"Structured list of requirement for green hydrogen"

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Abbreviations

GHG	Greenhouse Gas
GoO	Guaranty of Origin
LCA	Life Cycle Analysis
RED	Renewable Energy Directive
SMR	Steam Methane Reforming

1 Introduction

The European project CertifHy develops the first EU-wide framework for the generation of Guarantees of Origin (GoO) for green hydrogen. The objectives of this ambitious initiative are to develop a widely accepted definition of green hydrogen, to design a robust GoO scheme for green hydrogen and to propose a roadmap to implement the initiative throughout the EU.

A key point in the project is the definition of green hydrogen. In order to have a comprehensive definition, the Consortium starts with the identification and characterisation of the possible ways of production, distribution and supply of hydrogen, followed by an extended Life-cycle analysis (LCA), which has been used as basis for the development of options to define green hydrogen. In parallel, a structured list of requirements has been put forward and consulted with the industry aiming to cover all relevant aspects related to a comprehensive and inclusive definition for green hydrogen.

2 Methodology to develop criteria for the characterization of green hydrogen

In order to come up with a well-accepted definition for green hydrogen, that takes into account the input of all relevant stakeholders and represent a workable and implementable solution, the project has carried out a process throughout which, step by step, the main requirements needed to develop a definition have been studied, proposed and eventually selected.

For each of the process steps, a set of requirement (criteria set) have been considered relevant and have been put forward, as shown in figure 1. This report elaborates which are the requirements used within each criteria set, and how the consultation activities support the development of the criteria.

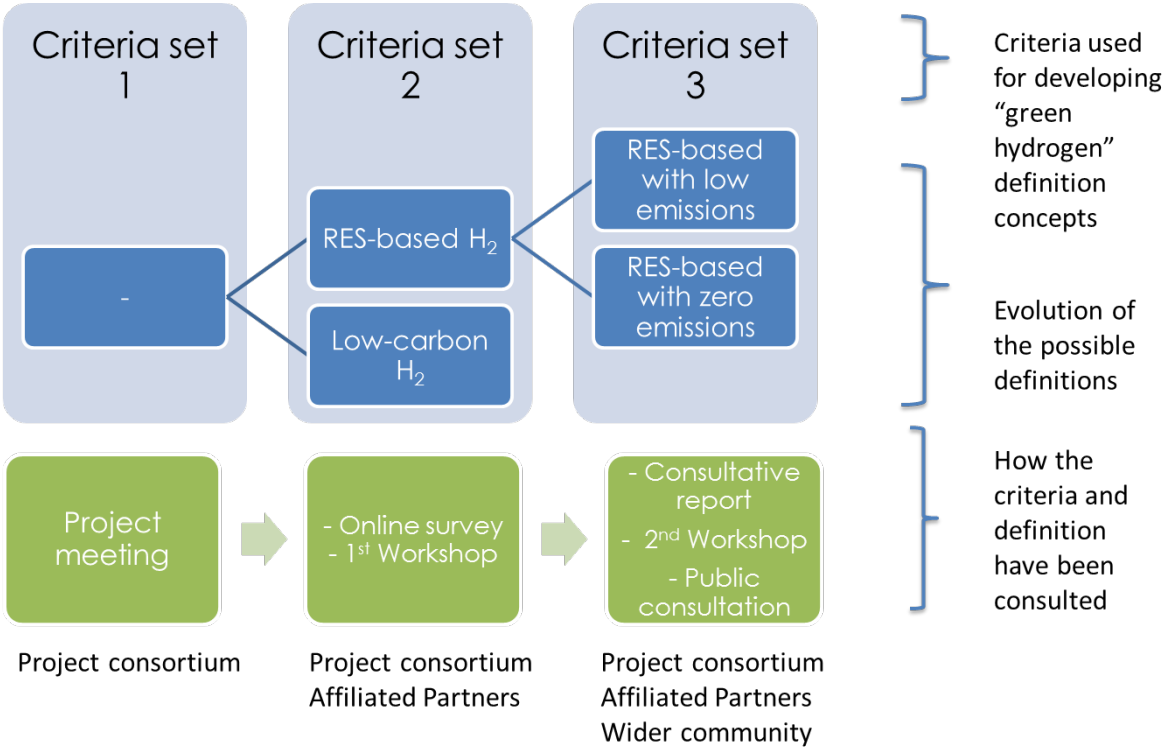


Figure 1. process

2.1 Criteria Set 1

The most relevant aspects considered when defining early concept of future definitions were:

- GHG emissions associated to the hydrogen produced
- The (renewable) origin of the energy required to generate the hydrogen
- The sustainability of the feedstock needed to generate the hydrogen

Considering these aspects, the project developed two main possible definitions:

The first approach was based on share of renewable energy and sustainability of feedstock. In this case the use of renewable energy and/or renewable feedstock is a condition for producing green hydrogen, and the amount of green hydrogen produced can be determined by the share of renewable energy and/or renewable feedstock in the total used or by a threshold.

