Hydrogen Europe

Impact assessment of the RED II Delegated Acts on RFNBO and GHG accounting

Hydrogen Europe Analysis

March 2023

Contents

The following document contains an analysis of the two proposed delegated acts supplementing the recast Renewable Energy Directive (RED II), concerning:

- rules for the production of renewable liquid and gaseous transport fuels of non-biological origin (henceforth - RFNBO DA),
- methodology for assessing GHG emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels (henceforth GHG DA).

1. Key concepts

1.1. GHG emission threshold

Both for RFNBOs as well as for Recycled carbon fuels (RCFs) the maximum GHG emission intensity threshold has been defined as 70% below a fossil fuel comparator of 94 gCO2eq/MJ, i.e. no more than **28.2 gCO2eq/MJ (equivalent to 3.38 tCO2eq/t_{H2} or 102 gCO2eq/kWh_{H2})**.

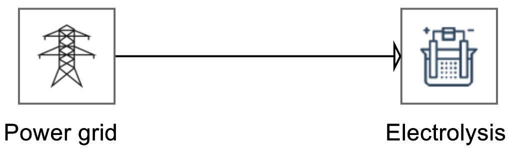
It should be noted however that this is the total carbon footprint of the fuel as delivered to the final consumer. Therefore, if hydrogen were to be transported to final users from the point of production or hydrogen would only be an intermediary product for the production of synthetic fuels, all emissions related to these processes should be included. Therefore, in reality, unless hydrogen is consumed onsite, the emission threshold at the point of hydrogen production is even lower. However, for the sake of simplicity, wherever this document refers to RFNBO/RCF emission threshold we mean 28.2 gCO2eq/MJ at the point of production.

1.2. Sourcing of electricity- the 4 cases

The RED recognises three scenarios for sourcing electricity for the production of hydrogen via electrolysis:

- **Case 1: average grid mix electricity**
- **Case 2: fully renewable electricity from directly connected renewable energy generation source**
- **Case 3: fully renewable electricity supplied via the electricity grid**
- **Case 4: a combination of the above**

Case 1 – average grid mix electricity

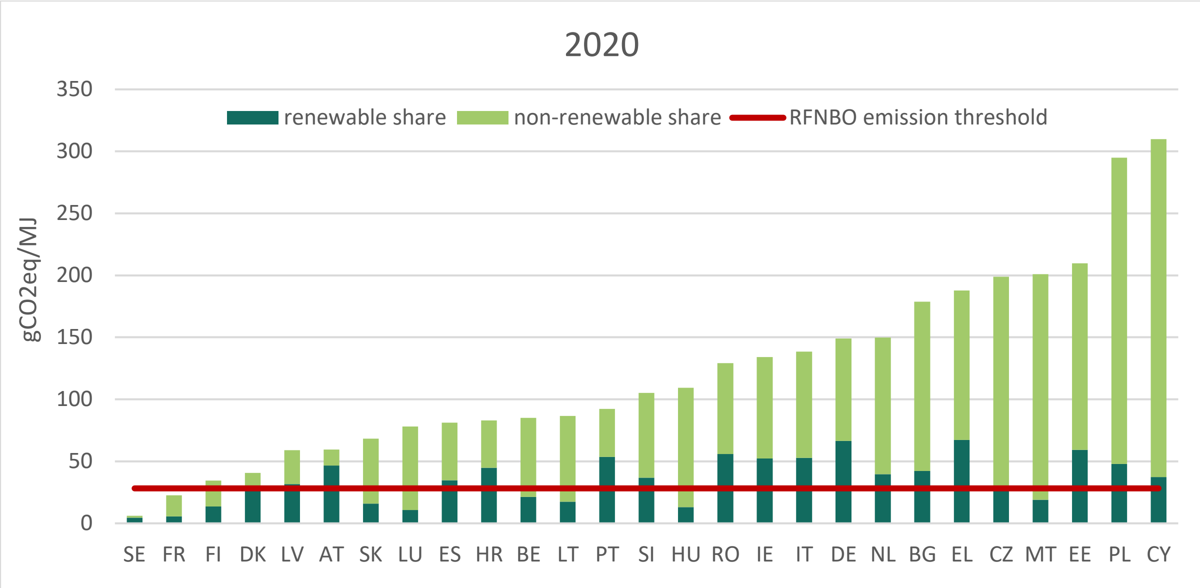


This is the default option, described by Article 27.3 of RED as "where electricity is used for the production of [RFNBOs], either directly or for the production of intermediate products, the average share of electricity from renewable sources in the country of production, as measured two years before the year in question, shall be used to determine the share of renewable energy".

The fulfilment of further criteria (additionality, temporal and geographical correlation) is not necessary.

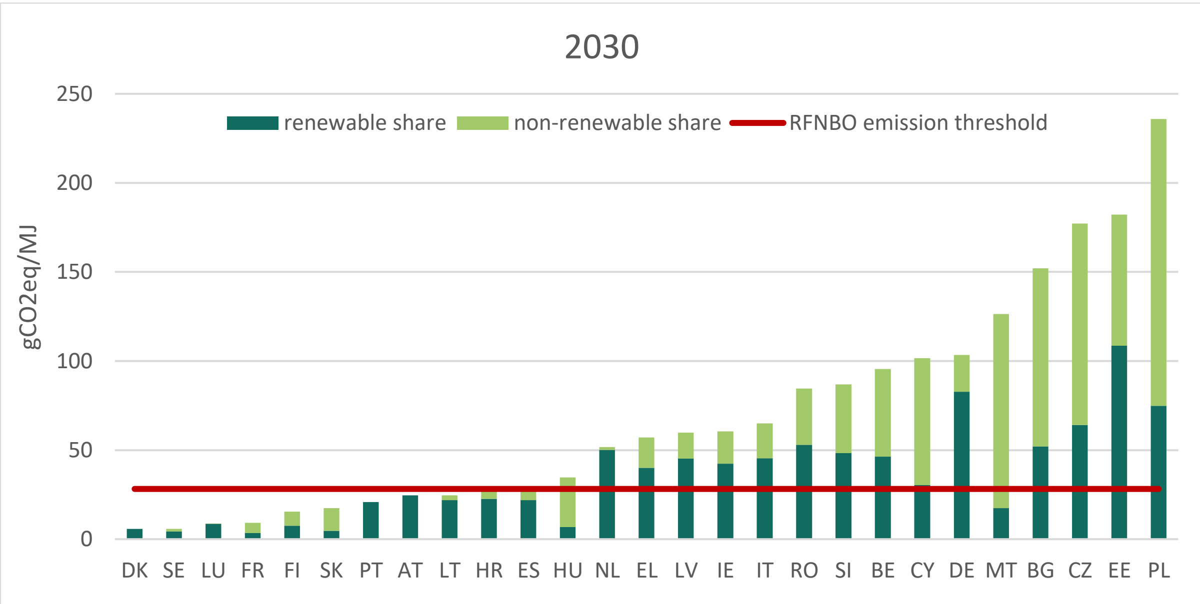
Because of the 70% GHG reduction requirement, this case will not be applicable in most Member States in the near future – either because the GHG intensity of the power grid would be too large or the RFNBO output just too small (following RES-E share).

Figure 1. hydrogen GHG emission intensity and renewable energy share from grid electricity in 2020



The situation might change by 2030 however (i.e. when the RFNBO targets come into force), when in 10 EU Member States it will be possible to produce hydrogen from grid electricity with an emission factor below the 70% GHG reduction threshold. However, in countries where the RES-E share will remain low and the grid emission intensity will be reduced via nuclear power, it will still make little sense to use this option without any RES-E PPAs – as the RFNBO output would be limited.

Figure 2. Hydrogen GHG emission intensity and renewable energy share from grid electricity in 2030

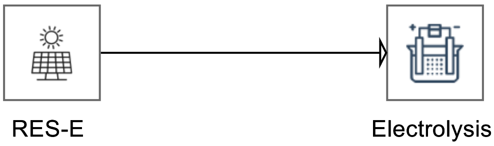


Examples:

In Ireland, there is a large share of res-E (70%) by 2030, but the overall grid emissions are above the threshold. So this route is still not viable.

