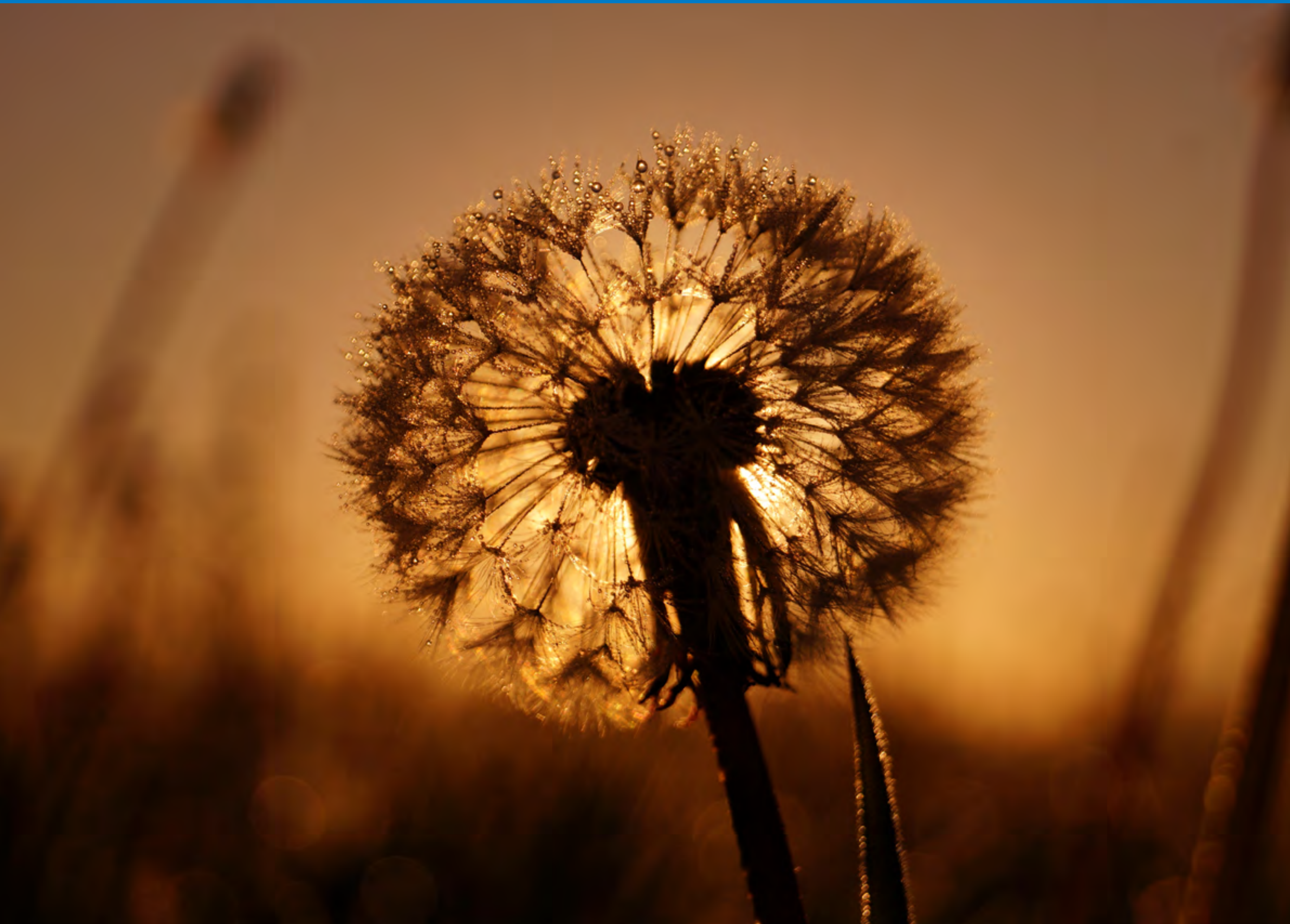
Netherlands Enterprise Agency

How to become RFNBO-certified

Lessons from actual pilot and pre-audits against RFNBO voluntary schemes



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1 Introduction and purpose

The European renewable energy directive contains targets for the use of renewable fuels of non-biological origin (RFNBOs) in industry and transport. Article 22a of the directive mandates the use of RFNBOs in industry in European Union (EU) Member States. The directive also contains an RFNBO sub-target of at least 1% in transport fuels under Article 25(1).

Many hydrogen production and/or import projects are currently being developed. These projects face uncertainties because the RFNBO market is at an early stage. One of the uncertainties concerns RFNBO certification and can be summarised by the following question: "How can you demonstrate compliance with the RFNBO requirements in the renewable energy directive using certification?" This question is the subject of this report.

In the Netherlands, the RFNBO requirements of the renewable energy directive must be complied with in order to receive RFNBO production subsidies. Demonstrating compliance with these requirements will be mandatory in order to count RFNBOs towards transport targets with effect from 1 January 2025 and in the near future towards an industry mandate that is currently being developed. As a result, many companies have started to look into RFNBO certification. Now that the first RFNBO voluntary schemes[1] have been recognised by the European Commission in December 2024, companies can begin RFNBO certification. This report is published shortly after the formal recognition of the first RFNBO voluntary schemes with the intention of helping companies in their efforts to become RFNBO-certified.

In the Netherlands, two pilot RFNBO certification projects have been conducted. The first pilot project included six pilot audits and was executed in the second half of 2022. Draft voluntary schemes based on drafts of the two hydrogen delegated acts were used during these first pilot audits. A public report on this first pilot project can be found through this link. A second pilot project, including a pre-certification audit against a draft of a voluntary scheme that has recently been recognised by the European Commission, was conducted in the first half of 2024. The lessons from both pilot projects were used to write this report.

The **purpose of this report** is to facilitate companies that wish to demonstrate compliance with the requirements on RFNBOs in the renewable energy directive. This report does so by providing descriptions and examples of how to demonstrate compliance with the RFNBO requirements in Chapter 4. As an introduction, the RFNBO legal framework and the topics "voluntary schemes", "certification" and "auditors" are briefly explained.

This report makes no reference to the requirements included in scheme documents of the RFNBO voluntary schemes, as these have included the requirements in (slightly) different wording and additional RFNBO voluntary schemes (more than the current three) may be recognised in the near future. This report does not refer to a particular scheme and no wording of requirements from a particular scheme has been copied, as this might be interpreted as a preference for that scheme. Instead, this report refers to the requirements of the EU RFNBO legal framework that formed the basis for the development of the RFNBO voluntary schemes. For most of the requirements, the wording in the RFNBO voluntary schemes is the same as or very similar to the wording in this report, since the schemes have also used texts from the legal framework and from the guidance on that legal framework.

Some readers will use the references to EU documents that are included in this report as a guide for further reading, while other readers will not. In the latter case, please just ignore the references. It is not necessary to read them, although they may provide additional insight into the legal requirements. The most important documents to read – outside this report – are the scheme documents from the RFNBO voluntary scheme of choice.

The current version of this report is version 1. An update of this report will be written and published based on relevant input[2] from readers and/or if we conclude that a revision is necessary. To further explain what the current report is about and to avoid incorrect expectations from this report and from a possible future update, we add the following remarks on the contents of this report:

- The target audience for this report consists of companies that wish to start RFNBO certification and are looking for guidance and examples of how to do so. This report is written for producers of renewable hydrogen that wish to become certified against an RFNBO voluntary scheme. Some of these producers may currently have little knowledge of this topic. Others will already be more experienced; they may be familiar with the contents of the first chapters and may therefore want to focus on the more detailed information in the Annexes.
- Since the report is intended for a large group of companies that will start RFNBO certification in the years ahead, we have omitted some more complex topics that are probably of interest to only one or a few companies. An example is co-processing, for which one of the documents in the EU RFNBO legal framework provides specific rules.

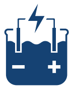
[1] The term "voluntary scheme" is used in the EU RFNBO legal framework and refers to certification schemes for RFNBOs that are similar to certification schemes such as FSC for wood and wood products and Fairtrade for cocoa, coffee and other products.

[2] We therefore welcome comments and suggestions, which should be sent to waterstof@rvo.nl.

- This report does not give all details of the RFNBO requirements in the renewable energy directive and the two hydrogen delegated regulations. Instead, it provides examples of how relevant parts of the regulations can be complied with.
  Details of the RFNBO requirements are given in the legislation itself, in the Q&A that the European Commission has published and also in the RFNBO voluntary scheme documents that have incorporated the regulations. Every company that wants to become RFNBO-certified must become familiar with the voluntary scheme documents and hence will become familiar with the details of the regulations.
- This report focuses on RFNBOs and therefore does not cover the topics of "recycled carbon fuels" (RCFs) and "low-carbon hydrogen". This is because the RED introduces clear targets for the use of RFNBOs in industry and transport, whereas there are no such clear targets (yet) for RCFs and low-carbon hydrogen in current European legislation. Many aspects of RCF and low-carbon hydrogen certification are the same as for RFNBOs. The GHG accounting rules are also the same (RCF) or very similar (low carbon hydrogen). This report will not deal with specific aspects of RCF and low-carbon hydrogen GHG calculations that are irrelevant for RFNBOs, such as emissions resulting from the diversion of inputs from a previous or alternative use.
- Version 1 of this report focuses on RFNBO compliance in Europe, with examples from the Netherlands. Some aspects of RFNBO certification outside Europe have not been addressed in this report[3]. We may include such topics when more experience has been obtained.

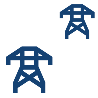
This report includes a number of figures in which the following pictograms are used:

Renewable electricity generation installations: solar farms and wind farms



Electrolyser

Smart electricity meter



Electricity grid

[3] Relevant information is provided in other reports, however, such as in this report on Chile and Uruguay.

2 EU RFNBO legal framework

This section presents the requirements that apply to RFNBOs in Europe when RFNBOs are to be counted towards renewable energy targets under the renewable energy directive (RED)[4]. The RED forms the basis of the EU RFNBO legal framework. The RED has been amended a number of times. In this report the two most recent versions will be referred to as "RED-II" and "RED-III" (see "Abbreviations" at the end of this report for full references). RED-III is the current version. The RED includes a definition of RFNBOs[5].

Detailed requirements for RFNBOs are included in delegated and implementing regulations published under the umbrella of the RED. This paragraph briefly presents the requirements. Chapter 4 and the Annexes give details together with examples of how to demonstrate compliance.

The EU RFNBO legal framework contains requirements for RFNBOs on the following subjects[6]:

(I) Electricity used for the production of RFNBOs
Requirements on the use of electricity for the production of RFNBOs are set out in Article 27(6) of the RED-III and in Delegated Regulation (EU) 2023/1184 (DR 2023/1184)[7]. These are requirements on demonstrating that renewable electricity is used for the production of RFNBOs and that the renewable electricity is additional, i.e. that taking RFNBO production installations into operation is combined with taking additional renewable electricity production installations into operation. For more details see paragraph 4.1 and Annex 1.

(II) GHG emission savings
RFNBOs must reduce greenhouse gas emissions by at least 70% compared to a fossil fuel comparator of 94 grams of CO2,eq per MJ. This requirement is set out in Article 29a of RED-III.
The calculation method in Delegated Regulation (EU) 2023/1185 (DR 2023/1185)[8] must be applied when making the GHG calculations to demonstrate compliance with the RED 70% GHG emission reduction criterion. For more details see paragraph 4.2 and Annex 2.

(III) Mass balance and traceability in the supply chain
The RFNBO sustainability information must remain physically linked to the RFNBO (according to the mass balance requirements of parts 1 and 2 of RED-III Article 30). This requirement also applies when the hydrogen is sold by a producer to an end-user, possibly through intermediaries, and also when the hydrogen is converted into a derivate such as ammonia or methanol.
Mass balance and traceability requirements are detailed in Implementing Regulation (EU) 2022/996 (IR 2022/996)[9].
For more details see paragraph 4.3 and Annex 3.

In addition to these three requirements I, II and III, the RFNBOs must meet the definition of RFNBO in the RED. Hydrogen produced from biomass or biogas is non-RFNBO.

[4] The full name is "Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast)". In October 2023 the RED was amended by Directive (EU) 2023/2413. A consolidated version of the amended RED can be found through this link.

[5] RFNBOs are defined in RED-III as follows:
- 'renewable fuels of non-biological origin' means liquid and gaseous fuels the energy content of which is derived from renewable sources other than biomass;
- 'energy from renewable sources' or 'renewable energy' means energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, osmotic energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogas.

[6] Please note that, due to the 2023 amendments to the renewable energy directive, some of the criteria have moved to another article, for instance RED-II Article 27(3) fifth, sixth and seventh subparagraphs moved to RED-III Article 27(6) second, third and fourth subparagraphs, RED-II Article 25(2) was reformulated and moved to RED-III Article 29a(1), and part of RED-II Article 28(5) was moved to RED-III Article 29a(3).

[7] The full name is "Commission Delegated Regulation (EU) 2023/1184 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin".

[8] The full name is "Commission Delegated Regulation (EU) 2023/1185 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels".

[9] The full name is "Commission Implementing Regulation (EU) 2022/996 of 14 June 2022 on rules to verify sustainability and greenhouse gas emissions saving criteria and low indirect land-use change-risk criteria".

The requirements in the delegated regulations are detailed. The European Commission has published a document entitled Q&A for the certification of RFNBOs and RCF from 14 March 2024, which will be referred to further in this report as "Q&A March '24".