The second approach was based on greenhouse gas (GHG) emissions. In this approach the GHG emissions of hydrogen production including all upstream process steps are calculated in a Life Cycle Analysis (LCA). Hydrogen produced will be considered green

2.2 Criteria set 2

Once the two conceptual approaches were developed, and number of criteria was identified as relevant. These include the following:

- Ways of proving the origin of the (renewable) sources,
- Appropriateness of various GHG thresholds existing in EU regulation, methodology to benchmark low GHG emission,
- Criteria to define by-product hydrogen,
- Completeness of all H2 production pathways,
- Approach to deal with losses associated to transport and storage, and
- Consideration of environmental impacts beyond climate change.

Another very important aspect that was addressed was:

- how to determine the amount of green hydrogen produced.

The requirements were put forward through an on-line survey. The 24 questions presented cover each of the above points, applicable to both approaches. The questionnaire can be found in the annex 1.

Taking into account the input from the online survey (March 2015) and the feedback received at the Affiliated Partners workshop on April 23rd 2015, and the results from the market study carried out in WP1, the CertifHy consortium proposes that the definition for green hydrogen should be:

- **Definition 1**: Green hydrogen is hydrogen from renewable sources with an associated GHG emissions intensity (based on a LCA approach) below a specified threshold. Any biomass used shall comply with the sustainability requirements according to the Renewable Energy Directive.

As displayed in figure2, the GHG content of the input is passed on to the hydrogen produced with the conventional approach.

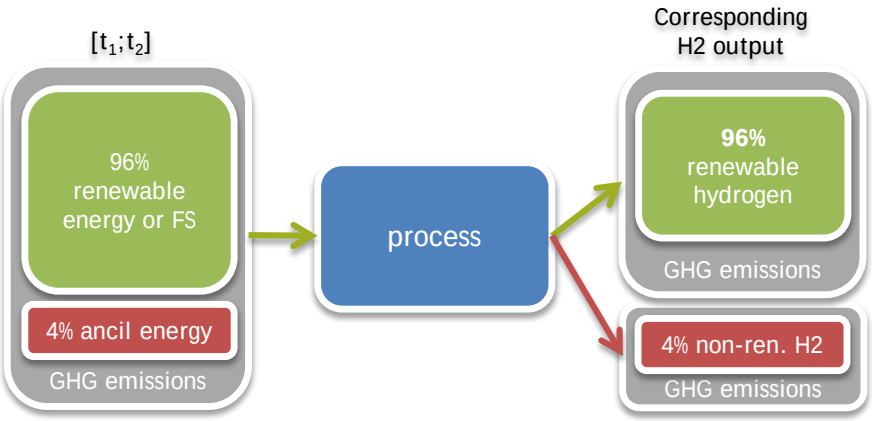


Figure 2. GHG emissions diagram

Consequently, the GHG content of green hydrogen depends on the process and feedstock.

- **Definition 2:** Green hydrogen is hydrogen from renewable sources with an allocated associated GHG emissions intensity of zero (based on an LCA approach) produced in a plant where the average emissions intensity of the non-zero-GHG hydrogen production (based on an LCA approach) of the past 12 months does not exceed the emissions intensity of the reference process (SMR of natural gas). Any biomass used shall comply with the sustainability requirements according to the Renewable Energy Directive.

Green hydrogen can only be generated if the average GHG emissions intensity of the facility over the reference period (12 months) is lower than that of the benchmark process (89,6 gCO2eq/MJ for central SMR of NG).

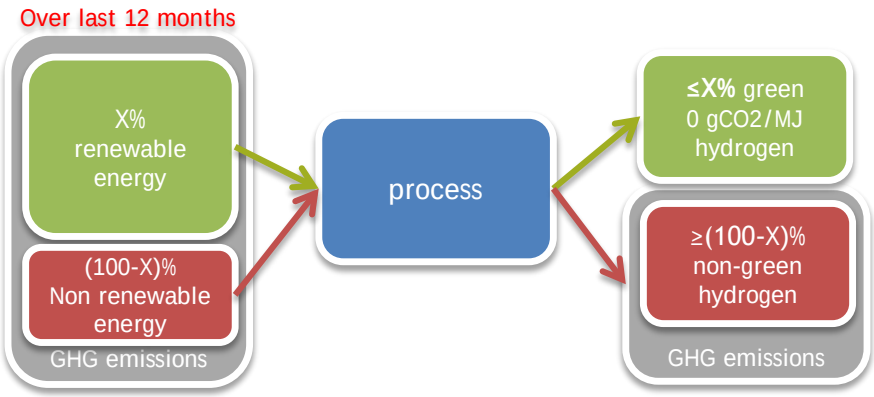


Figure 3 Offsetting approach

This approach structurally ensures that the emissions intensity of any non-green hydrogen produced by a facility producing green hydrogen does not exceed that of the benchmark process.