In Portugal, and Austria, the share of res-e is 100% or close to 100%, and the grid emissions below the threshold. In such case, producers will be able to procure electricity from the grid without further requirements.

Case 2: fully renewable electricity from directly connected renewable energy generation source



Case 2 is characterised by the presence of a direct connection that links an RFNBO facility and an installation generating and supplying renewable energy. Case 2 is one of two ways for RFNBO producers to claim a fully renewable use of electricity per the DA in RED II.

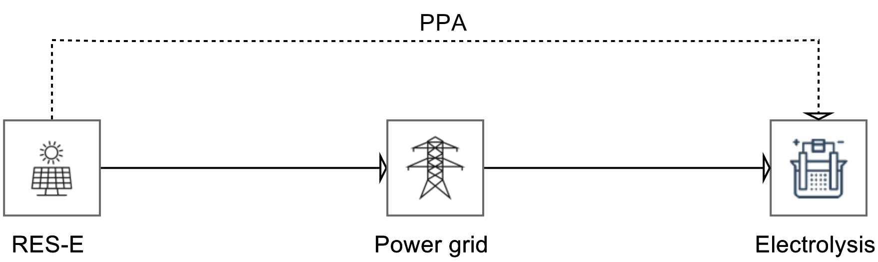
The RFNBO DA defines two preconditions that must be fulfilled to fully count the supplied electricity as renewable:

- the renewable energy installation's operation needs to come into operation not earlier than 36 months before the electrolyser (where coming into operation is understood as commissioning date).
- the installation producing electricity is not connected to the grid, or the installation producing electricity is connected to the grid but a smart metering system that measures all electricity flows from the grid shows that no electricity has been taken from the grid to produce RFNBOs.

In this case all hydrogen output would count as RFNBO and would have an emission factor of 0 gCO2eq/MJ.

This option would however require the electrolyser to operate in a flexible operating mode following the load of variable RES-E. It means the electrolyser would run only as much as the renewable energy asset. In the case of an electrolyser connected with a PV plant, this would be around 1,000 full load hours for central Europe (e.g. Munich, Paris), and around 1,800-2,000 full load hours for south of the Iberian peninsula. Large scale industry applications require significantly more constant supply, and thus it would not be a suitable option until a hydrogen pipeline network, interconnected with underground storage facilities, is put in place.

Case 3: fully renewable electricity supplied via the electricity grid



This is the second case when electricity can be treated as fully renewable.

RED II Article 27.3 foresees that, for RFNBO production: “electricity that has been taken from the grid may be counted as fully renewable provided that it is produced exclusively from renewable sources and the renewable properties and other appropriate criteria have been demonstrated, ensuring that the renewable properties of that electricity are claimed only once and only in one end use sector.”

In this case RFNBO producers do not need to be directly connected to a RES-E asset (as in Case 2) and can still have 100% of their fuel count as renewable (as opposed to Case 1), with an emission factor of 0 gCO2eq/MJ.

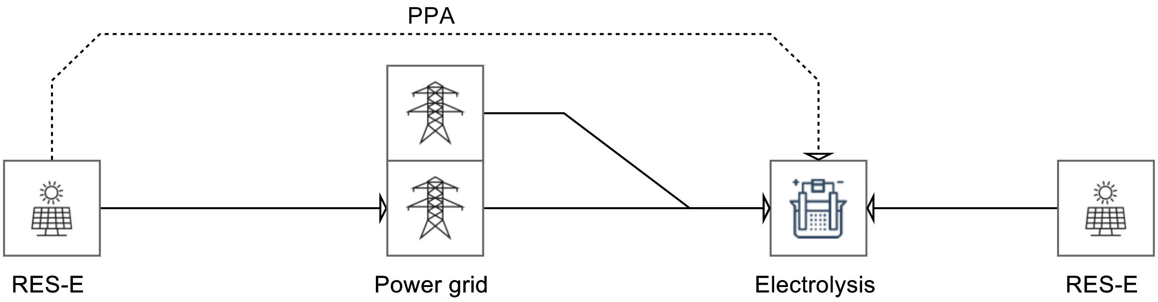
This case requires however several additional preconditions in order to be able to classify electricity as fully renewable, including:

- additionality
- temporal correlation
- geographical correlation

At the same time the RFNBO DA proposes a number of exemptions where the above criteria do not need to be followed. These are:

- the RFNBO installation is located in a bidding zone with more than 90% RES-E share,
- the electricity taken from the grid, used to produce RFNBOs is consumed during an imbalance settlement period during which it contributes to reduction of RES-E curtailment,
- the RFNBO installation is located in a bidding zone where the emission intensity of electricity is lower than 18 gCO2eq/MJ, in this case however the exemption applies only to the additionality requirement. Meaning that temporal correlation still applies. And obviously also geographical correlation, as the exemption is applied at bidding zone level.

Case 4: a mix of fully renewable and grid electricity



It should be highlighted that the above-mentioned scenarios for sourcing of electricity can all be used at the same time.

Even when coupled (either directly or via PPA) with a renewable asset with high-capacity factor, there will still be hours when the electricity which can be counted as fully renewable will only constitute a relatively small part of the electrolyser rated power. In those hours, the hydrogen producer has the option to either follow the intermittency and run its electrolyser only at partial load or to source additional electricity from the grid – and thus increasing the utilization of electrolyser and potentially reducing the overall costs of RFNBO production.

2. Assessment of key requirements

2.1 Additionality

What is being proposed?

Additionality means that RES-E must come from assets that would not exist in the absence of RFNBO production.

In practice, the additionality criteria has been defined in the RFNBO DA as series of conditions, including:

- the renewable energy installation's operation needs to come into operation not earlier than 36 months before the electrolyser (where coming into operation is understood as commissioning date),
- the renewable energy installation has not received any public financial support in the form of operating aid or investment aid.

A transitional phase is envisaged for the additionality requirement criteria and for all RFNBO installations which came into operation before the end of 2027, with the additionality requirement applying only from 1 January 2038. For all other RFNBO installations coming into operation after 1st January 2028, additionality requirements will apply from the first day.

Exemptions to additionality: The additionality requirement does not apply if:

- the electrolyser is located in a bidding zone with more than 90% RES-E share or
- where the emission intensity of electricity is lower than 18 gCO2eq/MJ

What is the rationale behind it?

The production of RFNBOs uses large amounts of renewable electricity and comes with relatively higher losses compared to direct use of electricity. Therefore, if RFNBO production would divert existing renewable electricity away the market, this may result in an overall increase of GHG emissions, since the gap would have to be closed by other generation – which in many cases might be a non-renewable power generation plants, with larger emissions.

While this is a sound principle – it should be noted however that there are sectors where use of RFNBOs would generate so high GHG emission savings that, even if existing RES electricity, taken from the market, would be replaced entirely by gas-fired CCGT power plants with a carbon intensity of 382 gCO2/kWh[1], the net GHG emissions would still be reduced. A good example of this is the steel sector where a switch to hydrogen based DRI, would result in GHG reduction of 30% [2]- even if all non-additional renewable electricity used for hydrogen production would be replaced by gas-fuel generation.

Why is it important?

The introduction of additionality requirement will limit the amount of renewable energy resources available for RFNBO producers.

This might have a significant impact on the uptake of renewable hydrogen – especially in industry, where the requirements for RFNBO might well exceed GW scale even for a single plant. As an example of the challenge posed by strict additionality – in order to entirely decarbonise ammonia production with renewable hydrogen in Poland, almost 400kt of renewable hydrogen and, by extension, almost 20 TWh of renewable electricity

[1] Assuming 52% efficiency of CCGT and natural gas emission factor of 56.2 gCO2/MJ.
[2] Including direct emissions.