Please note that hydrogen or hydrogen derivates that do not meet (all of) the above three requirements can still be considered as RFNBO[10]. However, in order to be counted towards the targets in Articles 22a and 25 of the RED, RFNBOs must meet the three requirements I, II and III listed above. If one or more of these requirements are not met, the hydrogen can be classified as:

- RFNBO that does not count towards the RED targets. This is the case when the RFNBO is produced from renewable energy but does not comply with the above requirements I, II and III; or
- Low-carbon hydrogen. This is hydrogen that is not produced from renewable electricity and meets the 70% GHG saving requirement. See the definition in Article 2 (11) of the gas directive.[11]

A producer, trader or user that aims to produce, trade or use RFNBOs that can be counted towards the RED-III RFNBO targets must be familiar with these requirements and with the documents in which they are set out. Compliance with these requirements must be demonstrated by certification against an RFNBO voluntary scheme and hence the producer, trader or user of the RFNBO needs to be familiar with the relevant documentation of a voluntary scheme of choice. RFNBO voluntary schemes are designed in such a way that certification according to these schemes demonstrates compliance with the RFNBO requirements in the RED, IR 2022/996, DR 2023/1184 and DR 2023/1185. RFNBOs not meeting these requirements are still considered as RFNBO, as is also illustrated in example 3 in paragraph 4.1.1.

[10] After all, the definition of RFNBOs in the RED is "liquid and gaseous fuels the energy content of which is derived from renewable sources other than biomass".

[11] Directive (EU) 2024/1788 of the European Parliament and of the Council of 13 June 2024 on common rules for the internal markets for renewable gas, natural gas and hydrogen, amending Directive (EU) 2023/1791 and repealing Directive 2009/73/EC (recast).

3 Voluntary schemes and certification

3.1 Voluntary schemes and EC recognition procedure

As was already noted in an earlier footnote, the term "voluntary scheme" is used in the EU RFNBO legal framework to refer to certification schemes for RFNBOs. Owners of the following six voluntary schemes have submitted their scheme to the European Commission (EC) for recognition of the scope for RFNBOs and RCF[12]:

- ISCC (extension of the scope to also RFNBOs and RCF)
- CertifHy (RFNBOs)
- REDcert (extension of the scope to also RFNBOs and RCF)
- KZR INiG System (extension of the scope to also RFNBOs and RCF)
- CCEE Hydrogen and Derivatives Certification System (RFNBO)
- RSB (extension of the scope to RFNBOs and RCFs, forest biomass and co-processing)

The words "extension of the scope to also RFNBOs and RCF" indicate that the voluntary scheme is currently already recognised for biofuels, bioliquids and biomass fuels and seeks an extension of the scope of the recognition to also include RFNBOs and RCF.

Currently, the first three schemes listed above have been recognised by the European Commission on 19 December 2024.

The actual status of the recognition process can be found on this webpage of the European Commission, in the list entitled "Approved voluntary schemes and national certification schemes" and in the "Applications" table.

The documentation for the recognised schemes can be found on the following webpages:

- Scheme documents for the ISCC RFNBO certification scheme are part of the ISCC EU scheme, documents can be found under "ISCC EU" on this web page;
- Scheme documents for the CertifHy EU RFNBO scheme can be found on this web page; and
- Scheme documents for the REDcert RFNBO certification scheme are part of the REDcert EU scheme, documents can be found under "REDcert-EU" on this web page.

For companies that want to use one of the voluntary schemes, it is important to realise that different voluntary schemes may have different detailed requirements. It is important to choose the scheme that is most suitable for the companies' operation, as explained in the example below.

Example 1

Schemes may have different detailed requirements as regards the 70% GHG reduction target: do you need to estimate the downstream GHG emission of your offtakes? In other words: does the scheme require you to calculate the GHG emissions of your process and leave downstream GHG emissions to your customers, or does the scheme require you to include modes and distances of transport to your customers and include these downstream GHG emissions in your GHG calculation?
This approach to include downstream emissions has the advantage that the entire 'cradle-to-grave' emissions are included and that it is demonstrated at the point of production that the RFNBO delivered and used meets the 70% GHG emission requirement at the point of use.
Of course, this approach is only possible if the customer/end user is known and if there is no other processing unit downstream, for instance converting RFNBO hydrogen into RFNBO ammonia or methanol.

3.2 Auditors and Certification Bodies

The certification against a voluntary scheme is performed by a Certification Body and will be based on on-site examination (audit) against all requirements of the voluntary scheme by auditors that work for the Certification Body (CB)[13]. Each certification scheme contains requirements for CBs, including requirements on education, training and qualification of the auditors. These requirements are part of the EC recognition of the voluntary schemes[14]. Only CBs that have signed a contract with a voluntary scheme are allowed to perform certification audits under that scheme.

3.3 Costs for certification

Audit and certification costs depend on the size, complexity and hence duration of the audit. During a workshop in October 2022, an auditor active in RFNBO certification presented indicative costs. See this presentation for details.

Fees for certification schemes consist of two components: a yearly fee depending on the size or annual turnover of the company, and a fee per amount of RFNBO traded. Fees for the certification schemes can be found on the websites of the schemes.

Companies seeking certification need to sign a commercial agreement with the chosen CB.

[12] Status as per start of 2025.

[13] Within this work field of RFNBO certification, the terms "Conformity Assessment Bodies" and "Certification Bodies" are identical. In this report the term Certification Bodies (CBs) is used. The meaning of "Certification Body" is defined in IR 2022/996: *'certification body' means an independent accredited or recognised conformity assessment body that concludes an agreement with a voluntary scheme to provide certification services for raw materials or fuels by carrying out audits of economic operators and issuing certificates on behalf of the voluntary schemes using the voluntary scheme's certification system*.

[14] The CBs must also be accredited. The (national) Accreditation Body supervises the CB and competent national authorities of EU Member States shall also supervise the operation of CBs (RED-III Article 30(9) second subparagraph). These topics "accreditation" and "supervision of CBs" are not further covered in this report because they are less relevant to companies starting the trajectory of becoming RFNBO-certified.

3.4 Certification procedure

Compliance with the RED RFNBO requirements can be demonstrated by certification against an RFNBO voluntary scheme. The recognised voluntary schemes contain RFNBO certification procedures that can be summarised as follows:

4. **Register with an RFNBO voluntary scheme**
   The voluntary schemes that are recognised for RFNBOs can be found via this webpage of the European Commission. Register with the owner of the recognised voluntary scheme of choice. Registration is performed via an online portal on the webpage of the voluntary scheme.
5. **Choose one of the CBs that is recognised by the RFNBO scheme**
   These CBs are listed on the website of the scheme. Discuss the certification procedure with the auditor(s) that the CB assigns to the company. Agree on commercial terms.
6. **Contract the CB, and plan the audit(s)**
   The time between contracting the CB and obtaining the certificate is typically three to six months. A pre-certification audit can be part of the procedure. This pre-certification audit is not a requirement of the voluntary schemes, so there is no requirement to have one. However, current practices with RFNBO certification and the associated preparations show that it is helpful to start with a pre-certification audit. In this way, issues can be identified and solved before the actual certification audit.
7. **Prepare for the audit**
   All documents and evidence that is needed for the audit must be accessible to the auditor at the location where the audit is conducted. Moreover, the auditor will probably ask for documents to be sent (for instance the GHG calculation) in digital form ahead of the audit, allowing the auditor to prepare for the audit.
   The performance of a risk assessment and internal audit by the company itself might be a requirement of the voluntary scheme.
8. **Welcome the auditor for the audit**
   The auditor will take the lead and will ask many questions. Therefore, staff responsible for all certification requirements as well as personnel with relevant knowledge (e.g. where to find physical meters and calibration data of these meters, where to find relevant documents, how to log in to portals, for instance for guarantees of origin or electricity production data, how the GHG calculation was performed, etc.) must be present or on stand-by.
   A typical RFNBO certification audit will last for one working day. In the case of complicated processes and/or very large plants (for instance including electrolysis as well as synthesis of ammonia or methanol), more than one audit day might be needed.
9. **Use the audit report to solve open ends**
   Study the audit report that the auditor sends a few days or weeks after the audit and take action to follow up and solve all remaining issues found during the certification audit.
10. **Close non-conformities**
   After the certification audit, the auditor may issue minor and/or major and/or critical non-conformities (NCs). The company that wants to be certified must – in order to become or remain certified – define corrective actions for the NCs, including a timeline, and perform these actions to eliminate the NCs. Depending on the nature of the NCs, (a) the auditor might be able to follow up non-conformities by e-mail and/or virtual meetings and (b) might be able to issue a certificate. In some cases, with too many and/or major non-conformities, the auditor can only close non-conformities and issue a certificate after another visit to the audit location. Certification schemes may have detailed rules on how this needs to be done.
   Not closing NCs can result in sanctions. Therefore, if a company cannot close an NC in time, it should consult the scheme documents and/or the auditor to become aware of possible consequences.
11. **Receive the certificate and audit reports**
   The CB will write an audit report (confidential) and a public summary audit report that will be published on the website of the voluntary scheme together with the certificate.
   If you are unfamiliar with certificates and (summary) audit reports, it might be worthwhile viewing some examples. We refer to the Roundtable of Sustainable Biomaterials, which is one of the voluntary schemes recognised by the European Commission for biomass. Its certificate database is available through this link. An example of a certificate can be opened through this link and the corresponding public summary audit report is available through this link.
   The level of detail given in audit reports and summary audit reports and on certificates can vary from one certification scheme to another. Minimum requirements are set by the European Commission in Annex II of IR 2022/996.
   We will add some examples of RFNBO certificates and RFNBO summary audit reports once the first actual RFNBO certificates are issued, the next time this report is updated.
12. **Continue the work to keep your certificate**
   After the issuing of an RFNBO certificate, the certified company:
   - must keep all information up to date;
   - must issue a "Proof-of-Sustainability" (PoS) for all RFNBOs sold;
   - must enter information on the RFNBOs sold and the PoS in the Union Database (for details see paragraph 4.3); and
   - must be audited annually to retain the RFNBO certificate. In the first year after becoming certified, an additional surveillance audit might be necessary (check the conditions of your scheme).

The voluntary schemes contain procedures on what needs to be done in the event of misconduct and actual or suspected fraud and how and when auditors can conduct announced or unannounced surveillance audits. The voluntary schemes also contain procedures for the handling of complaints and appeals. For details of these procedures, please refer to the certification scheme documents and websites.

It is important to understand that certification does not need to be carried out for the maximum capacity of the electrolyser if the plan is to expand the capacity at a later stage. In such a case, certification can be started for the initial capacity, followed at a later stage by recertification of the plant when the maximum capacity has been installed.

4 Demonstrating compliance with the RFNBO requirements

This chapter contains information on what to do to become RFNBO-certified. The first three paragraphs 4.1, 4.2 and 4.3 focus on requirements I, II and III respectively. Paragraph 4.4 is on general requirements including the need for documentation along the lines of quality management systems.

Some of the more detailed information, plus examples of how to demonstrate compliance with the requirements, is provided in Annexes 1 to 3. We do not aim to be exhaustive; some possible compliance options are omitted from the report. This report focuses on compliance demonstration in the next few years (up to 2030) and some options to demonstrate compliance with the first requirement on electricity used for the production of RFNBOs are therefore not yet relevant to the Netherlands. This is further explained in paragraph 4.1.3.

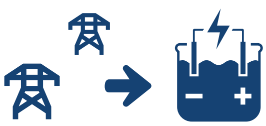
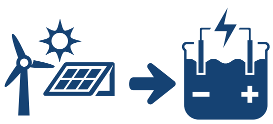
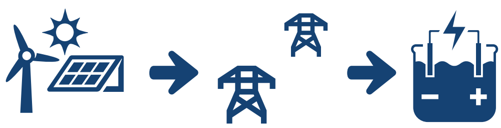
This chapter, plus the Annexes, contains the lessons that were learned in the six pilot audits in autumn 2022 and the pre-audit in summer 2024.

This chapter states where information and more details can be found. We will refer to the documents that are mentioned in Chapter 2. We will not make reference to voluntary schemes, because the different voluntary schemes have different formats and because we cannot refer to all of the recognised voluntary schemes.

4.1 Requirements for electricity used in the production of RFNBOs

The RED requirements for electricity used in the production of RFNBOs are included in Article 27(6) of the RED, with further details given in DR 2023/1184[15]. There are three options to produce RFNBOs from renewable electricity. These options are shown schematically in the table below and are further explained on a high level in the rest of this paragraph. Further details can be found in Annex 1.

Table 1 *- Three options for the production of RFNBOs from renewable electricity*

A Grid mix	B Direct connection	C Grid connection
		
RED Article 27(6) first subparagraph	RED Article 27(6), second and fourth subparagraphs, plus DR 2023/1184 Chapter 3	RED Article 27(6), third and fourth subparagraphs, plus DR 2023/1184 Chapters 4-7 and 11. Four subcategories: C1 90% or more renewables in grid mix C2 GHG intensity of grid is 18 g CO2,eq/MJ or less C3 Avoid curtailment / redispatchment C4 Power purchase agreement plus conditions (additionality, temporal & geographical correlation)

4.1.1 Option A – Grid mix

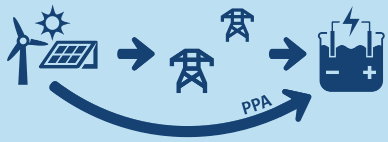
With this option, the renewable energy share of electricity production should be 80% or higher in order to reach the 70% GHG emission saving requirement. Such a high average share of renewable electricity is not anticipated in the Netherlands in the coming years; therefore, option A is not of interest as a 'stand-alone option' in the short term in the Netherlands. Consequently, operators of electrolysers in the Netherlands will use options B and C to produce RFNBOs that meet the three requirements.

Option A is of interest, however, when small shares of grid electricity are used in combination with options B and C. This makes it possible to meet the 70% GHG saving requirement, enabling that part of the grid electricity qualifies as RFNBO and meets all three RED-II/III RFNBO requirements. This is illustrated in example 2 below. More details are given in Annex 1 paragraph 1.1.

[15] The consolidated version of RED-III can be found through this link. DR 2023/1184 can be found through this link.