Two possibilities were proposed in order to address the application of the Renewable Energy Directive.

One is to consider that hydrogen from renewable sources is hydrogen generated exclusively from renewable energy and renewable feedstock.

This means that for a hydrogen production process requiring the combination of different forms of energy, only the hydrogen resulting from the combination of renewable energies may be considered as renewable.

An alternative way of applying the definition of “energy from renewable sources” is to define the share of “hydrogen from renewable sources” in total hydrogen production as the share of renewable energy consumption in total energy consumption.

With this approach, “hydrogen from renewable sources” may be produced from an energy and/or feedstock mix where only one form of energy or feedstock is renewable.

Option 1) Green hydrogen is hydrogen produced exclusively from renewable feedstock and renewable energy sources with an associated GHG emissions intensity (based on a LCA approach) below a specified threshold.

Option 2) Green hydrogen is hydrogen produced from a process using energy from renewable sources; the associated GHG emissions intensity (based on a LCA approach) needs to be below a specified threshold.

2.3 Criteria set 3

Once having the definitions presented above and the clarification that option 2 above applies for the use of renewable, following criteria has been identified:

- The origin of the (renewable) sources is defined based on the Renewable Energy Directive (RED),
- The GHG threshold will use the steam reforming of natural gas as reference (benchmark),
- The sustainability of input biomass shall comply with the requirements according to RED,
- For by-product hydrogen, the allocation of GHG emissions will be performed based on energy allocation (for the cases where input or output are not energy carriers, this allocation might be performed based on standard enthalpies of formation and reaction enthalpies), and
- Criteria on energy consumption in transport and storage (only relevant for the Guarantees of Origin (GoO)).

Once it has been decided that green hydrogen can only be hydrogen that comes from renewable energy source, it is important to define how to exactly account for the renewable energy input.

3 Conclusions

Based on the criteria development presented in chapter 2, green hydrogen shall comply with following requirements:

1. The energy sources used for the production of green hydrogen shall be renewable according to RED
2. The green hydrogen produced shall have GHG emissions calculated according to RED, based on LCA.
3. Criteria on GHG emissions can be either:
    a. The GHG emissions of the produced green hydrogen shall be bellow a define threshold based on the steam reforming of natural gas as reference (benchmark) (definition 1); or
    b. the total emissions of the producing plant during the last 12 months shall be bellow the benchmark and zero emissions are to the green hydrogen produced (definition 2)
4. All biomass used shall comply with the sustainability requirements presented in RED
5. For by-product hydrogen the GHG emissions allocation shall be based on energy (for none energy carriers an allocation approach based on standard enthalpies of formation and reaction enthalpies might be applied).

This list of requirements will be further detailed in order to have a robust GoO system for green hydrogen. At least following points will be further elaborate:

- Exact determination of the GHG emissions threshold value and specification if this threshold is a fixed value or is a moving value within certain timeframe (see requirement 3 above).
- Taking into account that the share of renewable sources is related to any input form, the GoO scheme shall determine which minimum threshold (might be zero) for the input energy form is required. Example: a process requires natural gas (90% of energy input) and electricity (10% of energy input), if the threshold is below 10% it might be enough that renewable energy is sourced in order to have certain share of green hydrogen, in case that the threshold is above 10% at least some of the gas shall come from renewable sources.
- The inclusion of by-product hydrogen and the allocation method shall be explicitly defined.
- The consideration of energy consumption in transport and storage to the issuance of GoO for green hydrogen shall be determined and if considered clear requirements on how to calculate this consumption shall be included.

Annex I: on-line survey- Criteria for defining green hydrogen

Survey to identify and characterize possible options for defining green

Introduction to the survey

The CertifHy project is launching its first consultation on the definition of green hydrogen in view of the implementation of a guaranty of origin scheme. As a first step, the consortium would like to receive the Affiliated Partners' input on the criteria to be applied for defining green hydrogen.

In a second step, there will be a consultation to a wider group of stakeholders aiming to gather extensive input on clearly defined options.