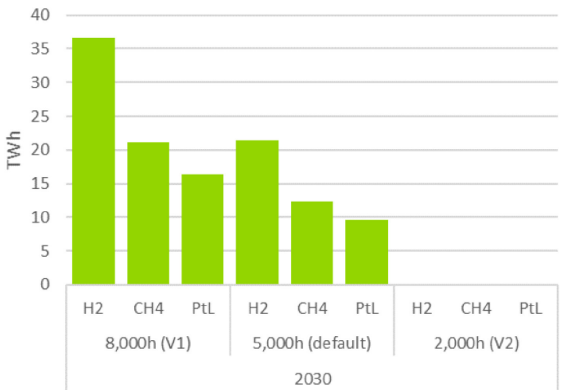
would be needed. For comparison, the current Polish national energy policy plan, envisages that all new solar PV, onshore and offshore wind assets, developed between 2020-2030 will be able to generate 19.6 TWh of additional renewable electricity by the year 2030. In other words, full decarbonisation of ammonia production in Poland would require more additional renewable energy than will be deployed in the entire country by the end of this decade – and Poland is still going to require that renewable electricity to reduce its reliance on coal-fired power plants (56% of planned power generation in 2030). Even though the proposed renewable energy directive will most likely only require to replace 40-50% of grey hydrogen with renewable one by 2030, it will undoubtedly remain a huge challenge in some EU Member States – further exacerbated if a strict approach to renewable energy additionality requirement is adopted.

Limiting access to available renewable assets might therefore have an opposite effect to the one envisaged by the introduction of the additionality principle – i.e. faced with a need for renewable power exceeding local RES potential, industrial operators might opt for CCS instead. The result would be less RFNBO production and thus less additional renewables.

What will be the impact?

The strictness of requirements with respect to the sourcing of renewable electricity inputs can have substantial impacts on the competitiveness of domestic production of RFNBOs within the EU. According to the EU COMs own assessment[3], **under the strict requirements, production of RFNBOs in the EU, which would be cost competitive with imports drops to zero** (see the V2 scenario in the figure below)**.**

Figure 3. RFNBO production potential in 2030 that would be cost competitive with imports in different scenarios with respect to sourcing of renewable electricity



Source: EU Commission.

On the other hand, it is assumed that the fact that similar requirements would be imposed on imported hydrogen should counter the loss of cost-competitiveness of domestic RFNBO production. This is however, at least partially, misguided. First – large scale import projects will mostly be based on dedicated directly connected renewable power[4], with little impact from the additionality principle. More importantly however,

[3] European Commission, Directorate-General for Energy, Technical assistance to assess the potential of renewable liquid and gaseous transport fuels of non-biological origin (RFNBOs) as well as recycled carbon fuels (RCFs), to establish a methodology to determine the share of renewable energy from RFNBOs as well as to develop a framework on additionality in the transport sector: final report. Task 1, Assessment of the potential of RFNBOs and RCFs over the period 2020 to 2050 in the EU transport sector, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2833/195142

[4] Examples:

- Western Green Energy Hub - 3.5 MTPA h2 in Australia using 50 GW dedicated wind and solar
- 0.2 MTPA h2 in Australia using dedicated wind and solar -
- Murchison Hydrogen Renewables - around 0.3 MTPA h2 in Australia using 5.2 GW dedicated wind and solar -

as the proposed CBAM regulation does not include any requirements with respect to sourcing of renewable electricity (and in some cases it even completely ignores indirect emissions from electricity generation) – the cost competitiveness of industrial goods produced domestically with the use of RFNBO will still suffer against goods produced outside and imported to the EU (for example green steel).

This suggests that posing strong requirements on RES-E sourcing can limit the market uptake of domestic RFNBO production substantially.

Overall assessment

Overall, the additionality principle is well justified and sensible. The transition phase as well as exemptions for bidding zones with high penetration of renewables (>90%) or low carbon intensity (<18 gCO2eq/MJ) make its implementation manageable for the production of transport fuels.

However, due to challenges in implementation for industry, impact on domestic EU industry cost competitiveness as well as limited GHG benefits, the RFNBO rules with regards to sourcing of renewable electricity, applicable to other sectors than transport, especially industry, should be relaxed, not least because industry has no guarantee that they will be able to access so much renewable energy capacity in time to meet their targets.

2.2 Temporal correlation

What is being proposed?

The temporal correlation requirement imposed by the RFNBO DA is an implementation of the Recital 90 of RED II which foresees that if grid electricity for RFNBOs is to be counted as renewable, there should be: "temporal […] correlation between the electricity production unit with which the producer has a bilateral renewables PPA and the fuel production."

The RFNBO DA implements the temporal correlation principle in the following way:

- It is required for Case 3 and 4 only (not needed for case 1 and is ensured by definition for case 2).
- Until 31st December 2029 the electricity consumed for the production of RFNBO must be matched with electricity generated within the same month.
- Starting from 1st January 2030, the electricity consumed for the production of RFNBO must be matched with electricity generated within the same hour.
- There is not grandfathering rule – i.e. the above implementation phases apply equally to all RFNBO installations irrespective of the date of entry into operation.
- There is one exemption where the temporal correlation rule does not need to be followed: i.e. when the electrolyser operates during hour when day ahead electricity price in Bidding zone was ≤ 20 €/MWh or ≤ 0.36 of the ETS carbon price (€/t CO2).
- at the latest by 1 July 2028, the EU COM should deliver a report to the European Parliament and the Council assessing the impact of the gradual strengthening of the requirements on temporal correlation – with the possibility of further relaxation of the rules depending on the outcome of that report.

- 1.8 MTPA h2 in Oman using 25GW dedicated wind and solar
- NEOM - 0.2 MTPA in Saudi Arabia using 3.9 GW dedicated wind and solar -
- Qair Pecem Port - 0.3 MTPA h2 in Brazil using 1.2 GW dedicated offshore wind -
- H2 Magallanes - 0.8 MTPA h2 in Chile using 10 GW dedicated wind -

What is the rationale behind it?

According to the EU COM assessment: the motivation to ensure temporal correlation is twofold.

- First, if there is a temporal mismatch between RES-E and RFNBO production, the latter may consume non-renewable electricity, undermining the RED II requirement that this electricity needs to be exclusively, from renewable sources.
- Second, RFNBO technologies are meant to be a pillar of fully renewable energy systems. They should facilitate the integration of intermittent RES-E production by being a flexible load oriented to RES-E infeed.

It should be noted however, that the way the temporal correlation is implemented is unfair and will be detrimental to the production of RFNBOs.

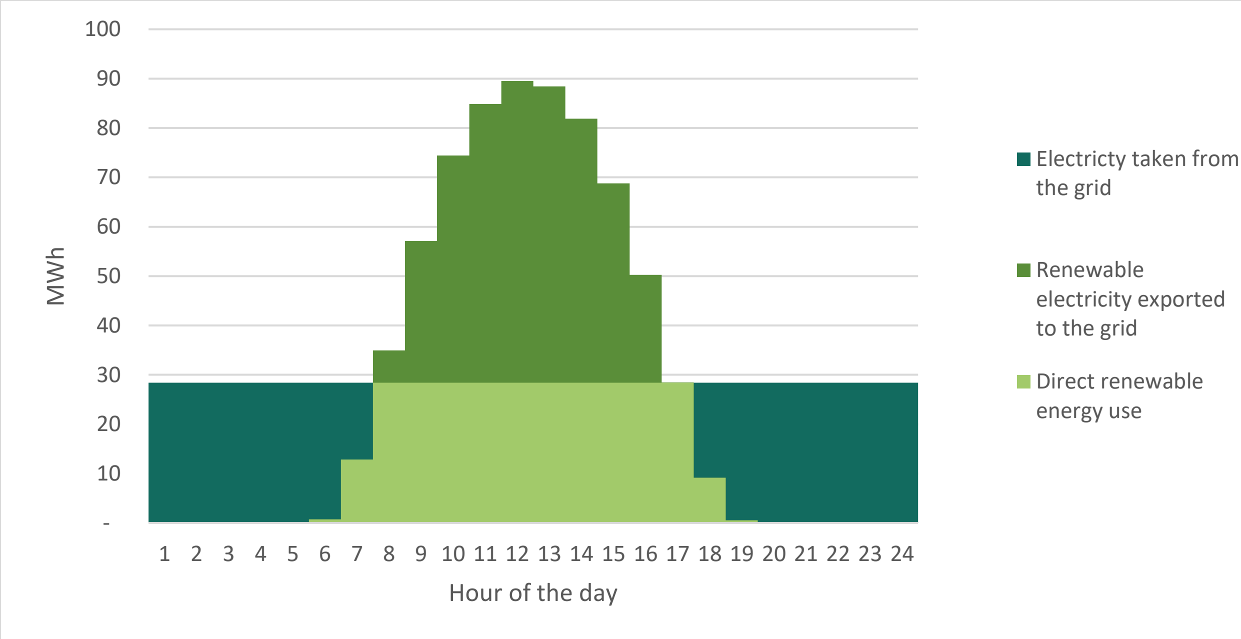
The unfairness of the proposed rules stems from the fact that the emissions associated to the electricity for which temporal correlation can't be demonstrated are fully accounted for, while no credit whatsoever is given for the GHG emission reduction for electricity exported to the grid (when the renewable power plant contracted under the PPA is producing more electricity than the RFNBO plant can absorb).

