SMR)		
• Hydrogen	65-75%	Partly dependent on required pressure of product

3.2 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.

[4]: Sterner, M. M. Jentsch, and U. Holzhammer (2011): Energiewirtschaftliche und ökologische Bewertung eines Windgas-Angebotes; Gutachten. Fraunhofer IWES.

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[5]. 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. In other words, the predominant market for a Green H_2 GoO is the industry.

In Figure 2 below, we see that these include refineries, metal processing, the chemical industry and other industries, such as food, glass, etc. The chemical sector uses hydrogen to produce a.o. ammonia, methanol, polymers, etc., whereas the metal processing sector uses hydrogen to yield iron reduction.

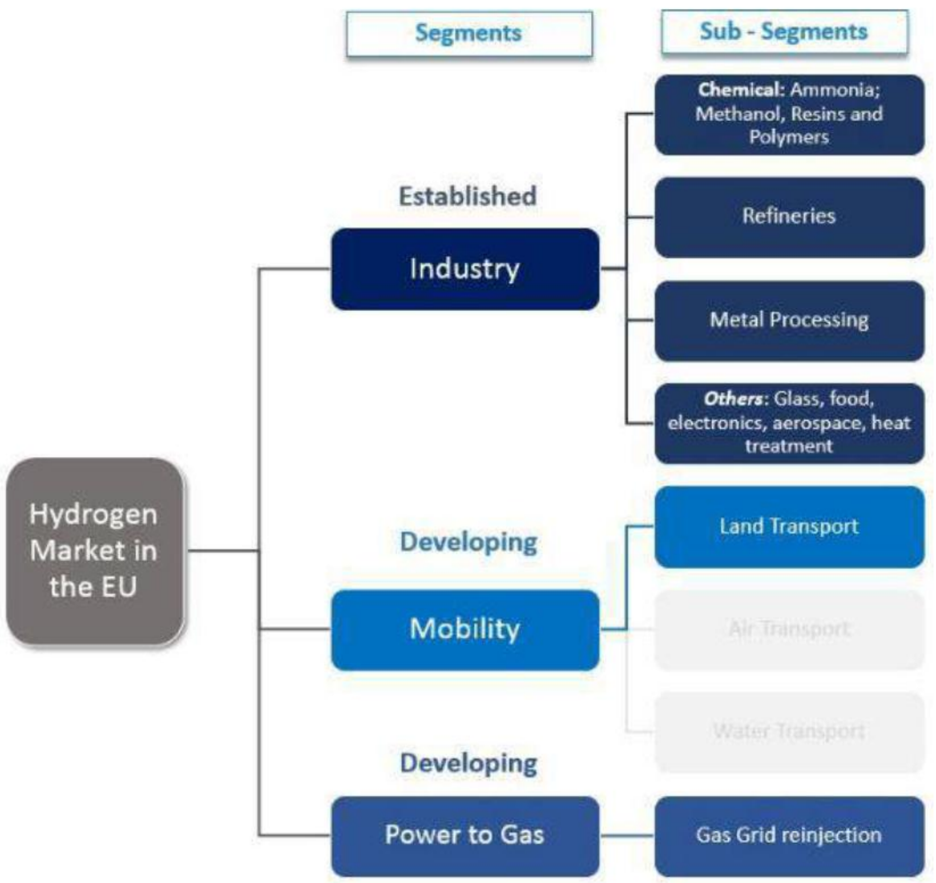

Figure 2: Hydrogen Market Segments and Sub-segments[6].

[5]: 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.
[6]: Fraile, D., J.C. Lanoix, P. maio, A. Rangel, and A. Torres (2015): Overview of the market segmentation for hydrogen across potential customer groups, based on key application areas. CertifHy Deliverable 1.2, Hinicio.

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)[5]:

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.

3.3 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 3 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 3: 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
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
Complex calculation rules for conversion	Keep calculation rules as simple as possible, e.g. with 'default' data and the option to submit motivated deviations.

4 Conclusions: Implications for a Green H2 GoO scheme

Key interactions between existing GoO schemes 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, e.g. a Green H_2 GoO scheme. Undesirable interactions are those that 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.

For the set-up of a GoO scheme for hydrogen, this leads to the following recommendations:

- 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 to occur after conversion, and to safeguard consumer trust.
- However, there is a trade-off between comprehensiveness of the accounting systems for conversion and the administrative burden of it. The optimum balance between the two may be a topic for further elaboration in the development of the green hydrogen GoO scheme, CertifHy WP4.