The consultation of the affiliated partners will take place between 18 February and 10 March. Its results will be presented at the Experts workshop that will take place on April 23rd, Brussels.

The goal of the survey is, in particular, to get input on:

- what determines whether or not a given process produces green hydrogen
- how to determine the amount of green hydrogen produced.

The Survey is divided in the following main sections:

1. Regulatory framework context
2. Presentation of the two main approaches to define green hydrogen given the current regulatory framework
3. Questionnaire on the criteria to be used for both approaches
4. Additional questions on methodology to address transportation
5. Annex: Calculation of results for different approaches and cases

In order to illustrate the implications of the different approaches and associated criteria an Annex shows the result of their application to different typical production pathway (the Annex is provided as a separate pdf document).

1. Regulatory introduction

A definition of green hydrogen needs to take into account any (current or future) policy context that green hydrogen and its certificate system may play a role in. Therefore, the project started with a **review of requirements from the most important current regulatory frameworks at EU level**. Based on this review, the following possible criteria for certification/ quality monitoring of green hydrogen can be identified:

- The renewable energy sources with which the hydrogen was produced with **specification of details on their origin** (originating from the Renewable Energy Directive (RED);
- **Life cycle GHG emissions** per volume unit of hydrogen. Refers to the RED and the Fuel Quality Directive (FQD);
- **Life cycle local pollutant emissions** per volume unit of hydrogen. Refers to the FQD;
- Scores on **sustainability criteria and parameters regarding the raw materials of bio-based hydrogen**. Refers to the RED and the FQD.

Therefore, the application of credible calculation methods to establish the values of the aforementioned parameters needs to be in line with the methods prescribed by RED and FQD.

The following definitions from RED are relevant for this survey:

- “(a) ‘energy from renewable sources’ means energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases;”
- “(e) ‘biomass’ means the biodegradable fraction of products, waste and residues from biological origin from agriculture (including vegetal and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste;”
- “(j) ‘guarantee of origin’ means an electronic document which has the sole function of providing proof to a final customer that a given share or quantity of energy was produced from renewable sources as required by Article 3(6) of Directive 2003/54/EC;”

Additionally to the methodology for calculating associated GHG emissions, the European Renewable Energy Directive[1] (RED) has defined criteria for the **sustainability of bio fuels.** The relevant sustainability criteria presented in Article 17 of the RED is applied for the purpose of this survey:

- “...shall not be made from raw material obtained from land with high biodiversity value, namely land that had one of the following statuses in or after January 2008, whether or not the land continues to have that status:...
- " ...shall not be made from raw material obtained from land with high carbon stock, namely land that had one of the following statuses in January 2008 and no longer has that status:..
- "... shall not be made from raw material obtained from land that was peatland in January 2008, unless evidence is provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil.”

NOTE: A full regulatory introduction is provided as a separate annex

[1] 2009/28/EC

2.The two main approaches to define green hydrogen given the current regulatory framework

The definition of green hydrogen can be based on various approaches depending on the purpose of the Guarantees of Origin (GoO) scheme. In order to have a reference to already available schemes in Europe (in particular the GoO scheme for green electricity and the one related to bio-fuels , from the Renewable Energy Directive), two approaches have been selected for gathering Affiliated Partner input; the final definition could also be a combination of both approaches.

First approach: Based on share of renewable energy and sustainability of feedstock

All hydrogen production processes require a certain amount energy which may be taken from the energy system (e.g. grid-electricity), and/or a certain amount of feedstock. In this approach, the use of renewable energy and feedstock is a condition for producing green hydrogen, and the amount of green hydrogen produced can be determined by the share of renewable energy and renewable feedstock in the total used or by a threshold.

A number of nuances can be included to this methodology:

- Sustainability criteria may be applied to the feedstock;
- When energy from the energy system is used (e.g. grid-connected electrolyzer), the GHG emissions or other environmental impact associated to the fraction of the energy used which is not of renewable origin may be considered for determining the amount of green hydrogen produced;
- Similarly, when energy is required for making available and processing feedstock, the associated GHG emissions may be considered for determining the amount of green hydrogen produced.
- If the hydrogen production process generates emissions (e.g. plasma-based pyrolysis of land-fill waste), these may also be considered.

Second approach: Based on greenhouse gas (GHG) emissions

In this approach the GHG emissions of hydrogen production including all upstream process steps are calculated in a Life-Cycle-Analysis (LCA). Hydrogen produced will be considered green if the associated GHG emissions are lower than a certain pre-defined threshold.

- Different input energies may be used to produce hydrogen (e.g. electricity from different sources);
- Certain choices need to be made for the methodology of the calculation of GHG emissions, e.g. to the allocation of emissions to several products of one process, or to the share of green hydrogen in case several different inputs are consumed.