It should be stressed that a monthly temporal correlation requires that electricity taken from the grid can be accounted as fully renewable **only on the condition that for each MWh of electricity taken from the grid an equal amount of electricity needs to be exported to the grid within 1 month**. An hourly temporal correlation would burden RFNBO with 100% of the GHG emissions associated to the electricity imported from the grid while at the same time completely disregarding the GHG reduction benefits associate to the additional electricity exported to the grid (that the RFNBO plant can't use in a given moment).

To showcase the issue with a strict hourly temporal correlation, we will use the following example: Assuming an electrolyser operator producing hydrogen for an off-taker in industry, where it would be necessary to supply a constant amount of hydrogen throughout the year (assuming downtime only for maintenance). If such a developer would secure a PPA with a solar PV plant, the daily energy balance might look like on the graph below: i.e.:

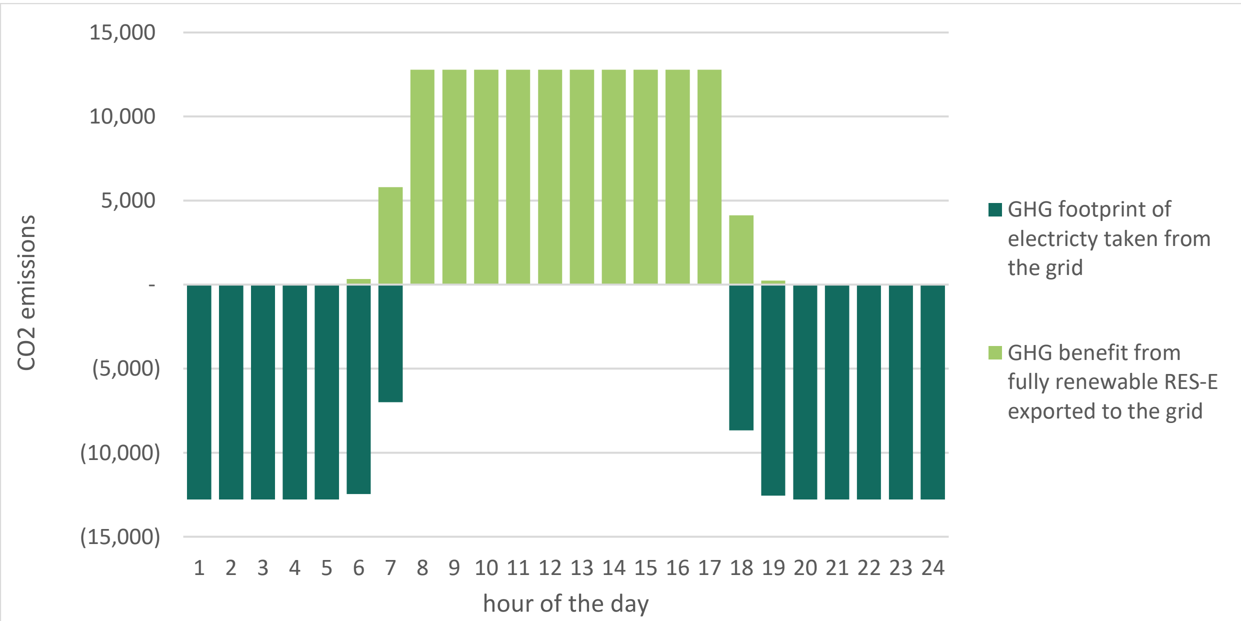
  - during the day, the electrolyser would be powered from the produced solar PV (light green) with a significant amount of fully renewable energy exported to the grid (green).
  - during the night, the electricity for operating the electrolyser would be supplied from the grid (dark green). The amount of electricity taken from the grid needs to be equal or lower than then excessed exported energy.

Figure 4. Energy balance for an electrolyser running full load with daily temporal correlation and RES-E electricity supply from solar PV



Taking electricity from the grid at night will result in additional demand which would have to be covered by a marginal generation power plants and thus will result in additional GHG emissions. On the other hand, the additional renewable energy exported to the grid during the day would displace other generation sources and thus result in saving GHG emissions.

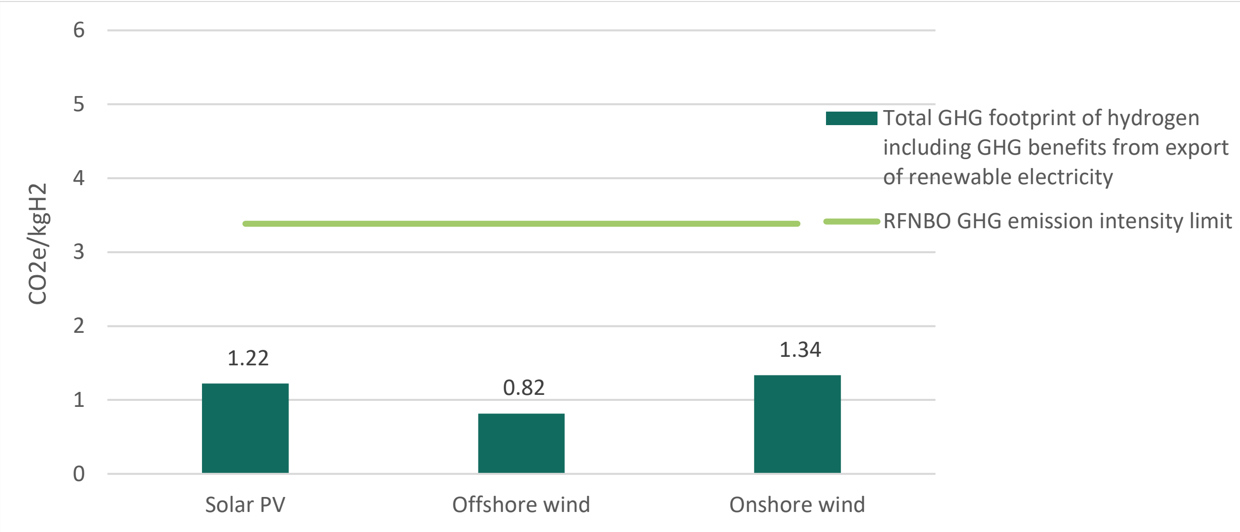
Figure 5. Balance of CO2 emissions for an electrolyser running at full load with daily temporal correlation and RES-E electricity supplied from solar PV



The Final GHG balance is largely depending on the renewable energy source, but in case of solar PV, which generates electricity during the day where there is more demand, while grid electricity used mostly at nights where there is high penetration of wind energy and high chance of RES curtailment, the overall GHG balance can be positive. **Hourly temporal correlation would completely disregard the GHG benefits of exporting fully renewable electricity to the grid while burdening RFNBO with the full amount of GHG emissions of electricity taken from the grid.**

Let's use the German power grid as an example. In both cases, when taking electricity from the grid, as well as when exporting excess renewable electricity to the grid, we assessed hour by hour, for the whole of 2021, which generation units we would activate and/or displace when producing RFNBO with 3 types of renewable sources (with a specific distribution of the renewable resources over the year). Based on this detailed analysis, we concluded it would be possible to run the electrolyser at full load (8,760h) without exceeding the 70% GHG reduction limit.