Example 2

Consider a grid-connected electrolyser with a Power Purchase Agreement (PPA) linked to a wind farm, and consider that the operator of the electrolyser can demonstrate that the hydrogen produced from the electricity delivered under the PPA meets the three requirements I, II and III above. Consider a month with poor wind speeds, causing the electrolyser to use more electricity from the grid in that month than can be supplied through the PPA. The electricity in that month is then partly sourced from the grid without a PPA. The amounts of electricity could be as follows, for example:



Electricity from	MWh electricity in month X	%	Tons of hydrogen in month X	RED-compliant RFNBO	Low carbon hydrogen
Grid to electrolyser stacks (with PPA)	5,040	90	90	90	
Grid to electrolyser stacks (no PPA)	560	10	10	4	6
Total to stacks	5,600	100	100	94	
Grid to balance of plant	150				
Total power consumption	5,750				

Please note that it is permissible to account for the electricity in such a way that the electricity for the balance of plant (compressor, gas cleaning, fans for cooling etc.) is entirely grid electricity and that all PPA-delivered electricity is attributed to the stacks.
If the average share of renewable energy in the grid (two years before the current year) was 40% and the total hydrogen production from the electrolyser in this month was 100 tons, then in this example:

- The 100 tons of hydrogen is produced from 5,600 MWh of electricity, of which 10% is sourced without a PPA;
- 94 tons of the hydrogen produced is RFNBO that meets the three RED requirements: 90 tons meet the requirements on the basis of the PPA and four tons meet the requirements as 40% of the electricity from the grid (not delivered through the PPA) is renewable electricity; and
- six tons of the hydrogen produced is not RFNBO but will probably be classified as low-carbon hydrogen. We write "probably", as the delegated act with details of the GHG accounting rules for low-carbon hydrogen has not yet been published.

The 150 MWh of electricity from the grid (without PPA) that is used in the balance of plant is not taken into consideration when calculating the shares of RFNBO and other types of hydrogen. This amount is considered for the GHG calculation as is further explained in Annex 2.

Please note that the 40% share of renewable energy in the grid in 2022 in the Netherlands is a rounded number; the actual calculation should be made with 39.650%.

Example 3
Consider the same example as above with one difference: in this example 3, the operator of the electrolyser is not able to demonstrate that the hydrogen meets the 70% GHG emission saving requirement during this month X. This means the 94 tons of hydrogen produced during month X is still classified as RFNBO (as it is produced from non-biomass renewable sources). However, this RFNBO cannot be considered "RED-compliant", as it fails to comply with requirement II in Chapter 2.

4.1.2 Option B – Direct connection

A directly connected electrolyser will have to meet the requirements for electricity in RED Article 27(6)(2) and DR 2023/1184 Chapter 3. This means that (a) the electricity is sourced through a direct line[16] and (b) the renewable electricity installation has not come into operation more than 36 months before the electrolyser comes into operation (additionality). The European Commission has provided guidance on how "come into operation" should be defined: this is the start date of any form of commercial production (of hydrogen, derivate or renewable electricity) that is intended to be used or sold and goes beyond the pure testing of the installation. See also answer 22 in the Q&A of March 2024.

Where additional production capacity is added to an existing installation producing RFNBOs, the added capacity will be considered to be part of the existing installation, provided that the capacity is added at the same site and the addition takes place no later than 36 months after the initial installation came into operation.

For a directly connected electrolyser, there is no need to sign a power purchase agreement (PPA), and receipt of a subsidy for the renewable electricity installation is no problem when it comes to meeting the RED RFNBO requirements. The requirements for temporal and geographical correlation are also irrelevant, since at any time the power is sourced from the renewable power source, with the result that these two requirements are always complied with.

Further details, including examples of how the electricity amounts can be documented, are provided in Annex 1, paragraph 1.2.

4.1.3 Option C – Grid connection

As shown in Table 1 at the beginning of this section, there are various sub-options for a grid-connected electrolyser. They are:

13. A share of renewable electricity in the grid that is higher than 90% – not (yet) applicable in NL
14. An emission intensity of electricity in the grid of less than 18 g CO2,eq/MJ– not (yet) applicable in NL
15. Providing net stability and avoiding curtailment/redispatchment – currently not possible in NL
16. Buying renewable power through a PPA

In this section we will only explain sub-option C4. This is because sub-options C1 and C2 will likely not be used in the Netherlands in the years to come because the average share of renewable electricity will not reach 90% in the Netherlands until around 2035 (sub-option C1) and the same holds for a GHG emission intensity of 18 g $CO_{2,eq}$/MJ (sub-option C2). The situation is the same in many other European member states that have not yet reached high shares of renewable electricity and/or nuclear power in the grid.

Sub-option C3 is currently also impossible in the Netherlands because TenneT, the Dutch national transmission system operator (TSO), does not yet provide evidence that

a. power-generating installations using renewable energy sources were redispatched downwards in accordance with Article 13 of Regulation (EU) 2019/943 and
b. the electricity consumed for the production of RFNBOs reduced the need for redispatching by a corresponding amount.

A possible later version of this report might include more details on this option.

Sub-option C4 comes with a number of requirements:

(I) signing a PPA;
(II) requirements on additionality (the renewable electricity generation installation must be relatively new and should not have received any subsidy, with a temporary exemption if the electrolyser is taken into operation before 1-1-2028);
(III) demonstrating temporal correlation; and
(IV) demonstrating geographical correlation.

Requirement (i): signing a PPA

The first requirement is to prove that a source of renewable electricity that meets the requirements has been secured and is used to produce the RFNBOs. Option C4 requires a PPA that meets the following criteria:

- It is signed directly by the RFNBO producer with the owner of the renewable electricity production installation(s) or with an intermediary (that can act as a contracting party, while ensuring that a direct relationship is maintained between the RFNBO producer and the renewable electricity producer). Please note that a PPA does not need to be with another entity; it can be with the same company, 'with yourself', in another location;
- The installations producing renewable electricity that is used to produce the hydrogen must be clearly identified in the PPA;
- The production of RFNBOs based on the renewable PPA can only be claimed if the electricity contracted under the PPA has effectively been produced; and
- The owner of the renewable electricity production installation(s) must send production data to the RFNBO producer. These must be monthly or hourly data depending on whether the temporal correlation should be demonstrated on a monthly or on an hourly basis.

[16] Which can be an AC line as well as a DC line, excluding or including transformers. The term "direct line" is defined in DR 2023/1184 Article 2. This definition refers to a definition in Article 2(41) of Directive (EU) 2019/944, which reads: "'direct line' means either an electricity line linking an isolated generation site with an isolated customer or an electricity line linking a producer and an electricity supply undertaking to supply directly their own premises, subsidiaries and customers."

Some companies might be reluctant to share or show PPA details. However, during the certification audit, the auditor must be able to check the PPA(s) and relevant data. The auditor will observe strict confidentiality and can sign a non-disclosure agreement if required.

Requirement (ii): demonstrating additionality
This second requirement is to prove that new renewable energy sources were installed to feed the electrolyser, thereby avoiding the need for current consumers that were already consuming the renewable power to resort to other (fossil) suppliers of electricity. It consists of two parts:

(iia) demonstrating that **the renewable electricity production installation is relatively new,** meaning that it has not come into operation more than 36 months before the date on which the electrolyser comes into operation.
Requirement (iia) is the same as the requirement for directly connected electrolysers: the renewable electricity installation has not come into operation more than 36 months earlier than the date on which the electrolyser comes into operation. The European Commission has provided guidance on how "come into operation" should be defined: this is the date when any form of commercial production (of hydrogen, derivate or renewable electricity) starts that is intended to be used or sold and goes beyond the pure testing of the installation. See also answer 22 in the Q&A of March 2024.
Where additional production capacity is added to an existing installation producing RFNBOs, the added capacity will be considered to be part of the existing installation, provided that the capacity is added at the same site and the addition takes place no later than 36 months after the initial installation came into operation.
Evidence of the date on which an installation started commercial production can be found in sales documents, in information from the TSO/DSO on electricity fed into or taken from the grid and in GOs that are issued for electricity and hydrogen production based on independent measurements by what is called a "measurement company" in the Netherlands.

(iib) demonstrating that **no financial support has been granted for the renewable electricity production**, meaning the renewable electricity generation installations have not received financial support in the form of operating aid or investment aid.
The electricity that is received under the PPA must come from renewable electricity generation installations that have not received financial support in the form of operating aid or investment aid, excluding:
- support received by installations before their repowering;
- financial support for land or for grid connections;
- support that does not constitute net support, such as support that is fully repaid; and
- support for installations generating renewable electricity that are supplying installations producing RFNBO used for research, testing and demonstration.

At least one of the voluntary schemes suggests that *"the absence of any support received shall be evidenced by providing a description of supporting schemes for renewable electricity in the relevant countries, bidding zones, states or regions along with a list of supported installations in the context of these supporting schemes originating from a public and trusted source (governmental and/or institutional). The installation(s) generating renewable electricity must not be identified in the list of supported installations".* We have discussed this requirement within RVO and we conclude that it is not possible to make such a list in the Netherlands, as there is no database containing information on all renewable electricity production installations plus enough parameters to be able to identify every single renewable electricity production installation. Therefore, in the Netherlands we offer another approach to auditors who will perform certification audits in which the operator of the electrolysers claims to have a PPA with a renewable electricity production installation that did not receive any subsidy. In such a case, the auditor can contact RVO (through waterstof@RVO.nl) and RVO will reply to the auditor and confirm whether this particular renewable electricity production installation did indeed receive no subsidy from one of the subsidy schemes executed by RVO[17]. Currently, there are only a limited number of MW-size renewable electricity production installations in the Netherlands that did not receive subsidy.

Please note that DR 2023/1184 contains a temporary exemption in Article 11: for electrolysers taken into commercial production before 1-1-2028, requirements (iia) and (iib) do not apply until 1-1-2038.

Requirement (iii): demonstrating temporal correlation
This requirement is to prove that RFNBOs were produced at the same time as the renewable electricity was produced. There is a clear distinction between the period up to 1-1-2030 and the period after 1-1-2030: up to 1-1-2030 a monthly correlation applies, whereas after 1-1-2030 an hourly correlation will apply.

As indicated in paragraph 5.2, the operator needs to make sure it has metering data of the electrolyser input and the renewable electricity output of the PPA contracted supplier. The RFNBO producer can prove the temporal correlation by comparing the electricity use in the electrolyser with the electricity produced from the renewable electricity production installations with which a PPA is signed.

Temporal correlation is also automatically fulfilled at a low electricity price. According to Article 6 of DR 2023/1184 on temporal correlation, temporal correlation will always be considered complied with if the RFNBO is produced during an hour in which the day-ahead electricity price is lower than €20/MWh or lower than 0.36 times the ETS price. Because of the difference between the periods up to 2030 and after 2030, the rule "temporal correlation is automatically fulfilled at

[17] In order to perform such a check, the auditor must receive from the company and send to RVO: (i) EAN code, (ii) location (municipality and address), (iii) starting date of commercial electricity production, (iv) capacity in MW, (v) technique (wind turbines, solar panels), (vi) name of the owner and (vii) name of the wind turbine farm or solar panel farm.

a low electricity price" gives different incentives before and after 1-1-2030:

- Before 1-1-2030, the operator of an electrolyser can count the number of hours in which this condition is met during a calendar month and add this number of hours to the number of hours in which the electrolyser can produce RFNBO hydrogen during that month. In order to be allowed doing so, the operator must also demonstrate fulfilling the requirements on additionality and geographical correlation for this number of hours.
- After 1-1-2030, for each hour in the year the temporal correlation will be met either through this low electricity price rule or by demonstrating the temporal correlation in the regular way as described above.

How should the storage of either electricity or hydrogen be dealt with under the temporal correlation requirements? This question is particularly relevant in the case of an hourly temporal correlation from 1-1-2030.

For compliance with the temporal correlation requirement, electricity storage is permitted on the basis of Article 6 on temporal correlation in DR 2023/1184. A storage asset (battery) must be new and must be located either between the renewable electricity production installation and the grid connection point of the electricity supply or between the grid connection point of the electrolyser and the electrolyser. In short, compliance with the temporal correlation can be demonstrated if the electricity used for hydrogen production was used in the same month/hour as it was produced in the renewable electricity production installations contracted under a PPA, or if the hydrogen is produced from electricity stored in a battery that was charged in the same month/hour as the electricity was produced in the renewable electricity production installations contracted under a PPA.

Annex 1, paragraph 1.3 provides further details on the following topics:

- How temporal correlation is automatically fulfilled at a low electricity price
- Example of how to demonstrate compliance with the temporal correlation requirement with a monthly reporting interval
- Example of how to demonstrate compliance with the temporal correlation requirement with an hourly reporting interval
- Example of how to demonstrate that electricity storage complies with the DR 2023/1184 rules.

Requirement (iv): demonstrating geographical correlation
This requirement is straightforward for European countries where the bidding zones are clearly identified. Again, we use the Netherlands as an example. The Netherlands is one bidding zone, including its offshore part where the offshore wind parks are located. As a result, the geographical correlation requirement is automatically complied with if both the electrolyser and the renewable electricity production installations are located in the Netherlands. The location of the renewable energy producing installations must be included in the PPAs.

Complying with this requirement (iv) in countries other than EU member states, in particular if they do not have bidding zones in their grid, might require an analysis of the electricity market in order to determine the equivalence of a bidding zone. An example of such an analysis can be found in this report on Chile and Uruguay, which was performed in 2024 at the request of the Ministry of Economic Affairs and Climate Policy.

The requirement on geographical correlation can also be complied with if the electrolyser is located in one bidding zone and the renewable electricity production installations are located in interconnected bidding zones. However, the electricity provision is then limited by the interconnection capacity and by the extra requirement that compliance can only be demonstrated for the hours during which the day-ahead electricity price in the bidding zone where the renewable electricity generation installation is located is equal to or higher than the day-ahead electricity price in the bidding zone where the electrolyser is located.