3. Survey for the definition of green hydrogen

This part is the core part of the survey, and it is divided into 5 sections:

- 3.1 Question regarding the **type of GoO scheme**
- 3.2 Questions relevant for the **first approach based on share of renewable energy and sustainability of feedstock**
- 3.3 Questions relevant for the **second approach based on greenhouse gas (GHG) emissions**
- 3.4 Questions relatated to possible **additional requirements** for the definition of green hydrogen
- 3.5 Questions related to the **transport of hydrogen** (relevant to the scheme definition)

IMPORTANT NOTES:

- Remember that for the questions in section 3.2. and 3.3, the annex provided as a separe document will help the reader with some concrete examples of applying the two approaches;
- You will need to introduce your contact information at the end of hte survey;
- questions marked with * are compulsory;
- You don't need to complete the survey at once. You may access it later on (always from the same computer-same IP).

Survey to identify and characterize possible options for defining green

3.1. Question regarding the type of GoO scheme

***1. Do you agree that the GoO scheme should allow GoO's to be traded and provided to any hydrogen user?**

- ◯ Yes
- ◯ No

Reason

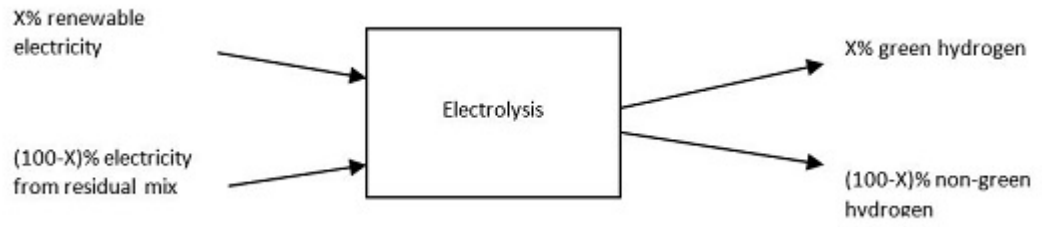
Defining the fraction of H2 production defined as green

2. Based on the diagrams presented below, which option is the most appropriate for determining the fraction of green Hydrogen produced by a given process? (Electrolysis is used as an example in all cases)

- ◯ option A) Renewable share based
- ◯ option B) Threshold based
- ◯ option C) share based with simplification threshold for cases with very high shares

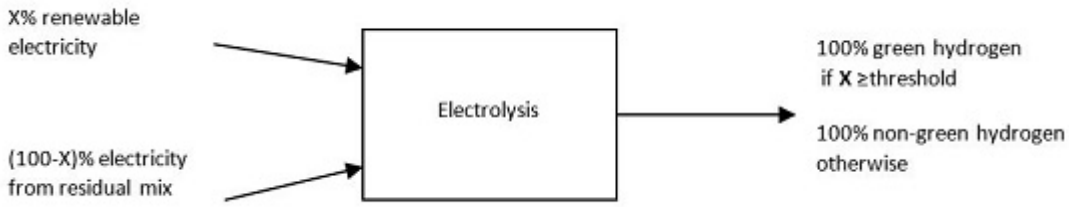
Reason

Option a) Renewable Share based



Example:
Electrolyzer connected to grid.
If 60% of the electricity consumed is purchased with a guaranty of origin (GoO), 60% of the hydrogen produced is green.

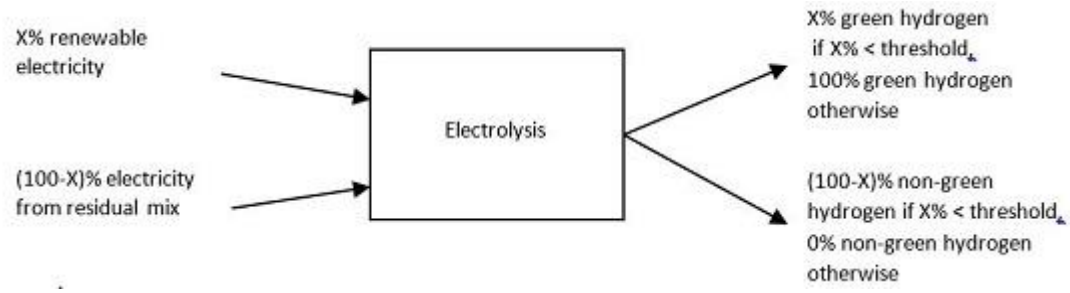
Option b) Threshold based



Example:
Electrolyzer connected to grid. The threshold set at 80%.