Figure 6. Total GHG emissions for hydrogen produced via an electrolyser operating at full load (8,760h) with annual temporal correlation (example Germany)



Why is it important?

Strict hourly temporal correlation together with a disregard for GHG benefits of fully additional RES-E exports to the grid would force the electrolyser operators to closely follow the load of the coupled RES-E assets and limit the amount of hours it can use grid electricity – even if it would be fully matched by a corresponding amount of RES-E exported to the grid.

Consequently, it would lead to three main negative results:

1. Increase cost of hydrogen due to a low utilisation of the electrolyser,
2. Reduced flexibility of the electrolyser to support balancing,
3. Limited potential to supply large industrial projects which need a constant supply.

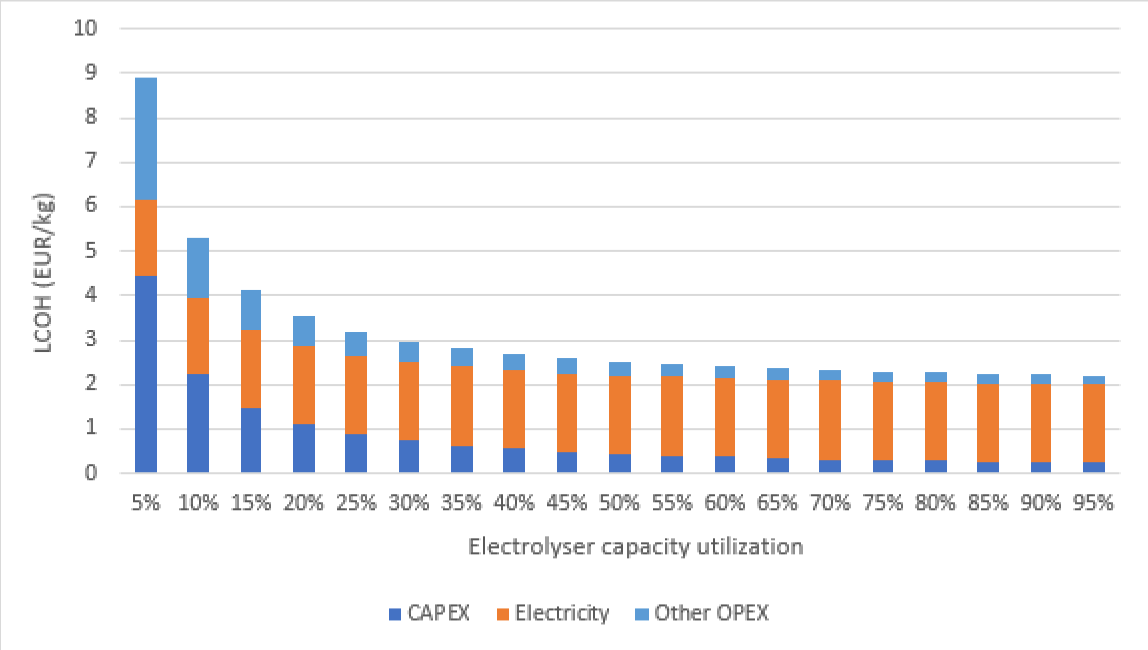
1. Reduced utilization of the electrolyser

Electrolysers are capital intensive, and it is key to **ensure high utilization rate to minimize the levelized cost of hydrogen** (LCOH). There is a direct correlation between utilization rate and cost of producing green hydrogen - increasing the load factor by 10% can reduce the LCOH by approximately 20%[5].

[5] If the power price remains the same

As shown on the graph below, lowering the capacity utilization would result in an increase of costs of RFNBO production, further limiting the competitiveness of domestic hydrogen production in the EU.

Figure 7. Levelized costs of hydrogen (EUR/kg) depending on capacity utilization of the electrolyser (assuming fixed electricity price)



2. Limited flexibility from electrolysers

Another negative consequence of hourly temporal correlation and of forcing the electrolyser to follow the production pattern of a single renewable power plant, is that it eliminates the possibility for that electrolyser to support the electricity TSO on balancing the power system. For instance, if the PPA is signed with a PV plant, the RFNBO plant will not be able to consume electricity during the night, even if there is an oversupply of wind energy (little demand) and the TSO is forced to dispatch downward some wind parks.

The provision of other ancillary services such frequency response will also be affected by such load-following requirements.

3. Planned projects with industrial offtakers

The majority of the power-to-hydrogen projects in the pipeline[6] have indicated that they will source electricity at least partially via the power grid. The projects most at risk are projects developed with an industrial off-taker in mind, where there is limited flexibility for strict RES-E load following as steady supplies of hydrogen are a necessity and where there is no developed hydrogen pipeline and storage infrastructure which would allow for off-site hydrogen production.

Another negative consequence of limiting the viability of grid connected electrolysis is that it would eliminate the potential to use electrolysers as a flexibility option in the electricity system and thus limit the possibility of using that flexibility to reduce RES-E curtailment and to provide other ancillary services to electricity grid operators.

[6] Hydrogen Europe projects database- with 57GW out of 80 GW worth of planned PtH projects by 2035 in the EU27 planning to use electricity from the grid.

Overall assessment

The temporal correlation requirements as defined in the RFNBO DA are still a huge obstacle for the renewable hydrogen sector in the EU. Hourly temporal correlation would negatively impact the cost competitiveness of onsite electrolysis in industrial clusters. As the development of the hydrogen backbone with integrated hydrogen storage will take many years, the end result might be a significant delay of the heavy industry decarbonisation effort.

The exemption from temporal correlation requirement in times when the electrolyser operates during the hour when day ahead electricity price in Bidding zone was ≤ 20 € €/MWh or ≤ 0.36 of the ETS carbon price (€/t CO_2) is a positive aspect. As is the transitional phase.

However due to the fact that PPAs are usually long term, 10-15 year agreements, the transitional phase until the end of 2029 without a grandfathering rule, will have a negligible positive impact.

It is therefore extremely important that the revision of the temporal correlation, planned for 2028 results in an indefinite extension of the monthly temporal correlation or at the very minimum allow to account the positive GHG benefit of additional renewable electricity exported to the grid in timeframes outside the required temporal correlation, in the final carbon footprint of the produced RFNBO/RCF.

2.3 Geographical correlation

What is being proposed?

The RED II foresees that in order for grid electricity used for RFNBO production to be counted as renewable, there should be a "geographical correlation between the electricity production unit with which the producer has a bilateral renewables PPA and the fuel production."

In practice the above provision has been implemented by a set of the following rules:

- The RES-E and the electrolyser need to be located in the same bidding zone[7] or
- The RES-E is located in an interconnected bidding zone and – if it is not an offshore bidding zone - the prices for the relevant period on the day ahead market were higher than in the bidding zone where the electrolyser is located.

What is the rationale behind it?

According to the EU Commission assessment, there are two reasons for this requirement. First, it would be difficult to argue that RFNBO electricity feedstock is of renewable origin if both assets are far away from each other or separated by a structural grid bottleneck. Second, RFNBO production, as a potential major electricity consumer, should not contribute to growing congestion issues with asymmetries between load centres and RES-E generation centres.

Why is it important and what will be the impact?

Overall, the geographical correlation requirements are manageable and do not pose unresolvable challenges to renewable hydrogen production projects.