4.2 GHG emission savings

The RED requirement of 70% GHG emission savings for RFNBOs is included in Article 29a of the RED, and details of the mandatory accounting methodology are published in DR 2023/1185[18]. In order to become certified under an RFNBO voluntary scheme, an employee of the company to be certified must make the RFNBO GHG emission calculations, thereby demonstrating that he/she is capable of doing so. Calculations will be checked by the auditor from the CB.

GHG calculations must be made on a monthly basis and – from 1-1-2030 and when using option C4 to comply with the first requirements on electricity use – on an hourly basis. There are ways to facilitate the task of making hourly GHG calculations. This is further explained in Annex 2.

There is a strong link between the GHG emission saving calculations and the documentation requirements, as the documentation needs to describe how data on inputs for the GHG calculation are collected and stored, which calculation formulas are used and how the use of these formulas leads to the conclusion that the 70% GHG emission saving requirement is met. Lower heating values must be used when converting mass to energy or vice versa.

Making RFNBO GHG calculations involves details that are further explained in Annex 2.

[18] The consolidated version of RED-III can be found through this link. DR 2023/1185 can be found through this link.

4.3 Mass balance, Proof of Sustainability and Union Database

The third requirement – after requirement one on renewable electricity use and requirement two on a minimum 70% GHG emission saving – is that the RED requires that the mass balance rules in Articles 30(1) and 30(2) of the RED and Articles 15 and 19 of IR 2022/996[19] are followed. The mass balance rules require strict accounting for produced, incoming (purchased) and outgoing (sold) volumes of RNFBO. There is a strong link between the mass balance rules and the overviews that have to be generated based on Article 8 of DR 2023/1184. Annex 3 to this report provides more details including a number of examples of such "Article 8 overviews" and mass balances.

A mass balance should be made on a monthly or quarterly basis. Some schemes or experts recommend a monthly basis, but this is not a requirement and quarterly mass balances are also possible (examples shown in Annex 3). Important aspects of the mass balance are:

- The mass balance concerns the production, purchase and sale of RFNBOs that comply with the three RED-III requirements and hence for which Proofs of Sustainability (POSs) can be issued. The mass balance must include the production, purchase and sale of all hydrogen (and derivatives), i.e. including RFNBOs that do not meet the RED-III requirements and also non-RFNBO hydrogen (derivatives).
- The mass balance should indicate which hydrogen is RFNBO and which is not, and which RFNBO is RED-compliant and which is not.
- Make sure all sources of the data are clearly described.
- Make sure formulas used are clearly explained.

Moreover, the traceability requirements of the RED also give detailed instructions on Proofs of Sustainability (PoSs) to be issued and on information to be entered into the so-called European Union Database. A PoS is defined in IR 2022/996 as follows: *"proof of sustainability" means a declaration by an economic operator, made on the basis of a certificate issued by a certification body within the framework of a voluntary scheme certifying the compliance of a specific quantity of feedstock or fuels with the sustainability and greenhouse gas emissions savings criteria set out in Articles 25(2) and 29 of Directive (EU) 2018/2001."* A PoS must contain detailed information on the sustainability of the RFNBO delivered and on the delivery itself, for instance details of the seller and the buyer must be included. Annex I of IR 2022/996 contains a list of (a) data to be transmitted through the whole supply chain and (b) transaction data. This list will also be included in the voluntary scheme documents. These data must be included in the PoS document. Annex I of IR 2022/996 was developed for biofuels and biomass, but it also applies to RFNBOs. IR 2022/996 will be updated in the year or years to come. We expect that terms in the regulation will then be updated to reflect that it also applies to RFNBOs.

The RFNBO voluntary schemes have templates available for RFNBO PoSs.

When selling an amount of RFNBO, a company can add a separate PoS document to the RFNBO delivery documentation, or it can integrate the PoS information into the company's delivery document format. POSs have to be delivered to the customer within 30 days after physical delivery of the hydrogen. It is important to have proof of a system that ensures that this will be done systematically and in a standardised manner. POSs must be delivered with the shipment of RFNBO. This may contain an annex with delivery documentation for each shipment, so as to link the physical shipments to the PoSs.

Union Database

RFNBO deliveries must also be recorded in the European Commission's Union Database. The auditor must be able to check the entries made, so he or she must also have access to the company records in the Union Database. The check of the companies' entries in the Union Database is important and an auditor can issue major non-conformities if there are deviations between the company's mass balance information and its entries in the Union Database.

At present (December 2024), no experience has yet been gained of entering information on RFNBOs in the Union Database. This section of the report is therefore being kept short. If you need information on the Union Database, the owner of the voluntary scheme that you selected can provide you with further information.

4.4 General requirements

Requirements on documentation

A company that wishes to become RFNBO-certified needs to document procedures and demonstrate complete and up-to-date bookkeeping, as many of the requirements in the voluntary schemes require documented evidence; that is what auditors will be looking for. Previous experience and existing procedures and systems of the company management systems can be used where possible as a basis. Many of the documents can be taken from common management systems, such as ISO 9001-compliant systems. This also includes elements for continuous improvement and learning from errors and mistakes. Furthermore, an internal audit process is required and necessary as part of the management system.

Please note that these documentation requirements are an essential part of the certification against an RFNBO voluntary scheme. If you can demonstrate compliance with the three RED requirements on RFNBOs but do not meet the documentation requirements, an auditor will still issue non-conformities and will not issue a certificate.

[19] The consolidated version of RED-III can be found through this link. IR 2022/996 can be found through this link.

The voluntary schemes and auditors require documentation of the commitment to certification and the procedures the company will follow to become and stay certified. In other words: in addition to doing what is required, you also need to write down in "procedures" what needs to be done, how it will be done, when it is required, who needs to take the action, who is responsible and how records will be kept. The organisational structure must also be documented, including who will take management responsibility for complying with the RED requirements and which tasks have been delegated to which employees. The general management must commit in writing to the certification efforts and communicate this to employees, suppliers and customers. The voluntary schemes also require a certified company to (i) organise internal audits to verify compliance with its own procedures, (ii) communicate updates of procedures to its personnel and (iii) ensure that personnel are properly trained.

One of the reasons for these requirements is that the documentation described above will cause the certification to be internalised and standardised so that it does not depend on the one or few employee(s) who prepared the initial audit. In many ways, these kinds of requirements are no different from any other management system certification, e.g. ISO 9001 or ISO 45001.

Lessons from the pilot audits are that the documentation requirements are more extensive than some companies starting certification anticipate. We therefore provide a list of topics that need to be documented. In the quality manual, a clear and thorough process description of the whole facility is required. This is the same as with all management systems, and should include items such as:

- Process description
- Critical control points
- Process charts/graphics
- Management statement
- Management review taking place once a year
- Responsibilities
- Internal audits against the requirements of the RFNBO voluntary scheme
  - Planning schedule
  - Proof of internal audits taking place
  - Remedial actions taken based on internal audits
  - Management taking notice of the internal audit (e.g. during management review)
- Description of control of system updates
- All measuring equipment has to be clearly identified
- Calculation methodology for GHG emissions
- Formula used and how this leads to required data
- How and which GHG data are collected
- How and which data are collected to demonstrate compliance with mass balance requirements
- How to prove monthly(/hourly correlation)
- Generally, references to offsite parties
  - All data of the offtaker(s) must be clearly registered
  - Suppliers (power, water, other)
- Risk assessment
  - Including plan of actions to mitigate the risks
- Retention period of stored data

During the audit(s), the CB must have access to these records and documentation. Moreover, the voluntary schemes require records and documentation to be kept for at least a number of years (details in the voluntary schemes).

Documents from the recognised schemes contain detailed information on what is required. Please read the scheme documents carefully and/or consult your auditor to become familiar with the documentation requirements.

Requirements on tasks and responsibilities

As with any management system, it is important to identify the key staff who are involved in the RFNBO production and related activities. In particular the roles of the staff involved in the calculations and measurements must be clearly identified, with their respective tasks, responsibilities and accountabilities.

Management commitment is essential; the auditor will likely want to see that the site or company senior management is involved and committed to the activities related to the RFNBO production and certification. This may involve a management statement, periodical management reviews and a clear delegation of authorisations to the relevant staff.

The auditor may want to understand how staff have been trained and how controls of activities are being enforced. This means that clear descriptions are required for the various roles and functions involved in the RFNBO production and certification:

- What should the background of these people be?
- What education?
- What experience?
- What internal training?
- What internal instructions?
- How is their performance measured?
- How are continuous improvements included in the staff management?

Requirements on metering and data on electricity production

Metering is an essential part of the evidence that an auditor will look at.

There are various types of metering devices. The hydrogen delegated regulations and IR 2022/996 do not contain specific requirements on metering equipment. Please consult the voluntary scheme documents and/or your auditor to understand requirements on metering equipment.

Calibration of measuring equipment (other than electricity meters which usually have a certificate) is generally required. (Check with the auditor beforehand, if unsure.)

Be sure to have a proper measurement protocol. This must showcase all steps of the process, to create proof that renewable energy was converted to produce hydrogen. All data that provide input, e.g. for GHG emission calculations, temporal correlation and compliance based on the grid renewable share, will come from metering devices. The measurement protocol will describe exactly which data must be measured where and when, as well as where and how these data are to be stored. The measurement protocol should include serial numbers of all measuring equipment used.

If you also apply to receive Guarantees of Origin (GoOs) for the hydrogen you produce, you also need a measurement protocol. It is efficient to have one measurement protocol for both the GoOs and for the certification against the voluntary scheme. Check at an early stage which requirements apply to metering for receiving GoOs, so as to avoid installing metering that does not meet the requirements.

Please note that receiving GoOs for hydrogen is not required for voluntary scheme certification (but obtaining and cancelling GoOs for the electricity used is required). Receiving GoOs for hydrogen is required under some subsidy schemes for RFNBO production.

Regular inspection of the metering equipment is required. Inspection reports must be available where relevant and applicable.

Live streaming data from the process (e.g. hydrogen quality measuring flow meters) can also be used as part of the RFNBO proof of compliance. Make sure this is included in the measurement protocol. 'Smart' meters are permitted; make sure you explain their role in the measurement protocol.

Not all data have to be separately measured. For example, with a combination of a purity measuring device (for mobility, fuel cells) and a flow meter it will be possible to calculate the amount of MJ output of the electrolyser. (Of course, this has to be clearly described in the measurement protocol.)

To be able to make tables such as those shown in Annex 1, data from smart electricity meters must be available in digital format. This includes data from the owner of the renewable electricity production installations with which PPAs are signed (or from the directly connected solar or wind park). In the case of a grid connection with a PPA, the contract between the electrolyser operator and the owner of the renewable electricity production installation should include provisions on data sharing.

Requirements on claims

The voluntary schemes include requirements that prevent producers, traders or users of RFNBOs making multiple claims based on the same volume of RFNBOs produced, traded or used. In summary, these are the following two requirements:

3. Avoid double claims in case of more than one certification
   If a company is certified according to more than one certification system, one of which is an EC-recognised voluntary scheme, the auditor of the voluntary scheme will need to receive all data including the data submitted for certification against the other scheme. The auditor will check whether multiple claims have been made. For instance, a producer of RNFBOs and low-carbon hydrogen is not permitted to sell part of the production as RED-compliant RFNBO under the voluntary scheme and to sell all other hydrogen as renewable hydrogen under another certification scheme, as this would be a double claim. This is because part of the hydrogen is not produced from renewable sources (see, for instance, the numbers in example 2), whereas all hydrogen sold is claimed to be renewable, part of which is claimed to be RED-compliant.
4. Avoid double claims as a consequence of voluntary scheme certification in combination with Guarantees of Origin (GoOs)
   GoOs can be issued for both electricity and hydrogen. In the case of GoOs issued for electricity, the voluntary schemes require electricity GoOs to be cancelled when the electricity is used for the production of RFNBO hydrogen. In the case of a directly connected electrolyser, this includes any issued GoOs for self-consumption (GoOs for self-consumption are not issued in all EU member states). The GoOs to be cancelled must have been issued for the renewable electricity that was purchased directly (for a directly connected electrolyser) or via the grid under the PPAs, if a PPA is required.
   In the case of GoOs issued for hydrogen, the European Commission will define further rules on how GoOs and PoSs are to be linked. Such rules are currently being discussed, as part of the details of how RFNBO information is to be entered and forwarded in the Union Database.

Annex 1 – Options for electrolyser connections

NOTE: Although this is a detailed explanation, we do not intend this to be an exhaustive overview of all possible options and exceptions. Please refer to the RFNBO voluntary scheme documentation and relevant EU legal documents for a full overview.

The RED requirements on electricity used for the production of RFNBOs are included in Article 27(6) of the RED, with further details provided in DR 2023/1184[20]. There are three options for the production of RFNBOs from renewable electricity. These may be combined. For instance, a directly connected electrolyser might also be connected to the grid. The electrolyser owner might demonstrate that the hydrogen produced through the direct-connection meet the RFNBO requirements for direct connection, and that the hydrogen produced through the grid-connection complies with the RFNBO requirements for grid-connection. See also answer 14 in the Q&A of March 2024.

1.1 Option A – Grid mix

Option A is based on RED Article 27(6)(1), which reads: *"Where electricity is used for the production of renewable fuels of non-biological origin, either directly or for the production of intermediate products, the average share of electricity from renewable sources in the country of production, as measured `two years before the year in question, shall be used to determine the share of renewable energy."* The share of renewable energy sources for electricity (for years n-2) can be found in the following table from EuroStat (showing data for the Netherlands, with values presented as percentages):

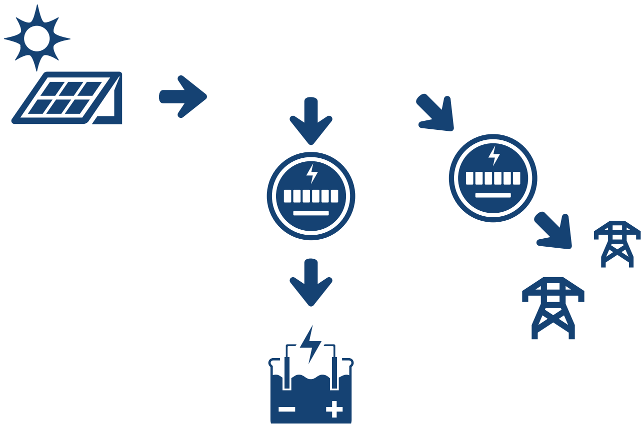
Table | Line | Bar | Map

TIME	2020	2021	2022	2023
GEO				
Netherlands	26.407	33.251	39.650	46.400

This EuroStat table for all EU countries can be opened through this link.