- If 85% of the electricity consumed is purchased with a GoO, 100% of the hydrogen produced is green.
- If only 60% of the electricity consumed is purchased with a guaranty of origin, none of the hydrogen produced is green.

Option C) Renewable share based, simplified in case of very high share of renewable



Example:

Electrolyzer connected to on-site wind-farm and grid. The threshold is set at 90%.

- If 92% of the electricity consumed is of renewable origin (e.g. from on-site wind-farm or purchased with a GoO), 100% of the hydrogen produced is green.
- If only 60% of the electricity consumed is of renewable origin, 60% of the hydrogen produced is green.

Consideration of the GHG emissions associated to energy consumed that is not renewable

3. When a fraction of the energy used is non-renewable energy, should attention be paid to the associated GHG emissions?

- ◯ Yes
- ◯ No

4. if answer to Q3 is yes, how should the associated GHG emission be taken into account?

- ☐ By applying a penalty (correction factor) when the associated emissions are higher than the GHG emissions for the reference process (production by SMR) (see examples in annex)
- ☐ By applying a bonus (correction factor) when the associated emissions are lower than the GHG emissions for the reference process (production by SMR) (see examples in annex).
  Should the bonus only apply when a minimum renewable input threshold is reached (e.g. 50% renewable) ? specify in the comments box
- ☐ By defining a maximum level of emissions (gC02/kgH2) beyond which the process will not be eligible for being a source of green hydrogen (although a fraction of the energy used is renewable)
- ☐ By excluding the use of certain energy sources due to the high environmental impact (e.g. nuclear)

Other (please specify)

Application of sustainability criteria to the feedstock used

5. When solid biomass is used as a feedstock... (tick if yes)

- ☐ should compliance with applicable existing sustainability criteria be a condition for the hydrogen produced to be green?
- ☐ Should the 2009/28/EC Renewable Energy Directive be used as a basis for the sustainability criteria?
- ☐ Should other sustainability criteria be applied?

If other criteria should apply, please specify which criteria and to which feedstocks

Exclusion of energy sources for the energy consumed that is not renewable

6. When a fraction of the energy used is non-renewable energy, are there primary energy sources if used (e.g. nuclear, coal without CCS etc.) making the process ineligible for the production of green hydrogen (even though a fraction of the energy used is renewable)? If so, which ones?

- [ ] None
- [ ] Nuclear energy
- [ ] Fossil energy without CCS

Others (please add a complete list)

Requirement of GoO for renewable energy used from the energy system

***7. For being able to consider energy used from the energy system (electricity or gas) as renewable, must it be covered by a Guarantee of Origin (GoO)?**

- ◯ Yes
- ◯ No. If not, how should the renewable energy used be identified?

***8. As consideration may be given to the "quality" of a GoO (e.g. from existing/old hydropower plants against newly built hydropower plants), should there be additional requirements on the GoO's for green hydrogen, e.g. additionally of installations, simultaneous production of RES, etc.?**

- ◯ No
- ◯ Yes. If yes, please specify which quality requirements are needed

Hydrogen generated as a by-product

Survey to identify and characterize possible options for defining green

***9. In an approach based on share of renewable energy and sustainability of feedstock, H2 as a by-product is considered green only to the extent that renewable energy is used and the feed-stock is sustainable. Do you agree?**

- ◯ Yes
- ◯ No, If not, please explain

3.3 Approach 2: Based on GHG emissions

∗10. The Renewable Energy Directive[1] (RED) and the Fuel Quality Directive[2] (FQD) define a methodology to calculate GHG balances for fuels[3]. A few examples illustrating the following questions are included in the Annex.
Shall the RED/FQD GHG calculation methodology be used for hydrogen?

[1] 2009/28/EC, [2] 98/70/EC, [3] See Article 19 and especially ANNEX V of the RED

- ◯ Yes
- ◯ No

Reason/ Comments:

∗11. Which shall be the GHG reference to define a threshold for green hydrogen? (fossil fuel comparator)

- ◯ Steam methane reforming of fossil natural gas (89.6 gCO2eq/MJ)
- ◯ Fossil fuel comparator for gasoline and diesel used in the RED (83.8 gCO2eq/MJ)
- ◯ Other (please specify):

∗12. What should be the GHG threshold for green hydrogen?