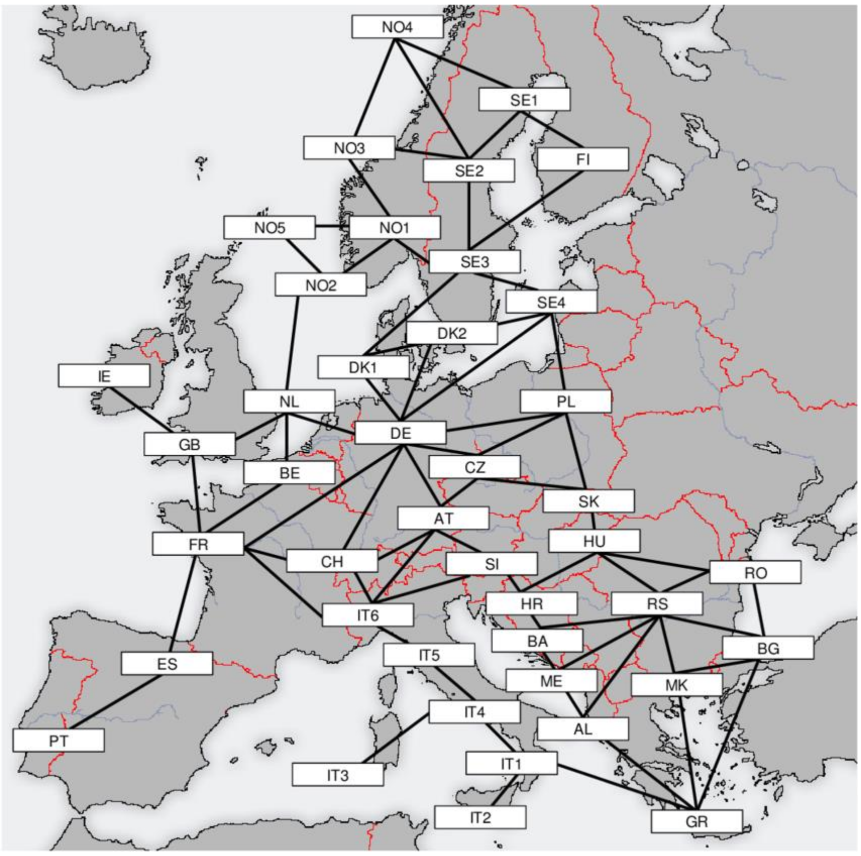
[7] Or were located in the same bidding zone when the Renewable energy plant came into operation. This is only valid for onshore bidding zones, not applicable for offshore bidding zones.

The term ''interconnected'' is not clearly defined and subject to interpretation. And also member states are allowed to introduced stricter rules, possibly leading to market fragmentation.

Onshore and offshore bidding zones are not treated equally, providing more uncertainty to offshore renewable energy projects that might fear a future reconfiguration of bidding zones and that could affect negatively the operation of the RFNBO production.

There are however some issues with the wording. The additionality article in the RFNBO DA (Article 5) allows for electricity to be supplied without power purchase agreements in place - if fuel producers produce an amount of renewable electricity in their own installations that is at least equivalent to the amount of electricity claimed as fully renewable. Whereas the wording in the geographical correlation article (Article 7) still explicitly requires electricity to be generated under a renewable PPA both in case of co-location in the same bidding zone as well as in case the RES-E is located in interconnected offshore bidding zone. This seems to undermine the usefulness of allowing to avoid putting PPA in place for RES-E assets owned by the RFNBO producer from Article 5

Figure 8. Map of interconnected bidding zones in Europe



Source: Vlachos, Andreas & Dourbois, G.A. & Biskas, Pandelis. (2016). Comparison of two mathematical programming models for the solution of a convex portfolio-based European day-ahead electricity market. Electric Power Systems Research. 141. 313-324. 10.1016/j.epsr.2016.08.007.

3. Emissions accounting methods

3.1. GHG accounting methods for grid electricity

What is being proposed?

The GHG DA requires that in case grid electricity (not qualifying as fully renewable) is used for the production of RFNBO, the operator is required to use one of the following three alternative methods to calculate the carbon intensity of grid electricity:

a) Average annual greenhouse gas emissions intensity determined at the level of countries or at the level of bidding zones - if the required data are publicly available.
b) Attributed depending on the number of full load hours the installation producing RFNBO/RCF is operating. Where the number of full load hours is equal or lower than 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 for which reliable data are available, grid electricity used can be assumed to be zero-emission. Where this number of full load hours is exceeded, grid electricity used in the production process of RFNBO/RCF shall be attributed a greenhouse gas emissions value of 183 g CO2eq/MJ; or
c) Based on the GHG emissions value of the marginal unit generating electricity at the time of the production of RFNBO in the bidding zone - if this information is publicly available from the national transmission system operator.

The chosen method should be applied for a full calendar year (i.e. without the possibility to freely alternate between them during the year).

Furthermore, if the method set in point (b) is used, it shall also be applied to electricity that is used to produce RFNBO/RCF that is fully renewable.

Why is it important and what will be the impact?

The possibility of using the carbon intensity of electricity of the bidding zone (instead of the entire country) is positive – as it allows the operators located in bidding zones with a lower carbon intensity than the country average, to operate many more hours.

A good example of this rule is France. The country average for 2020, given in table A in Part C in the Annex to the GHG DA, for France is 19.6 gCO2eq/MJ. This value is however inflated by the emissions for France overseas territories. The average emission factor for a bidding zone covering only mainland France is 15.1 gCO2eq/MJ – I.e. on a level that would allow for the mainland France bidding zone to qualify for the additionality exemption (see section ''additionality- what is being proposed'' in page 7) and to produce hydrogen from grid electricity at a carbon intensity level making it possible to reach the 70% GHG reduction level required for RFNBO.

The alternative b) is applied to all the electricity used (grid electricity and fully renewable electricity) for the calculation of the total full load hour for which a carbon intensity of 0 gCO2e/MJ can be applied. This a change compared to previous draft of the DA, effectively reducing the total amount of zero-emission grid electricity that can be utilised.

3.2. Mixing of electricity from multiple sources

What is being proposed?

The GHG DA requires that if in a given period when RFNBO/RCF are produced simultaneously with other non-renewable fuels, the GHG emissions should be averaged out between all outputs, resulting with all of them having the same emission intensity per MJ (Part A, point 1 of the GHG DA Annex).

In other words – if 50% of electricity used in the electrolysis process would be fully renewable and the other half would be taken from a non-renewable source, the total emissions will have to be equally distributed between the renewable hydrogen output and the non-renewable one. In case of high GHG intensity of grid electricity, it may result in making even the fully renewable output not reached the GHG reduction threshold to be recognised as RFNBO.

This is shown on the example below, where 50% of renewable electricity is complemented with 50% of grid electricity with a carbon intensity of 450 gCO2/kWh (equivalent to natural gas fired CCGT). In such case every kg of hydrogen (even the fully renewable one) would be allocated with half of the emissions – in this case 11.2 kgCO2/kgH2, which is well above the required threshold of 3.38 kgCO2/kgH2. No outputs would be classified as RFNBO **– not even the part corresponding to the use of fully renewable electricity.** This rule is designed to limit the amount of carbon-intensive (grey) electricity used for hydrogen production.

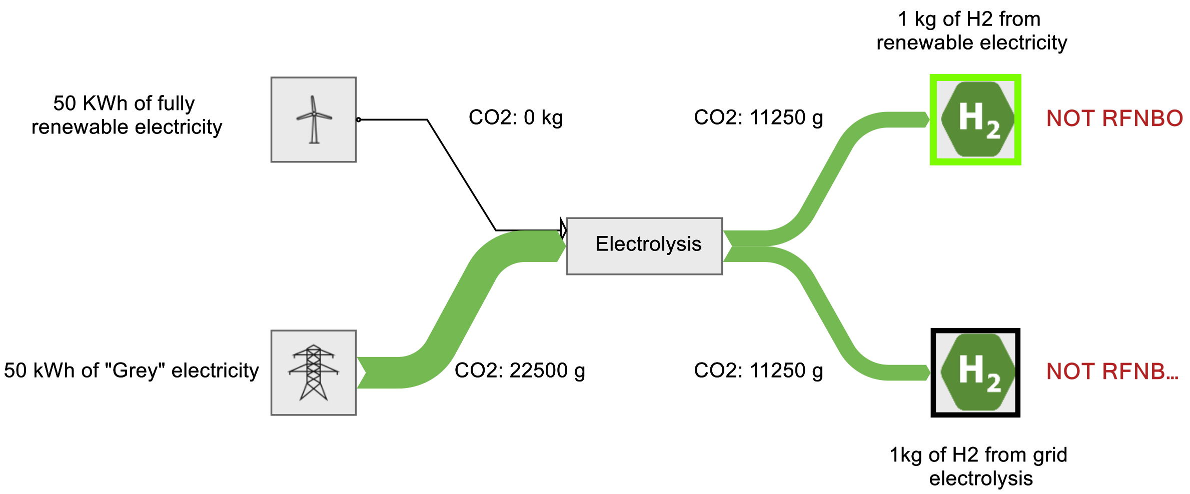


Figure 9. Allocation of GHG emissions to multiple outputs when using various electricity input sources

The period over which the emissions need to be averaged out to all outputs should be no longer than the period required for temporal correlation – i.e. no longer than 1 month until the end of 2029 and hourly from 1st January 2030.