1.2 Option B – Direct connection

In case of a directly connected electrolyser[21], operators are still also permitted to take electricity from the grid (demonstrating compliance with the requirements of either option A or option C), see answers 14 and 30 in the Q&A of March 2024. The figure below shows an example where the electrolyser is directly connected to solar panels and takes electricity from the grid. As a result, at least two electricity meters are required, to measure both grid delivery and offtake from the grid as well as the amount of electricity used by the electrolyser. The location of the smart electricity meters can vary, with the best configuration depending on specific project details.



The two electricity meters can be used to distinguish the following four situations:

- Situation a): the solar panels generate more electricity than used by the electrolyser. Part of the electricity is delivered to the grid.
- Situation b): the electricity from the solar panels is entirely used by the electrolyser. There is no intake of electricity from the grid.
- Situation c): there is some production from the solar panels used by the electrolyser. Moreover, the electrolyser uses electricity from the grid.
- Situation d): there is no production from the solar panels. The electrolyser uses electricity from the grid.

In situations a) and b), the electrolyser operates fully as a directly connected electrolyser, in situation c) both as a directly connected and as a grid-connected electrolyser and in situation d) as a grid-connected electrolyser. For situation c, it is important to demonstrate how much electricity was taken from the solar panels, as the rules for directly connected electrolysers require that (to demonstrate compliance via the direct connection) no electricity was taken from the grid in respect of the amount of electricity from the direct connection. For the electricity taken from the grid, compliance must be demonstrated by means of option A (which also leads to non-RFNBO production) or by means of one of the sub-options under option C.

[20] The consolidated version of RED-III can be found through this link. DR 2023/1184 can be found through this link.

[21] Which can be an AC line as well as a DC line, excluding or including transformers. The term "direct line" is defined in DR 2023/1184 Article 2. This definition refers to a definition in Article 2(41) of Directive (EU) 2019/944, which reads: "'direct line' means either an electricity line linking an isolated generation site with an isolated customer or an electricity line linking a producer and an electricity supply undertaking to supply directly their own premises, subsidiaries and customers."

In RED Article 27(6) second subparagraph and DR 2023/1184 Chapter 3, there is no indication of the time interval that should be applied for data collection and for GHG calculations for directly connected electrolysers. We would recommend using a monthly reporting interval unless the rules on temporal correlation for electricity taken from the grid dictate the use of an hourly reporting interval.

The tables below show how the accounting could look. This is an example (using real data) for a 20 MW solar park in combination with a 2 MW electrolyser. In this example there is no evidence that the electricity from the grid complies with DR 2023/1184, and hence option A "Grid mix" is used for the grid electricity with a 2022 average share of renewable electricity in the grid of 40%. The operator of the electrolyser might in the first instance collect data in the following format:

Table 2 *- Real data example of 20MW solar park and 2MW electrolyser*

Month	A. Production by solar park (MWh)	B. Delivery to the grid (MWh)	C. Electricity from the direct line used in the electrolyser (MWh)	D. Electricity taken from the grid and used in electrolyser (MWh)	E. Total use of electricity in the electrolyser (E = C + D) (MWh)	F. Amount of hydrogen produced (RFNBOs and non-RFNBOs) (ton)
Jan. '24	604	449	155	26	181	3.2
Feb. '24	523	392	131	39	170	3.0
March '24	1,452	1,016	436	80	516	9.2
April '24	2,151	1,575	576	79	655	11.7
May '24	2,822	2,078	744	74	818	14.6
June '24	2,616	1,896	720	72	792	14.1

Here are some remarks for readers trying to understand what happens with the combination of the 20 MW solar park and the 2 MW electrolyser:

- It will probably be impossible to keep the electrolyser in continuous operation in winter months and comply with the 70% GHG emission saving requirement on a monthly basis, because the amount of renewable electricity provided during the darkest months is too low to be able to achieve a 70% GHG emission reduction. Therefore, during winter months the electrolyser operates in start-stop mode (only switching on during sunny days). Continuous operation might be possible if the ratio between the MW_{peak} of the solar park and the MW_{input} of the electrolysers is larger than the ratio of 10 in the example above.
- During winter months, the production of electricity from the solar park (column A) is larger than the use of electricity from the solar park by the electrolyser (column C) because (a) the electrolyser stays switched off during cloudy days and (b) during sunny day-hours the production by the 20 MW solar park is often higher than the use in the 2 MW electrolyser. So, also on winter days, with the electrolyser turned on, part of the electricity produced by the solar park is fed into the grid. Combining the direct connection with a grid connection will therefore yield more full-load hours. However, this can only be done if compliance with the RED requirements can be demonstrated via the grid connection based on option A or on one of the sub-options C1-C4 described below.

For reporting under a voluntary scheme, the common rules for providing reliable information in Article 8 of DR 2023/1184 must be complied with, which gives the following table:

Table 3 - Example of reporting according to 2023/1184

Month	(a) Amount of electricity used to produce RFNBOs (MWh)	(i) Amount of electricity sourced from the grid that does not count as fully renewable (MWh)	Proportion of renewable electricity[22]	(ii) Amount of electricity that counts as fully renewable obtained from a direct connection (MWh)	(iii) Amount of electricity sourced from the grid that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(1) (MWh)	(iv) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(2) (MWh)	(v) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(3) (MWh)	(vi) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(4) (MWh)	(b) Amount of renewable electricity generated by the installations generating renewable electricity, regardless of whether they are directly connected to an electrolyser and regardless of whether the renewable electricity is used for the production of RFNBOs or for other purposes (MWh)	(c) Amounts of RFNBOs produced by the fuel producer (ton)	Amount of hydrogen produced (RFNBOs and non-RFNBOs) by the fuel producer (ton)
Jan. '24	181	26	40%	155	0	0	0	0	604	3.0	3.2
Feb. '24	170	39	40%	131	0	0	0	0	523	2.6	3.0
March '24	516	80	40%	436	0	0	0	0	1452	8.3	9.2
April '24	655	79	40%	576	0	0	0	0	2,151	10.9	11.7
May '24	818	74	40%	744	0	0	0	0	2,822	13.8	14.6
June '24	792	72	40%	720	0	0	0	0	2,616	13.4	14.1

In the table above, the last column gives the total amount of hydrogen as measured. In this numerical example, the efficiency of hydrogen production is 1 ton of hydrogen per 56.0 MWh of electricity used. The numbers in the second last column are calculated in the same way as the calculation in example 2 in paragraph 4.1.1: electricity that counts as fully renewable will produce RFNBO hydrogen, and electricity sourced from the grid that does not count as fully renewable produces hydrogen that is partly RFNBO hydrogen and partly non-RFNBO-hydrogen. Here is a numerical example: for the June 2024 data in the table above, the amount of RFNBOs produced in this month is calculated as "(720/56 + 72*40%/56) = 13.4 tons".

We have coloured one row with a red background colour. In Annex 2 below we will show that the 70% GHG reduction criterion was not complied with in February, and hence the 2.6 tons of hydrogen produced during this month qualifies as RFNBO that is not RED-compliant. Issuing Proofs of Sustainability (PoSs) for this hydrogen is not permitted, as is further explained in Annex 3 below. This is why we marked this row red; it must be dealt with in a different way in the mass balance accounts than the other rows.

1.3 Option C – Grid connection

This section provides further details on the following topics:

- How temporal correlation is automatically fulfilled at a low electricity price;
- Example of how to demonstrate compliance with the temporal correlation requirement with a monthly reporting interval;
- Example of how to demonstrate compliance with the temporal correlation requirement with an hourly reporting interval; and
- Example of how to demonstrate that electricity storage complies with the DR 2023/1184 rules.

How temporal correlation is automatically fulfilled at a low electricity price

First, we provide some information on the third subparagraph of Article 6 in DR 2023/1184 on temporal correlation. This subparagraph states that – in summary – that the temporal correlation will always be considered complied with if the RFNBO is produced during an hour in which the day-ahead electricity price is lower than €20/MWh or lower than 0.36 times the ETS price. This possibility results in different incentives before and after 1-1-2030:

[22] Although the rounded number "40%" is given in this table for the year 2022, calculations must be made with the unrounded number 39.650%.

- Before 1-1-2030, the operator of an electrolyser can calculate the number of hours in which this condition is met during a calendar month and add this number of hours to the number of hours in which the electrolyser can produce RFNBO hydrogen during that month.
- After 1-1-2030, for each hour in the year the temporal correlation will be met either through this low electricity price rule or by demonstrating the temporal correlation in the regular way by comparing the electricity produced from the renewable electricity production installations with which a PPA is signed with the electricity use in the electrolyser.

This difference is explained by examples with numbers in the tables that follow later in this chapter, after the first table below.

There are two further considerations:

5. Demonstrating that the day-ahead electricity price is low will only demonstrate that the temporal condition requirement is complied with for one hour or for a series of hours in a row. The other requirements under sub-option C4 on additionality and geographical correlation must also be complied with, and evidence for this has to be provided for electricity that is sourced under a PPA. This can be electricity that was generated during hours or a month other than the hour or month under consideration for the temporal correlation.
6. The operator of the electrolyser might also make use of the provision in DR 2023/1184 Article 4(3) (explained above) which – based on information from the TSO (TenneT in the Netherlands) – can demonstrate compliance with the first general requirement concerning the electricity used for the hours in which renewable electricity production is downwards redispatched and the use of electricity for RFNBO production avoids redispatchment. This provision also demonstrates compliance on a per-hour basis and, of course, the number of hours in which the requirements are complied with cannot be aggregated if (all or part of) the hours are the same hours, i.e. hours where compliance is demonstrated by both Article 4(3) as well as by Article 6 third subparagraph.

All auditors must check (by means of sampling) whether this rule in DR 2023/1184 Article 6 third subparagraph in conjunction with the rule in DR 2023/1184 Article 4(3) has been correctly applied, based on a list of day-ahead and ETS prices and (when the TSO has made this possible) information from the TSO on compliance with 2023/1184 Article 4(3) with regard to downward redispatchment, as in the example below. Please note – in accordance with point 2 above – that the number of hours in which the temporal correlation is complied with in this period on 4 July up to 13:00 is eight, not ten, because the hours in the last column cannot be aggregated, as they are duplicates of those in the "temporal correlation complied with" column.

***Table 4** - Data on day-ahead and ETS prices for temporal correlation*

Date	Hour	Day-ahead price (€ / MWh)	ETS price (€ / ton)	0.36 * ETS price	Temporal correlation complied with?	(Based on TSO evidence:) Compliance through 4(3)?
04/07/24	00:00 - 01:00	58.50	68.71	24.74	No	No
04/07/24	01:00 - 02:00	35.00	68.71	24.74	No	No
04/07/24	02:00 - 03:00	16.35	68.71	24.74	Yes	No
04/07/24	03:00 - 04:00	10.00	68.71	24.74	Yes	No
04/07/24	04:00 - 05:00	7.43	68.71	24.74	Yes	No
04/07/24	05:00 - 06:00	7.35	68.71	24.74	Yes	No
04/07/24	06:00 - 07:00	31.25	68.71	24.74	No	No
04/07/24	07:00 - 08:00	34.91	68.71	24.74	No	No
04/07/24	08:00 - 09:00	32.86	68.71	24.74	No	No
04/07/24	09:00 - 10:00	22.23	68.71	24.74	Yes	No
04/07/24	10:00 - 11:00	-10.00	68.71	24.74	Yes	No
04/07/24	11:00 - 12:00	-35.69	68.71	24.74	Yes	Yes
04/07/24	12:00 - 13:00	-70.00	68.71	24.74	Yes	Yes

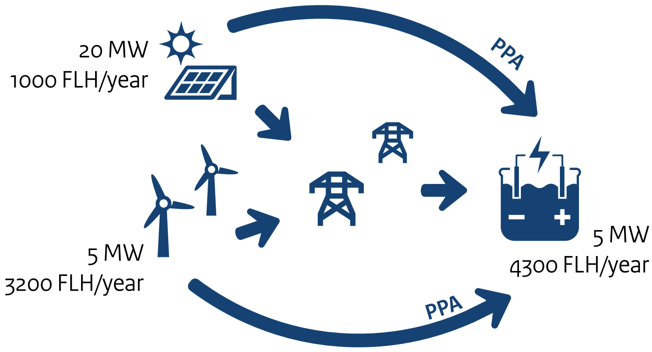
Example of how to demonstrate compliance with the temporal correlation requirement with a monthly reporting interval
Tables like the examples shown below (Table 5) are key to demonstrating compliance with the RED RFNBO requirements.

Tables can be made in a spreadsheet program such as Excel, in commercially available database programs or in software developed by the companies that own/operate the electrolysers.

The tables demonstrate that the amount of electricity used in the electrolyser (second column) equals the sum of electricity in columns three and five, six, seven, eight and nine which is electricity that fully complies with the requirements or which partly leads to RFNBO production in the case of electricity taken from the grid without further evidence. The auditor may ask – taking some of the numbers from the table – to demonstrate how they were calculated based on the smart meter readouts.