- ◯ 50% below the GHG reference (see Q10 above)
- ◯ 60% below the GHG reference (see Q10 above)
- ◯ 70% below the GHG reference (see Q10 above)
- ◯ Other (please specify)

3.3 Approach 2: Based on GHG emissions

Fraction of H2 production defined as green

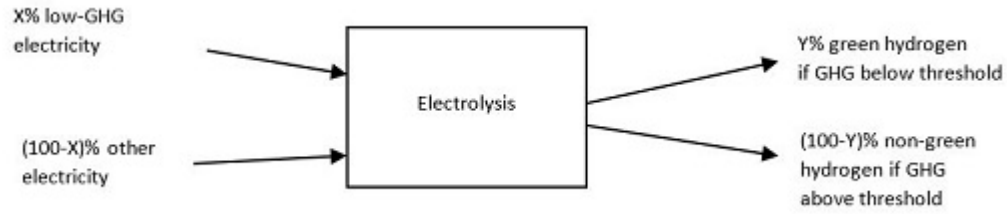
***13. Based on the diagrams presented below, which option is the most appropriate for determining the fraction of green Hydrogen produced by a given process? (Electrolysis is used as an example)**

◯ Option a) low-GHG energy input share based

◯ Option b) Total threshold based

Reasons:

Option a) low-GHG energy input share based

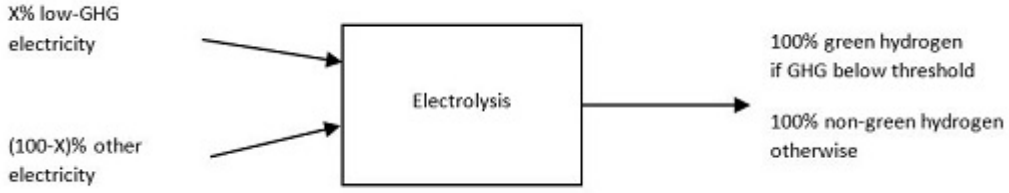


Example:
Electrolyzer connected to grid.

If X=60% of the electricity consumed has zero GHG emissions associated to its production, and 40% electricity has high associated GHG emissions (e.g. coal-based electricity), 60% of the hydrogen produced is green while 40% of the hydrogen produced is not green.

However, a small amount of high-GHG electricity can be used to produce additional green hydrogen as long as the GHG balance of the entire green hydrogen is below the threshold. In this concrete example with a GHG threshold set at 35.8 g CO2eq/MJ (60% below SMR), up to an additional 5.5% can be sold as green hydrogen giving a total green hydrogen share of Y=65.5%, and a 34.5% share of grey hydrogen.

Option b) Total threshold based



Survey to identify and characterize possible options for defining green

Example:

Electrolyzer connected to grid.

The threshold is set at 60% below steam methane reforming of fossil natural gas. This means a threshold of 35.8 g CO2eq/MJ.

- If 92% of the electricity consumed has zero GHG emissions and 8% is coal-based electricity, the total GHG emissions of the hydrogen produced are 33.9 g CO2eq/MJ, and thus 100% of the hydrogen produced is green.

- If only 80% of the electricity consumed has zero GHG emissions and 20% is coal-based electricity, the total GHG emissions of the hydrogen produced are 84.7 g CO2eq/MJ, and thus, none of the hydrogen produced is green.

More examples are provided in the Annex.

3.3 Approach 2: Based on GHG emissions

Application of sustainability criteria to the feedstock used

14. When solid biomass is used as a feedstock... (tick if yes)

- [ ] should compliance with applicable existing sustainability criteria be a condition for the hydrogen produced to be green?
- [ ] Should the 2009/28/EC Renewable Energy Directive be used as a basis for the sustainability criteria?
- [ ] Should other sustainability criteria be applied?

If other criteria should apply, please specify which criteria and to which feedstocks

Exclusion of energy sources for the energy consumed that is not low GHG electricity

15. Are there primary energy sources if used (e.g. coal without CCS, etc.) making the process ineligible for the production of green hydrogen (even though a fraction of the energy used is low GHG electricity)? If so, which ones?

- [ ] None
- [ ] Fossil energy without CCS
- [ ] Others (please include complete list)

Requirement of GoO for low-GHG energy used from the energy system

***16. What mean should be allowed for identifying low GHG energy used (e.g. electricity or gas) ?**

- ◯ Energy mix declared by supplier in accordance with EU regulation
- ◯ Low GHG emissions certificates
- ◯ GoO's
- ◯ Others (please specify)

17. In case of using GoOs and taking into account different qualities of GoOs (e.g. from existing/old hydropower plants, against newly built hydropower plants) should there be additional requirement for them, e.g. additionally of installations, simultaneous production of RES, etc.?