What is the rationale behind it?

While no detailed explanation is provided, we understand that the reason to introduce this rule was to prevent an unintended effect where all emissions would be allocated to the residual output (non-renewable part of the output), thus allowing to claim RFNBO production while using highly carbon intensive grid electricity.

Why is it important?

This rule limits the amount of non-renewable electricity that can be "mixed" with fully renewable electricity at any given time as even a relatively small amount can, especially in countries with high carbon intensity of grid electricity, inflate the GHG intensity of renewable hydrogen above the required GHG threshold, making even the renewable portion of output not eligible as RFNBO.

The impact of this rule varies depending on the carbon intensity of grid electricity of a country (or bidding zone).

In countries with low enough grid carbon intensity, the rule would allow to operate the electrolyser at maximum capacity at all times , without the risk of exceeding the 70% GHG reduction threshold (as of 2020 - Sweden and France would qualify for this). Not only will the output hydrogen remain below the required GHG intensity threshold, but the total RFNBO output would be increased by the amount equal to the share of renewables in the electricity mix.

On the other hand, countries like Poland with high grid carbon intensity of 197 gCO2/MJ 16% renewables in the electricity mix, almost no grid electricity could be used, as even a small addition of <10% in a given time, would lead to the hydrogen output in that period not meeting the RFNBO GHG emission threshold – including the part based on fully renewable electricity.

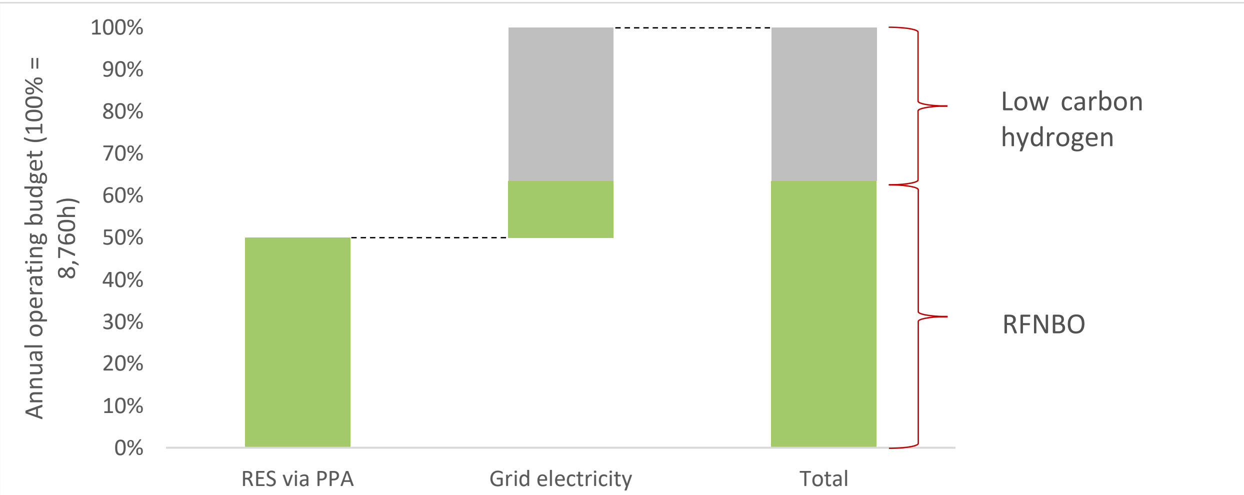
Example: France

Taking the example of mainland France bidding zone, and assuming that:

- the carbon intensity of electricity is 15.1 gCO2/MJ,
- the RES-E share in the grid mix is 25%,
- the operator has a PPA with wind and solar PV RES-E providers, which would guarantee up to 4,000 FLH of fully renewable electricity.

Given that the GHG intensity of grid electricity is low enough to enable production of hydrogen below the 70% GHG reduction threshold, the electrolyser operator could increase the electrolyser capacity factor up to 100% (disregarding any possible needs to power down the equipment for maintenance). The total output of RFNBO would be increased by the amount of RES-E share in the grid mix (25%) multiplied by the amount of FLH for which the grid electricity was used (4,860h). All of the remaining hydrogen output, while not being RFNBO - would still meet the definition of low carbon hydrogen.

Figure 10. Total possible electrolyser full load hours (FLH) in France, assuming RES-E PPA delivering fully renewable electricity covering 4,000 FLH



The situation would be completely different in countries with high carbon intensity of the grid. Taking the extreme example of Poland, where the carbon intensity of electricity is 196.5 gCO2/MJ and the RES-E share in the grid mix is only 16%, grid electricity could be used to increase the electrolyser FLH only from 4,000 to

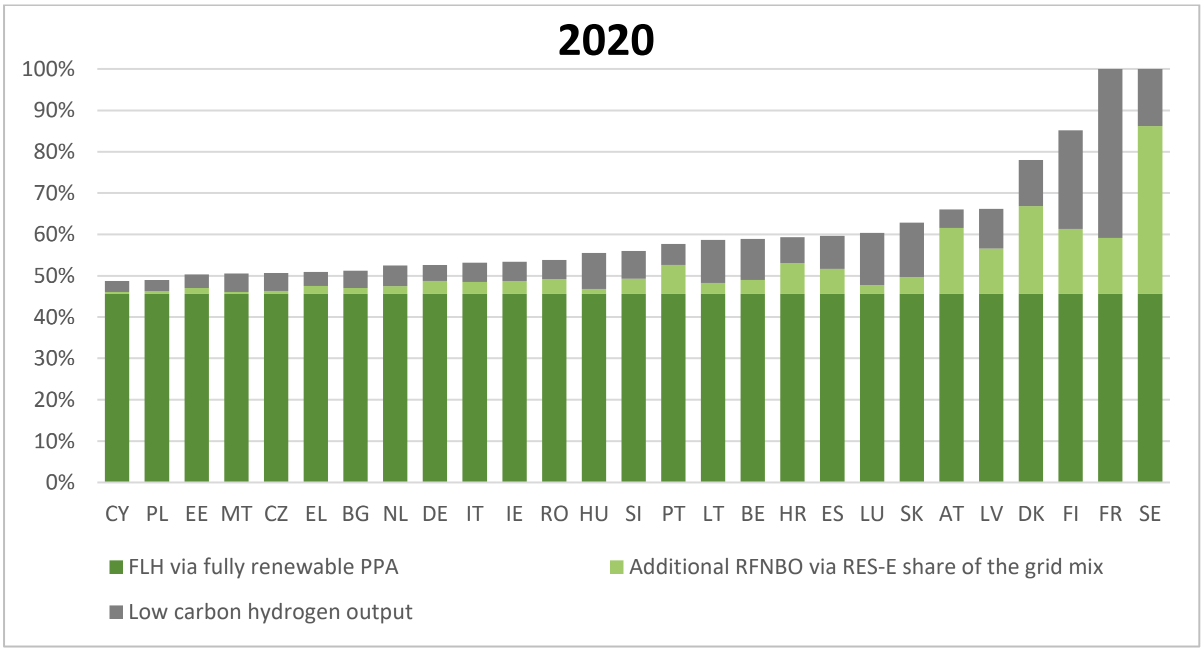
~4,300 hours[8] (as opposed to 8,760h in France) – making the grid connected electrolysis option in Poland far less attractive.

What will be the impact?