When demonstrating compliance on a monthly temporal correlation basis, the rule in DR 2023/1184 Article 6 third subparagraph in conjunction with the rule in DR 2023/1184 Article 4(3) (see table above) can help to increase the number of hours in a month during which RFNBOs can be produced. In the case of DR 2023/1184 Article 4(3), no further evidence is needed, so the PPA electricity can be added to that amount. In the case of DR 2023/1184 Article 6 third subparagraph, only compliance with the temporal correlation requirement is demonstrated, so a PPA and compliance with the additionality and geographical correlation requirements is still necessary, which means that the number of RFNBO production hours is still limited by the amount of electricity obtained through the PPA. An advantage of this rule in DR 2023/1184 Article 6 would be that electricity provided under a PPA with a solar park can be spread more evenly over the year, so the additionality and geographical correlation demonstrated by such a PPA can – for electricity provided in summer months – be used in winter months for those hours in which the temporal correlation is demonstrated through DR 2023/1184 Article 6 third subparagraph.

The table below has been made based on the following layout:



During the period of monthly temporal correlation, an example of the data table looks like this:

Table 5 *- Example of reporting of electricity and RFNBO production for temporal correlation (monthly)*

Month	(a) Amount of electricity used to produce RFNBOs (MWh)	(i) Amount of electricity sourced from the grid that does not count as fully renewable (MWh)	Proportion of renewable electricity[23]	(ii) Amount of electricity that counts as fully renewable obtained from a direct connection (MWh)	(iii) Amount of electricity sourced from the grid that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(1) (MWh)	(iv) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(2) (MWh)	(v) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(3) (MWh)	(vi) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(4) (MWh)	(b) Amount of renewable electricity generated by the installations generating renewable electricity, regardless of whether they are directly connected to an electrolyser and regardless of whether the renewable electricity is used for the production of RFNBOs or for other purposes (MWh)	(c) Amounts of RFNBOs produced by the fuel producer (ton)	Amount of hydrogen produced (RFNBOs and non-RFNBOs) by the fuel producer (ton)
Jan. '24	1,750	188	40%	0	0	0	0	1,562	2,015	29.2	31.3
Feb. '24	1,603	181	40%	0	0	0	0	1,422	1,814	26.7	28.6
March '24	1,867	202	40%	0	0	0	0	1,665	2,681	31.2	33.3
April '24	2,231	198	40%	0	0	0	0	2,033	3,608	37.7	39.8
May '24	2,285	186	40%	0	0	0	0	2,099	4,177	38.8	40.8
June '24	2,216	180	40%	0	0	0	0	2,036	3,932	37.6	39.6
July '24	2,229	186	40%	0	0	0	0	2,043	3,984	37.8	39.8

[23] Although the rounded number "40%" is given in this table for the year 2022, calculations must be made with the unrounded number 39.650%.

The operator of the electrolyser needs to be able to demonstrate how these values were calculated. For instance, the amount in column (b) must follow from the monthly quantities of electricity obtained under the two PPAs and must be further evidenced by the cancellation of GOs from the renewable electricity generation installations that are contracted in the PPAs.

Demonstrating a monthly temporal correlation means that weather patterns do not need to be strictly followed as long as the amount of renewable electricity supplied under PPAs is sufficient to produce RFNBOs and demonstrate compliance with the 70% GHG emission saving requirement (see Annex 2 below).

<u>Example of how to demonstrate compliance with the temporal correlation requirement with an hourly reporting interval</u>
In many cases, demonstrating an hourly temporal correlation will require the electrolyser to be run at partial load or to be shut down during hours with low availability of renewable electricity complying with the RED requirements. The producer of RFNBOs must keep data for all hours per year. The table below gives an example for some selected hours, for the same electrolyser/PPA layout as shown above, and for two days:

- the early morning of 7 July 2024. This was a Sunday with day-ahead prices in the Netherlands of around zero from midnight to 09:00 due to moderately high wind speeds and low electricity demand, followed by negative prices until 18:00 as solar power increased renewable electricity production further.
- the late afternoon and evening of 9 July 2024. This was a sunny Tuesday in the Netherlands with moderate and slightly fluctuating wind speeds during the whole day. In this example it is assumed that in the evening the operator of the electrolyser keeps the electrolyser at minimum load (15% of maximum load) in anticipation of a slight increase in wind speeds early on Wednesday 10 July. The operator does so hoping that there is enough wind speed and hence enough electricity production by the PPA-linked wind farm to meet the 70% GHG emission reduction requirement during the hours in which there is no production from the PPA-linked solar farm.

The table below has a slightly different format than the table shown above for demonstrating compliance with the temporal correlation requirement with a monthly reporting interval. The first difference (first two columns) is that the table lists data for all individual hours during all days in a year. The second difference is the addition of the last column, which is used to indicate whether the temporal correlation is demonstrated by the “low price” rule in DR 2023/1184 Article 6 third subparagraph.

Table 6 *- Example of reporting of electricity and RFNBO production for temporal correlation (hourly)*

Date	Hour	(a) Amount of electricity used to produce RFNBOs (MWh)	(i) Amount of electricity sourced from the grid that does not count as fully renewable (MWh)	Proportion of renewable electricity[24]	(ii) Amount of electricity that counts as fully renewable obtained from a direct connection (MWh)	(iii) Amount of electricity sourced from the grid that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(1) (MWh)	(iv) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(2) (MWh)	(v) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(3) (MWh)	(vi) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(4) (MWh)	(b) Amount of renewable electricity generated by the installations generating renewable electricity, regardless of whether they are directly connected to an electrolyser and regardless of whether the renewable electricity is used for the production of RFNBOs or for other purposes (MWh)	(c) Amounts of RFNBOs produced by the fuel producer (ton)	Amount of hydrogen produced (RFNBOs and non-RFNBOs) by the fuel producer (ton)	Day-ahead electricity price lower than €20/MWh or 0.36*ETS price
07/07/24	04-05	5.000	0.000	40%	0	0	0	0	5.000	1.859	0.089	0.089	yes
07/07/24	05-06	5.000	0.000	40%	0	0	0	0	5.000	1.753	0.089	0.089	yes
07/07/24	06-07	5.000	0.000	40%	0	0	0	0	5.000	3.184	0.089	0.089	yes
07/07/24	07-08	5.000	0.000	40%	0	0	0	0	5.000	6.770	0.089	0.089	yes
07/07/24	08-09	5.000	0.000	40%	0	0	0	0	5.000	11.091	0.089	0.089	yes
....	....												
09/07/24	14-15	5.000	0.000	40%	0	0	0	0	5.000	18.271	0.089	0.089	yes
09/07/24	15-16	5.000	0.000	40%	0	0	0	0	5.000	16.550	0.089	0.089	yes
09/07/24	16-17	5.000	0.000	40%	0	0	0	0	5.000	13.463	0.089	0.089	no
09/07/24	17-18	5.000	0.000	40%	0	0	0	0	5.000	10.233	0.089	0.089	no
09/07/24	18-19	5.000	0.000	40%	0	0	0	0	5.000	5.575	0.089	0.089	no
09/07/24	19-20	2.517	0.000	40%	0	0	0	0	2.517	2.517	0.045	0.045	no
09/07/24	20-21	1.221	0.000	40%	0	0	0	0	1.221	1.221	0.022	0.022	no
09/07/24	21-22	0.778	0.000	40%	0	0	0	0	0.778	0.778	0.014	0.014	no
09/07/24	22-23	0.750	0.183	40%	0	0	0	0	0.568	0.568	0.011	0.013	no
09/07/24	23-24	0.750	0.067	40%	0	0	0	0	0.683	0.683	0.013	0.013	no

The table shows:

- On 7 July from 04:00 to 07:00 the production of renewable electricity from the PPA-linked installations was not sufficient to cover the demand of the electrolyser running at maximum capacity. In these hours the temporal correlation requirement was complied with due to the low electricity prices (lower than €20/MWh) and hence for each of these hours 5 MWh of electricity can be claimed to be electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(4). We have therefore coloured these rows with a green background colour. Please note that for this extra amount of electricity the additionality and geographical correlation has to be demonstrated. This is done by demonstrating over a certain period – for instance a mass balance period of three months – that the sum of all amounts of electricity in column (vi) *"amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(4) (MWh)"* was actually sourced by the PPA-linked installations and that GOs for this amount – issued for the PPA-linked installations – are cancelled for the producer of the RFNBOs.
- The last two rows for 7 July and the first two rows for 9 July also have a "yes" for *"Day-ahead electricity price lower than €20/MWh or*

[24] Although the rounded number "40%" is given in this table for the year 2022, calculations must be made with the unrounded number 39.650%.

*0.36*ETS price*". For these rows, however, the automatic compliance with the temporal correlation requirement is not relevant during these hours, as the temporal correlation is also demonstrated by this table, showing that the electricity purchase from the PPA-linked installations is greater than the electricity use for RFNBO production.

- It can be seen that on 9 July the electrolyser is ramped down following the decrease in solar electricity production. However, the use of electricity in the electrolyser cannot be lower than 0.75 MWh per hour (a 15% minimum load is assumed for the PEM electrolyser where the maximum load is 5 MW). The last two rows (9 July, 22:00-24:00) therefore show that electricity that does not count as fully renewable has been taken from the grid to avoid the electrolyser having to be shut down. In Chapter 5.4 we will show that in the hour from 22:00 to 23:00 the 70% GHG reduction criterion was not complied with, and hence the 13 kilograms of hydrogen produced during this hour qualifies as RFNBO that is not fully RED-compliant. This is why we have coloured this particular row with a red background colour. Issuing Proofs of Sustainability (PoSs) for these 13 kilograms of hydrogen is not permitted, as is further explained in paragraph 4.3.

<u>Example of how to demonstrate that electricity storage complies with the DR 2023/1184 rules</u>

On the subject of electricity storage ("batteries"), Article 6 of DR 2023/1184 states that (underlining added) *"From 1 January 2030, the temporal correlation condition shall be considered complied with if the renewable liquid and gaseous transport fuel of non-biological origin is produced during the same one-hour period as the renewable electricity produced under the renewables power purchase agreement <u>or from renewable electricity from a new storage asset that is located behind the same network connection point as the electrolyser or the installation generating renewable electricity, that has been charged during the same one-hour period in which the electricity under the renewables power purchase agreement has been produced."</u>* In the table below, we show how this can be demonstrated for the same electrolyser configuration as above, but now with a 5 MW / 10 MWh battery that is installed together with the electrolyser (i.e. new) with the aim of enabling the electrolyser to run at relatively low load during the night while producing RFNBOs when there is insufficient wind. Data for 9 July are shown that were also shown in Table 6.

The numbers are shown in Table 7 below. In this case the electrolyser was run at 35% load overnight, which was possible as there was some overnight production of renewable electricity from the wind turbines. In the case of a windless night (or an electrolyser only using electricity from solar panels), it would have been necessary to opt for a lower overnight load. The strategy would always be to use (almost) all stored electricity overnight until a new supply of electricity from the solar panels can take over the following day.

In the table below, not all columns are shown, as the full table does not fit on this page. The three columns furthest to the right in Table 6 have been omitted. Numbers that have changed and columns that have been added as compared to Table 6 are coloured red. Data on the battery charge/discharge and load are added in the four columns furthest to the right in Table 7. The data in this table demonstrate that as a result of the electricity storage no electricity has to be taken from the grid that does not comply with DR 2023/1184. As a consequence, all hydrogen produced is RED-compliant RFNBO. The red-marked line for the 22:00-23:00 data has disappeared, as the 70% GHG emission saving is now also met in that hour. Please note that in this example the load/unload efficiency of the battery has not yet been taken into account, this should be added when this example is used for reporting data for an actual electrolyser.

Table 7 *- Example of use of battery storage for RFNBO production in case of hourly temporal correlation*

Date	Hour	(a) Amount of electricity used to produce RFNBOs (MWh)	(i) Amount of electricity sourced from the grid that does not count as fully renewable (MWh)	Proportion of renewable electricity[25]	(ii) Amount of electricity that counts as fully renewable obtained from a direct connection (MWh)	(iii) Amount of electricity sourced from the grid that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(1) (MWh)	(iv) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(2) (MWh)	(v) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(3) (MWh)	(vi) Amount of electricity that counts as fully renewable in accordance with the criteria set out in DA 20223/1184 Article 4(4) (MWh)	(b) Amount of renewable electricity generated by the installations generating renewable electricity, regardless of whether they are directly connected to an electrolyser and regardless of whether the renewable electricity is used for the production of RFNBOs or for other purposes (MWh)	Battery: charge / discharge (C / D)	Amount of electricity used to charge the batteries (MWh)	Amount of electricity discharged from batteries (MWh)	Amount of electricity stored in the battery at start of this hour (MWh)
09/07/24	12-13	5.000	0.000	40%	0	0	0	0	7.500	18.792	C	2.500	0	2.345
09/07/24	13-14	5.000	0.000	40%	0	0	0	0	7.500	19.542	C	2.500	0	4.845
09/07/24	14-15	5.000	0.000	40%	0	0	0	0	7.500	18.271	C	2.500	0	7.345
09/07/24	15-16	5.000	0.000	40%	0	0	0	0	5.155	16.550	C	0.155	0	9.845
09/07/24	16-17	5.000	0.000	40%	0	0	0	0	5.000	13.463	-	0	0	10.000
09/07/24	17-18	5.000	0.000	40%	0	0	0	0	5.000	10.233	-	0	0	10.000
09/07/24	18-19	5.000	0.000	40%	0	0	0	0	5.000	5.575	-	0	0	10.000
09/07/24	19-20	2.517	0.000	40%	0	0	0	0	2.517	2.517	-	0	0	10.000
09/07/24	20-21	1.750	0.000	40%	0	0	0	0	1.221	1.221	D	0	0.529	10.000
09/07/24	21-22	1.750	0.000	40%	0	0	0	0	0.778	0.778	D	0	0.973	9.471
09/07/24	22-23	1.750	0.000	40%	0	0	0	0	0.568	0.568	D	0	1.183	8.498
09/07/24	23-24	1.750	0.000	40%	0	0	0	0	0.683	0.683	D	0	1.067	7.316

[25] Although the rounded number "40%" is given in this table for the year 2022, calculations must be made with the unrounded number 39.650%.