◯ No

◯ Yes. If yes, please specify which quality requirements are needed:

Hydrogen generated as a by-product

***18. In the GHG balance calculation, which allocation methods are appropriate for H2 as a by-product? Please prioritize (1 = most appropriate; 5 =least appropriate)**

	1. Most appropiate	2.	3.	4.	5. Least appropiated	I don't know
Substitution method (steam methane reforming of natural gas assuming 100% efficiency)	☐	☐	☐	☐	☐	☐
Energy allocation (it is not possible to apply this to all processes!)	☐	☐	☐	☐	☐	☐
Mass allocation	☐	☐	☐	☐	☐	☐
Cost allocation	☐	☐	☐	☐	☐	☐
No GHG allocation if it is a waste stream which is not used further, neither as energy source nor as feedstock (i.e. hydrogen vented or flared today)	☐	☐	☐	☐	☐	☐
other	☐	☐	☐	☐	☐	☐

Reasons /Comments (required)

3.3 Additional requirements to both Approaches

19. In addition to GHG balance and taking into account that the processes might include different environmental impacts, which other impacts shall be at least included with a threshold for the definition of green H2? See further information in the table below (More than one response is possible)

- [ ] Stratospheric Ozone Depletion
- [ ] Acidification
- [ ] Eutrophication
- [ ] Photochemical Smog
- [ ] Terrestrial Toxicity
- [ ] Aquatic Toxicity
- [ ] Human Health
- [ ] Resource Depletion
- [ ] Land Use
- [ ] Water Use
- [ ] Nuclear Waste
- [ ] Other (please specify)

Additional Environmental Indicators

Impact	Geographic Impact Scope	Relevant Substances	Indicator	Specific Unit (per unit of hydrogen)
Stratospheric Ozone Depletion	Global	Chlorofluorocarbons (CFCs) Hydrochlorofluorocarbons (HCFCs) Halons Methyl Bromide (CH_3Br)	Ozone Depleting Potential	Trichlorofluoromethane (CFC-11) equivalents
Acidification	Regional Local	Sulfur Oxides (SOx) Nitrogen Oxides (NOx) Hydrochloric Acid (HCL) Hydroflouric Acid (HF) Ammonia (NH_4)	Acidification Potential	Hydrogen (H+) ion equivalents
Eutrophication	Local	Phosphate (PO_4) Nitrogen Oxide (NO) Nitrogen Dioxide (NO_2) Nitrates Ammonia (NH_4)	Eutrophication Potential	Phosphate (PO_4) equivalents
Photochemical Smog	Local	Non-methane hydrocarbon (NMHC)	Photochemical Oxident Creation Potential	Ethane (C_2H_6) equivalents
Terrestrial Toxicity	Local	Toxic chemicals with a reported lethal concentration to rodents	Lethal Concentration LC_{50}	Converts LC_{50} data to equivalents
Aquatic Toxicity	Local	Toxic chemicals with a reported lethal concentration to fish	Lethal Concentration LC_{50}	Converts LC_{50} data to equivalents
Human Health	Global Regional Local	Total releases to air, water, and soil.	Lethal Concentration LC_{50}	Converts LC_{50} data to equivalents
Resource Depletion	Global Regional Local	Quantity of minerals used Quantity of fossil fuels used	Resource Depletion Potential	Ratio of quantity of resource used versus quantity of resource left in reserve
Land Use	Global Regional Local	Land area required for the installation and the wastes disposed of	Land Availability	Land area
Water Use	Regional Local	Water used or consumed	Water Shortage Potential	Ratio of quantity of water used versus quantity of regional/ local resource
Nuclear Waste	Global Regional	Quantity of medium or high level radioactive waste disposed of in a dedicated radioactive waste repository	Radiaoactive Waste	Quantity of radioactive waste

Survey to identify and characterize possible options for defining green

Questions related to the transport of hydrogen (relevant for the scheme def...

20. Taking into account that different transport paths from production to final user have different losses and auxiliary energy demand, which option is preferable?
If transport losses/auxiliary energies are taken into account, GoOs need to be purchased both for the amount of hydrogen sold and for the hydrogen quantities lost/auxiliary energies consumed in transport to the point of sale.

- ◯ Default value for transport losses/auxiliary energies for an average process will be defined for which additional GoGs need to be purchased
- ◯ Different default values for the different transport paths will be defined for which additional GoGs need to be purchased
- ◯ Each producer will calculate/estimate the transport losses/ auxiliary energies for which he needs to purchase additional GoGs
- ◯ No transport losses/ auxiliary energies will be taken into account

Please, reason your answer. Other options also possible (please specify)

21. In order to disregard the transport and storage losses / energy used, which relevant threshold shall be used?
Threshold (in percentage of losses)

- ◯ < 1%
- ◯ < 2.5%
- ◯ < 5%
- ◯ Other (please specify)

***22. Please, add your contact information**

Name	
Company	
Country	
Email	
Phone	