Annex 2 – GHG emission savings

The RED requirement of 70% GHG emission savings for RFNBOs is included in Article 29a of the RED. Details of the mandatory accounting methodology are published in DR 2023/1185[26].

Explanation of how to make actual GHG calculations

In this chapter we will show in broad outline how actual[27] GHG calculations can be made. For every company that wishes to be RFNBO-certified, at least one of the employees must demonstrate the ability to make such calculations[28].

The best way to understand and be able to make GHG calculations is that you start from scratch and make your own calculation. An auditor would check the calculation and point to parts in the calculation where improvements or corrections need to be made.

In the next few pages, we will explain how this works for RFNBO hydrogen produced in an electrolyser at 30 bar, followed by compression to 300 bar for short-term storage and further compression to 900 bar in a hydrogen disperser. We will assume that the hydrogen will be used in fuel cell cars.

The basic calculation that is repeated several times is:

Emission = amount of energy/material/service used * emission factor

with units

[g $CO_{2,eq}$/kg of hydrogen] = [unit /kg of hydrogen] * [g $CO_{2,eq}$ /unit]

(Only for transport, the calculation is slightly different as is further explained below.) The "unit" is, for instance, MWh for electricity, litre for the material "deionised water" or m³ for the service "wastewater treatment". Emissions are calculated in g $CO_{2,eq}$/kg of hydrogen, and after completing the calculations in the whole chain (production, transport, possible conversion, further transport and use) the calculated value is converted into the unit "g $CO_{2,eq}$/kg of hydrogen" and then the emission reduction percentage is calculated, as shown below.

Emission factors can be found, for instance, in DR 2023/1185, in the scheme documents from the voluntary schemes and in databases such as the Ecoinvent database. This example calculation below is made with the following conversion factors (with sources mentioned):

***Table 7** - Conversion factors for GHG emission calculations*

Energy/material/service	Conversion factor	Unit	Source
Grid electricity (Netherlands)	99.9	g $CO_{2,eq}$ / MJ	DR 2023/1185 Annex C
	359.64	g $CO_{2,eq}$ / kWh	Calculated from value above
Deionised water	0.43	g $CO_{2,eq}$ / litre	Ecoinvent version 3.9.1
Tap water	0.20	g $CO_{2,eq}$ / litre	LBST, 2022[29]
Wastewater	363.67	g $CO_{2,eq}$ / m³	Ecoinvent version 3.9.1

Using the numbers for the month "February" in the example table for a directly connected electrolyser in Table 3 in paragraph 1.2 in Annex 1 [30] and assuming 10 litres of deionised water, 15 litres of tap water and 0.016 m³ of wastewater per kg of hydrogen produced, the calculations for the electrolyser are as follows:

- Electricity complying with DR 2023/1184: 131/3 [kWh/kg H_2] * 0 [g $CO_{2,eq}$/MWh] = 0 g $CO_{2,eq}$ / kg H_2
- Grid electricity: 39/3 [kWh/kg H_2] * 359.64 [g $CO_{2,eq}$/kWh] = 4,675.3 g $CO_{2,eq}$ / kg H_2
- Deionised water: 10 [litre/kg H_2] * 0.43 [g $CO_{2,eq}$/litre] = 4.3 g $CO_{2,eq}$ / kg H_2
- Tap water: 15 [litre/kg H_2] * 0.20 [g $CO_{2,eq}$/litre] = 3.0 g $CO_{2,eq}$ / kg H_2
- Wastewater: 0.016 [m³/kg H_2] * 363.67 [g $CO_{2,eq}$/m³] = 5.8 g $CO_{2,eq}$ / kg H_2

The total emissions from the production of hydrogen in the electrolyser are therefore 4,688.4 g $CO_{2,eq}$ / kg $H_{2,\text{ produced, 30 bar}}$.

[26] The consolidated version of RED-III can be found through this link. DR 2023/1185 can be found through this link.

[27] The word "actual" in "actual GHG calculations" stems from the requirements in the RED for biofuels and biomass, where the use of default GHG emission values and default GHG emission savings is permitted as listed in Annexes V and VI of the RED. As an alternative to the use of default values, actual GHG values calculated by the economic operator may be used. For biofuels and biomass, therefore, a distinction is made between "default GHG emission values" and "actual GHG emission values". For RFNBOs only actual GHG values can be used, as default values are not available. The wording "actual GHG calculation" is used deliberately in this document, as IR 2022/996 also applies to RFNBOs and as IR 2022/996 includes requirements on making actual GHG calculations (see, for instance, the footnote below).

[28] IR 2022/996 Article 14(4) reads: "Economic operators may only make actual GHG values claims after their capability to conduct actual value calculations has been verified by an audit."

[29] Report "RFNBO Greenhouse gas emissions - GHG emission factors and conversion efficiencies for making RFNBO GHG emission calculations" (November 2022) by Ludwig-Bölkow-Systemtechnik, available through this link.

[30] In that example, 3 tons of hydrogen was produced, so we divide the input numbers given for the month "February" by 3 tons/month.

The next step is the compressor. The operator of the electrolyser that makes the GHG calculation should measure the electricity use by the compressor. Here, we will use a number from Table 28 in LBST(2022): compression from 30 to 300 bar requires 5.93 $MJ_{electricity}$ per kg of H2. If the electricity is taken from the grid, this gives:

- Grid electricity: 5.93/3.6 [kWh/kg H_2] * 359.64 [g $CO_{2,eq}$/kWh] = 592.4 g $CO_{2,eq}$ / kg H_2

The total emission from production and compression is 5,280.8 g $CO_{2,eq}$ / kg $H_{2, 300 bar}$.

Then the hydrogen is transferred to a dispenser via a pipeline. We assume that the pipeline transport does not cause emissions, as there is no compression in the hydrogen pipeline network and the hydrogen is transported by the 30 bar input pressure and a slightly lower output pressure. A compressor then brings the hydrogen to 900 bar, which input should again be measured. Here we use a calculated value based on the two formulas in paragraph 3.8 of the LBST(2022) report: compression from 300 to 900 bar requires 3.23 $MJ_{electricity}$ per kg of H_2.

- Grid electricity: 3.23/3.6 [kWh/kg H_2] * 359.64 [g $CO_{2,eq}$/kWh] = 322.7 g $CO_{2,eq}$ / kg H_2

[Please note that using a tube trailer at 300 bar, transporting the hydrogen to a different location and then emptying the tube trailer and compressing to 900 bar requires much more compression electricity than 3.23 $MJ_{electricity}$ per kg of H_2. This is because the effective average pressure at the inlet of the compressor is much lower than 300 bar as the tube trailer is emptied. To calculate the effective inlet pressure, see LBST 2022 section 3.7.2. In this same section, the required amount of electricity for compression to 900 bar emptying a tube trailer from 300 bar to 20 bar is listed in Table 26 as 12.39 $MJ_{electricity}$ per kg of H_2.]

We cannot just add this amount to the previous amount, as hydrogen losses have to be taken into account (leakage from the pipeline network). Such leakage/loss rates should preferably be measured. If they were not measured, they can be taken from LBST (2022) or other reliable sources. In LBST (2022) a leakage rate of 0.25% is reported for pipeline transport. The 99.75% of hydrogen that enters the second compressor brings a slightly higher emission than the 5,280.8 g $CO_{2,eq}$ / kg $H_{2, 300 bar}$, as the emissions have to be assigned to a slightly smaller amount of hydrogen. Therefore, the total emissions after transporting the hydrogen through the pipeline are: (5280.8 / 0.9975) g $CO_{2,eq}$ / kg $H_{2, transported per pipeline}$. Adding the 322.7 g $CO_{2,eq}$ / kg H_2 for the further compression to 900 bar gives 5,616.8 g $CO_{2,eq}$ / kg $H_{2, 900 bar}$.

The emission in use is zero in this case, as fuel cell cars do not emit CH_4 and N_2O.

The emission reduction percentage can now be calculated by converting into MJ and then using the formula from DR 2023/1185 Annex A, Article 2:

- The emission intensity is (5,616.8 g CO_2,eq per kg H_2 / 120 MJ per kg H_2) = 46.81 g $CO_{2,eq}$ per MJ H_2
- The emission reduction is 100* (94 - 46.81)/94 = 50.2%.

This is clearly not compliant with the minimum 70% GHG saving requirement. Even if the hydrogen had not been compressed but used just after production plus pipeline transport (with a 0.25% loss), the saving for this example would only have been 58%. This is because the share of grid electricity in this example is too high (in combination with an emission factor of 99.9 g $CO_{2,eq}$ /MJ for grid electricity in the Netherlands). This is why the row in Table 3 for February is coloured red. The other months can result in a 70% or higher GHG emission saving, depending on the amount of GHG emissions in the rest of the hydrogen provision pathway.

If, in your process, you use nitrogen (for flushing), adsorbents, sodium hydroxide or other chemicals, you must also include these inputs in your calculation. You may disregard the energy and materials that were used to build the installation.

For electricity taken from the grid which is not fully renewable, GHG emissions will be taken into account in accordance with one of the three options set out in DR 2023/1185 Annex A, Article 6. The option chosen must be applied during a whole calendar year. In this report we will work with the first option, because the second option requires data that is not yet available[31] and because the third option can only be applied if the national TSO provides hourly data on which kind of electricity production technology was the marginal production technology; the Dutch TSO TenneT has not done this to date. We will make an addition to this report when data enabling to use the second and/or third option becomes available.

Slightly different approach for transport calculations

In the case of calculating transport emissions, the basic calculation is slightly different and is made in two steps. First, the amount of transport fuel (diesel, fuel oil etc.) is calculated:

Amount of fuel used per ton of material transported = transport distance * transport efficiency

with units

[MJ fuel / ton of hydrogen] = [km]*[MJ fuel / (ton, km)]

[31] The second method requires reliable data on the number of hours in which the marginal price of electricity was set by installations producing renewable electricity or nuclear power plants in the preceding calendar year. Such data are not yet available in the Netherlands.

Then, the emission as a result of the combustion of the fuel is calculated

Emission = 0.001 * Amount of fuel used per ton of material transported * emission factor

with units

[g $CO_{2,eq}$/kg of hydrogen] = [ton / kg] * [MJ fuel / ton of hydrogen] * [g $CO_{2,eq}$ / MJ fuel]

Finally, using the following formula, the CH_4 and N_2O emissions from the fuel combustion are added (if data are available). These emissions cannot be incorporated by using a higher emission factor for the fuel, as these emissions are not fuel-specific but are specific to the combustion technology.

Emission = 0.001 * transport distance * emission factor for CH_4 and N_2O emissions

with units

[g $CO_{2,eq}$/kg of hydrogen] = [ton / kg] * [km] * [g $CO_{2,eq}$ / (ton, km)]

The above formulas are illustrated by the following example calculation for the transport of hydrogen in a 960 kg "Calvera 2021" tube trailer over a one-way distance of 150 km and assuming empty return (the example is also shown in Table 17 of [LBST, 2022]). The emission factors for diesel fuel (combustion) and the emission factor for CH_4 and N_2O emissions in this kind of tube trailer are listed in the tables below.

Amount of diesel fuel per ton of hydrogen = 150 km * 25.1 MJ / (ton, km) = 3,765 MJ / ton H_2

Emission (fuel combustion) = 0.001 * 3765 * 95.1 = 358.05 g $CO_{2,eq}$/kg of H_2

Emission (due to CH_4 and N_2O emissions) = 0.001 * 150 * 16.461 = 2.47 g $CO_{2,eq}$/kg of H_2

Total emissions: 360.52 g $CO_{2,eq}$/kg of H_2

Emission factors for transport emission calculations

Emission calculations for transport as in the example calculation above use emission factors such as those listed in the tables below. We have included these numbers in this report, as values in the two tables below are not included in DR 2023/1185. If you do not find the tube trailer type that was used in your case, take the next higher rounded number, so if you use a tube trailer with a capacity of 200 kg, use the emission factor for the tube trailer with a capacity of 315 kg in the table below.

Please note that empty return is included in the fuel efficiencies in Table 8 and Table 9 below. In other words, if you use the value in MJ / (ton*km) in the table below and multiply this by 150 km (as in the example above), the empty return of 150 km is already included in the calculation.
Please also note that the liquid hydrogen carrier is fuelled by the hydrogen boiloff. Details of these numbers can be found in [LBST, 2022][32].

***Table 8** – Emission factors for tube trailers. Please note: empty return is included in the fuel efficiency*

Tube trailer (diesel fuel)	Fuel efficiency (diesel fuel)	Transport exhaust gas emissions (engine emissions)			Source
Gross transport capacity	MJ/(ton*km)	g CH_4/(ton*km)	g N_2O/(ton*km)	g $CO_{2,eq}$/(ton*km)	
155 kg H_2 (gas)	132.2	0.551	0.245	86.699	LBST, 2022[32] for numbers in column 2 and JRC, 2019[33] for numbers in columns 3-5
315 kg H_2 (gas)	65.0	0.271	0.120	42.628	
630 kg H_2 (gas)	39.7	0.166	0.073	26.036	
803 kg H_2 (gas)	30.4	0.127	0.056	19.937	
960 kg H_2 (gas)	25.1	0.105	0.046	16.461	
1,195 kg H_2 (gas)	19.9	0.083	0.037	13.051	
1,400 kg H_2 (gas)	16.7	0.070	0.031	10.952	
3,500 kg H_2 (liquid)	6.59	0.027	0.012	4.322	

[32] Report "RFNBO Greenhouse gas emissions - GHG emission factors and conversion efficiencies for making RFNBO GHG emission calculations" (November 2022) by Ludwig-Bölkow-Systemtechnik, available through this link.
[33] JRC report EUR 28349 EN "Definition of input data to assess GHG default emissions from biofuels in EU legislation" - Version 1d (2019). The engine emissions for a 40-ton diesel truck with a 27-ton payload were extrapolated using the load of the weight for the tube trailers.

Table 9 – Emission factors for transport of liquid hydrogen or transport of hydrogen carriers by ship. Please note: empty return is included in the fuel efficiency.

Ship type (fuel type)	Fuel efficiency in MJ / (ton * km)	Source
LH_2 carrier (160,000 m^3)	0.10056	LBST, 2022[32]
Refrigerated NH_3 carrier 50 kt (Fuel oil)	0.16300	
Methanol carrier 100 kt (Fuel oil)	0.05920	
NH_3 inland carrier LRG GAS 87 (Diesel)	0.50020	

Table 10 – Emission factors for fuels used in transport.

Fuel	Emission factor (g $CO_{2,eq}$/MJ)			Source
	Fuel combustion	Upstream emissions	Total	
Diesel	73.2	21.9	95.1	Annex B in DR 2023/1185
Gasoline	73.4	19.9	93.3	
Heavy fuel oil	80.6	13.6	94.2	
Methanol	68.9	28.2	97.1	
Ammonia (fossil sources)			2,351.3	

Hourly GHG calculations

A further challenge that companies might encounter is that the final subparagraph of Article 1 in Annex A of DR 2023/1185 states that the time interval in which GHG is made must be in line with the requirements applying to temporal correlation. This means that after 1-1-2030, and when applying sub-option C4 as described above, the 70% GHG emission saving threshold must be checked for every hour of production. At first glance, this might seem to be a lot of work, but there are at least two methods by which this can be done quite easily. This is because the only hour-to-hour variation will be the ratio of electricity taken from the grid which is not fully renewable to the total amount of electricity used for production of the RFNBO. This total amount of electricity is the sum of fully renewable electricity (which counts as having zero GHG emissions, see DR 2023/1185 Annex A, Article 5) and electricity taken from the grid which is not fully renewable.

Both methods start with the hard work: ensure that you can make a GHG calculation on your RFNBO production following the general outline explained above. Then, have this calculation checked by the auditor. If this is done, the two ways to take the hourly variation into account are:

1. Make a table with GHG emission saving results as a function of the share of non-fully renewable electricity used for RFNBO production that looks like the table below (numbers in the second column are calculated for the example above with two compression steps from 30 to 300 bar and from 300 to 900 bar). Then, for every hour for which you fill out the table with electricity following the format of DR 2023/1184 Article 8 (see the examples given on previous pages in this report), calculate the share of non-fully renewable electricity and then automatically take the GHG emission reduction value from the table. In Excel, this can be done by means of the formula "VLookup" (or "Vert. Zoeken" in Dutch).

Table 8 - Calculation of maximum grid input to stay above 70% GHG emission reduction

Fraction of electricity that does not comply with DR 2023/1184	GHG emission saving percentage
0%	91.8%
1% (or below)	89.9%
2% (or below)	88.1%
3% (or below)	86.3%
4% (or below)	84.5%
5% (or below)	82.7%
6% (or below)	80.9%
7% (or below)	79.1%
8% (or below)	77.3%
9% (or below)	75.4%
10% (or below)	73.6%
11% (or below)	71.8%
12% (or below)	70.013%
12.00719% (or below)	70.0000%
13% (or below)	68.2%
etc.	etc.

Please note that this table demonstrates that in the electrolyser a maximum of 12.007% of non-fully renewable electricity can be used to reach the 70% GHG saving requirement.

2. Calculate the critical share of fully renewable electricity used for RFNBO production with which just 70.000% of GHG emission savings are achieved. In your hourly data table, add a “GHG emission saving requirement complied with (yes/no)” column and set the value to “yes” if the share of fully renewable electricity is higher than this critical share and to “no” if this share is lower. Example: this critical share for the example configuration shown above is 12.00719% of non-fully renewable electricity as compared to the total electricity input. In the table with numbers for the hourly temporal correlation (Table 6), the data on 9 July 2023 and the hour from 22:00 to 23:00 show a share of non-fully renewable electricity of (100%*0.183/0.750 =) 24.3%, and hence the hydrogen production in the electrolyser in this hour does not meet the 70% GHG emission saving requirement. The hour from 23:00 to 24:00 has a share of non-fully renewable electricity of 8.93% and hence in this hour the 70% GHG emission saving requirement was met (assuming a pathway configuration as in this GHG example calculation).

Please note that you have to repeat this work every year as the GHG intensity of the non-fully renewable electricity will vary from year to year. You will also have to repeat this work when other values in your GHG calculation change, such as the number of other inputs in your RFNBO production, the efficiency of the electrolysers and/or the distance or mode of RFNBO transport.

One possible complication is that the efficiency of the electrolyser might vary as a function of the load of the electrolyser. If so, the table above might be replaced with a matrix with the electrolyser efficiency on the X-axis. For every hour, the GHG emission saving can then be taken from this matrix after calculation of (a) the fraction of electricity that does not comply with DR 2023/1184 and (b) the load factor of the electrolyser.

Other topics of interest with regard to GHG calculations
With regard to RFNBO GHG emission calculations, the following particularities might be of interest:

- Global warming potentials of CO_2, N_2O and CH_4. In the rules for calculating the GHG impact of biofuels and bioliquids (Annex V.C) and of biomass fuels (Annex VI.B), RED-III prescribes the use of global warming potential values for CO_2, N_2O and CH_4 of 1, 298 and 25 respectively. However, IR 2022/996 prescribes the use of global warming potential values for CO_2, N_2O and CH_4 of 1, 265 and 28 respectively. This is an inconsistency that can lead to some confusion. Nevertheless, the third subparagraph of Annex C of DR 2023/1185 (which gives the methodology for assessing GHG emission savings from RFNBOs) clearly states that for RFNBOs and RCFs the GWPs relative to CO_2 over the 100-year time horizon as set out in Annex V, part C, point 4 to Directive (EU) 2018/2001 must be used. Hence, for RFNBOs the GWP values of 298 for N_2O and 25 for CH_4 must be used.
- Global warming potentials of H_2. Hydrogen is also a greenhouse gas. Leakage of hydrogen will lead to increased concentrations of GHG gases in the atmosphere. This has not yet been taken into account in the accounting methodology in DR 2023/1185, as there is still uncertainty as to the global warming potential of hydrogen. Policymakers from the European Commission have indicated that a global warming potential number for hydrogen might be added in a future update of the GHG accounting methodology. This will mean that leakage of hydrogen will also have to be calculated in a contribution to $CO_{2,eq}$ emissions.

Annex 3 – Mass balance examples

Mass balances are important in demonstrating compliance with RED requirements. Readers looking for details of the RED mass balance requirements are advised to look into the scheme documents from the voluntary scheme of choice. These schemes have taken over requirements from Articles 30(1) and 30(2) of the RED and from Articles 15 and 19 of IR 2022/996[34].

Making a mass balance for hydrogen production, conversion and use and keeping it up to date is fairly straightforward when taking into account the mass balance requirements from the scheme documents (which have incorporated the requirements from the RED and from IR 2022/996) and when the overview tables have been created as presented in Annex 1, the financial bookkeeping is up to date and links have been made to actual deliveries of hydrogen. One of the requirements for mass balances is that a certified company must make a separate mass balance for each physical location that falls within the scope of the certification.

In the case of hydrogen production for RFNBOs other than hydrogen, the conversion efficiency must be included in the mass balance records and the related quantities of sustainability and greenhouse gas emission saving characteristics must be adjusted by applying this conversion efficiency.

Mass balances for producers, converters and end-users vary slightly. Therefore, we will give three examples below. The mass balance consists of two parts: an overview part (in the examples shown on the left) and a part comprising a list of all incoming and outgoing consignments during the mass balance period including PoS numbers. The RED requires a mass balance period of up to three months.

The first example below (a mass balance for a producer) is made from the numbers for the grid-connected electrolyser (Table 3) for the months of January, February and March. Note that there is no production of RED-compliant RFNBO in February as the producer failed to demonstrate compliance with the 70% GHG emission saving requirement, as was illustrated in Annex 2.

1 Mass balance example for an RFNBO producer P

Mass balance for period: January - March 2024	Hydrogen (kg)	RED-compliant RFNBO (kg)
Carried forward from previous mass balance period	0	0
Production within mass balance period	93,200	60,400
January 2024	31,300	29,200
February 2024	28,600	-
March 2024	33,300	31,200
Sold & delivered within mass balance period	93,100	60,300
Administrative stock at end of mass balance period	100	100
Physical stock at end of mass balance period	100	100
Carried forward to next mass balance period	100	100

Deliveries during current mass balance period				
Recipient	**Hydrogen (kg)**	**RED-compliant?**	**RED-compliant RFNBO (kg)**	**PoS numbers**
Offtaker X	11,493	yes	11,493	#####-ProdP-2024-01
Offtaker Y	12,326	yes	12,326	#####-ProdP-2024-02
Offtaker Y	32,800	no		
Offtaker X	8,298	yes	8,298	#####-ProdP-2024-03
Offtaker Z	16,481	yes	16,481	#####-ProdP-2024-04
Offtaker X	11,702	yes	11,702	#####-ProdP-2024-05
	93,100		**60,300**	

[34] The consolidated version of RED-III can be found through this link. IR 2022/996 can be found through this link.

In this first example, some of the RFNBO hydrogen produced is kept in stock, for instance in the hydrogen container at 300 bar similar to the previous GHG example calculation. When a combination of a physical amount of hydrogen and an administrative amount of RFNBOs is in stock at the end of the mass balance period, this amount (100 kg in the example above) can be entered as "carried forward from previous mass balance period" in the mass balance for April-June 2024.

If there is an administrative amount of RFNBO in stock at the end of a mass balance period but no physical stock, it is not permissible to carry this administrative stock forward to the next mass balance period. Instead, it must be cancelled.

2 Mass balance example for a company that converts one type of RFNBO into another type of RFNBO

The example below is for a company X (the same company as offtaker X in the example above) that converts one type of RFNBO into another type of RFNBO, in this example from hydrogen purchased from producer P into ammonia. For the conversion, it is important to specify the conversion efficiency. The calculation of this efficiency must be documented for verification by the auditor.

Mass balance for period: January - March 2024	RED-compliant RFNBO (kg)
Carried forward from previous mass balance period	0
Purchased within mass balance period	31,493 kg hydrogen
Conversion efficiency: 5.667 kg NH_3 per kg H_2	
Sold & delivered within mass balance period	178,460 kg ammonia
Administrative stock at end of mass balance period	0
Physical stock at end of mass balance period	0
Carried forward to next mass balance period	0

RFNBO purchased during mass balance period

Supplier	RED-compliant RFNBO (kg)	RFNBO type	PoS numbers
Producer P	11,493	hydrogen	#####-ProdP-2024-01
Producer P	8,298	hydrogen	#####-ProdP-2024-03
Producer P	11,702	hydrogen	#####-ProdP-2024-05
	31,493		

RFNBO sold and delivered during mass balance period

Recipient	RED-compliant RFNBO (kg)	RFNBO type	PoS numbers
Company Q	125,925	ammonia	#####-CompanyX-2024-01
Company R	52,536	ammonia	#####-CompanyX-2024-02
	178,460		

3 Example for a user of RFNBO (industry Z)

The final example is for a user of RFNBO. The RFNBO use must be administered in the mass balance. "Administered use" – recorded in the table below under "Used to comply with transport obligation" and "Used to comply with industry obligation" – has the consequence that the PoSs cannot be traded with the next company in the chain of custody. It is possible that the PoSs will have to be submitted to a national authority – like the Dutch Emissions Authority in the Netherlands – in order to comply with an industry obligation. If an RFNBO user also delivers hydrogen to others, these sale transactions will be recorded in the sub-table "RFNBO sold during mass balance period". If this company Z uses both hydrogen and another type of RFNBO (e.g. ammonia), this company must make two mass balances: one for hydrogen and one for the other type of RFNBO.

Mass balance for period: January - March 2024	RED-compliant RFNBO-hydrogen (kg)
Carried forward from previous mass balance period	0
Purchased within mass balance period	38,803
Used to comply with transport obligation within mass balance period	0
Used to comply with industry obligation within mass balance period	38,803
Administrative stock at end of mass balance period	0
Physical stock at end of mass balance period	0
Carried forward to next mass balance period:	0

RFNBO purchased during mass balance period			
Supplier	**RED-compliant RFNBO (kg)**	**RFNBO type**	**PoS numbers**
Producer P	16,481	hydrogen	#####-ProdP-2024-04
Producer P	22,322	hydrogen	#####-CompanyT-2024-11
	38,803		

RFNBO sold during mass balance period			
No sales in this mass balance period			
Carried forward to next mass balance period:			0

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Abbreviations

CB / CBs Certification Body / Certification Bodies

DR 2023/1184 Commission Delegated Regulation (EU) 2023/1184 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin

DR 2023/1185 Commission Delegated Regulation (EU) 2023/1185 of 10 February 2023 supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels

EC European Commission

GoO / GoOs Guarantee of Origin / Guarantees of Origin

IR 2022/996 Commission Implementing Regulation (EU) 2022/996 of 14 June 2022 on rules to verify sustainability and greenhouse gas emissions saving criteria and low indirect land-use change-risk criteria

PoS / PoSs Proof of Sustainability / Proofs of Sustainability

PPA / PPAs Power Purchase Agreement / Power Purchase Agreements

RCF / RCFs Recycled Carbon Fuel / Recycled Carbon Fuels

RED General reference to the Renewable Energy Directive, without specific reference to a version number
(see RED-II and RED-III below).

RED-II Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast), in the version predating the amendments made in October 2023 through Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023

RED-III Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast), including the amendments made in October 2023 through Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023

RFNBO / RFNBOs Renewable Fuel of Non-Biological Origin / Renewable Fuels of Non-Biological Origin

RED-compliant RFNBO RFNBO complying with requirements I, II and III listed in Chapter 2 of this report

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