The rule requiring to average out GHG emissions over the fuel outputs will have a different impact depending on the GHG intensity of the electricity in the bidding zone and its RES-E share. In bidding zones with high penetration of renewables and low emission intensity it will allow to use grid electricity to increase the total capacity factor of the electrolyser and thus allowing to simultaneously increase the output of RFNBO and reduce the levelized cost of hydrogen (LCOH). The extreme example of this would be countries with GHG emission intensity below 18 gCO2e/MJ where, the electrolyser could be operated at full load without the riskof not meeting the 70% GHG reduction threshold.

On the other hand, in bidding zones and countries where the carbon intensity is high, the rule would limit the possibility to increase the electrolyser capacity factor in any other way than via PPA oversizing or energy storage – **and thus limiting the economic viability of Case 4** – in all but few EU Member States.

Figure 11. Total Full Load Hour (FLH) potential in Case 4 with 4,000 FLH delivered via fully renewable PPA based on 2020 data



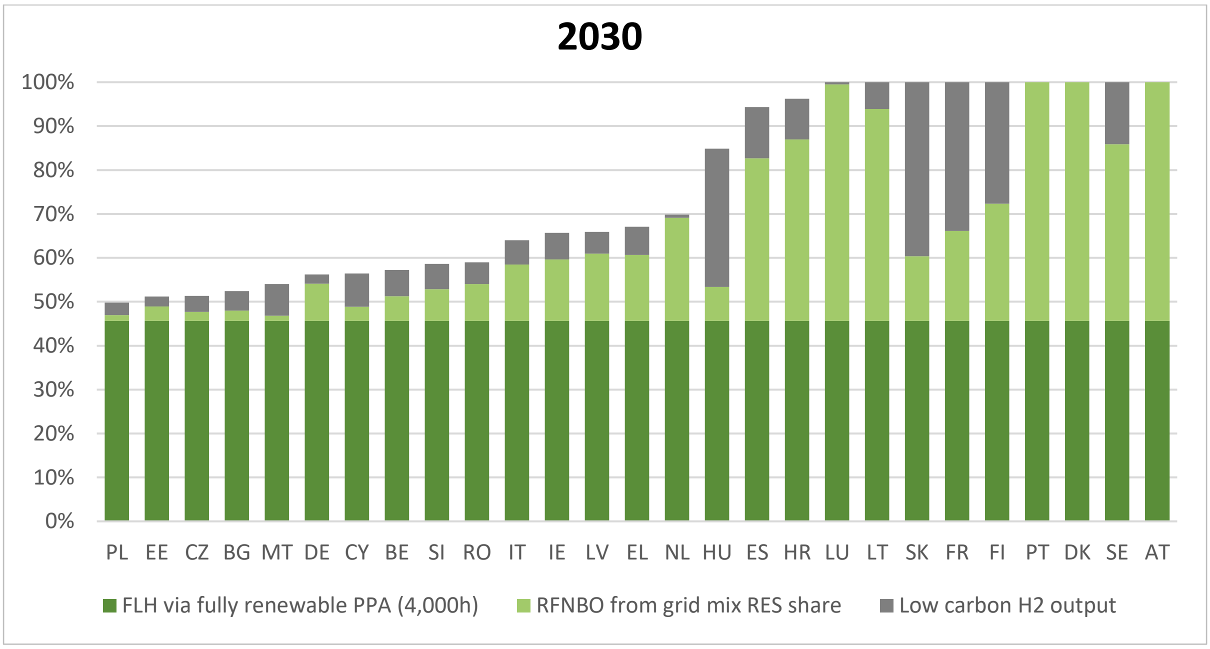
Case 4 is the most relevant case for use of RFNBO in industry, where a high capacity factor for electrolysis is required; not only for the cost reduction but also for matching the constant demand for hydrogen. This rule of emissions allocation restricts the use we can do of electricity grid, further complicating the business case for the use of RFNBO in industry. With hourly temporal correlation already limiting the viability of RES-E PPA overcapacity, this rule further impacts the possibility of using grid electricity to increase the operating time of electrolysis.

Limiting the feasibility of grid-connected onsite electrolysis would also reduce the future potential to use electrolysers as a flexibility option in the electricity system and thus limit the possibility of using that flexibility to reduce RES-E curtailment and to provide other ancillary services.

[8] A lot depends on the assumed RES-E mix supplying the initial 4,000 FLH, the provided figure is based on the scenario that a 200 MW electrolyser would have a PPA with 220 MW onshore wind and 95 MW solar PV.

On the other hand, if the renewable energy targets defined in the National Energy and Climate Plans (NECPs) were met, by 2030 the situation would improve significantly in a number of EU Member States.

Figure 12. Total FLH potential in Case 4 with 4,000 FLH delivered via fully renewable PPA based on 2030 projections[9]



[9] where data on GHG intensity of grid intensity was available the 2030 projections are based on NECPs, and on EU COM Reference scenario in other cases.

3.3. Using partially renewable inputs

What is being proposed?

In case of co-processing where RFNBOs and RCFs are only partially replacing a conventional input in a process, the GHG emission intensity of outputs does not need to be averaged out but can be separately established on a proportional basis of the energetic value of inputs between:

– the part of the process that is based on the conventional input and

– the part of the process that is based on RFNBOs and RCFs assuming that the process parts are otherwise identical.

Why is it important?

This is a very positive rule as it allows for gradual introduction of renewable inputs into processes in response to growing demand for renewable fuels (note this was not the case in previous drafts of the DA, and thus it is a positive change.

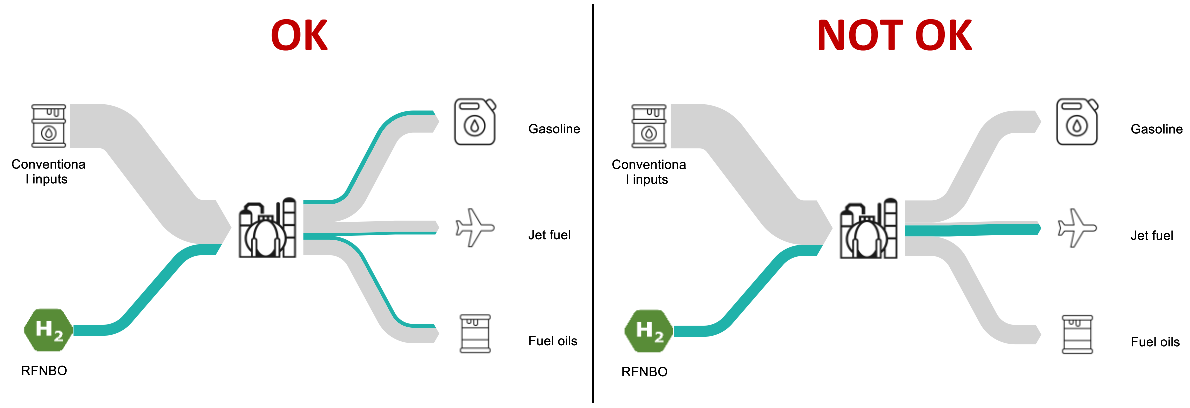
What will be the impact?

Without this rule the GHG benefit from GHG intensity reduction resulting from introduction of renewable inputs would have to be applied equally to the entire output stream – meaning that no RFNBO would be produced unless the entire process emission intensity would be reduced by the required 70%.

Now, if a refinery operator would like 10% of the outputs to be renewable, a corresponding proportion of energy inputs (e.g. 10%) needs to be renewable.

This makes it possible to gradually decarbonize fuel production and opens the e-fuels production market also to large scale existing refineries.

However, it needs to be noted that the rule still needs to be applied proportionally to all outputs – so one cannot freely allocate the renewable character (and GHG benefit) to one output only (e.g. e-kerosene).



4. Other aspects

4.1. The role of nuclear energy

What is being proposed?

Because of an often-repeated misconception it should be noted that there is nothing in the RFNBO DA says that nuclear-based hydrogen will count as green hydrogen. The rules state that, once a country's grid electricity hits decarbonisation targets of 18g CO2eq/MJ, the need for "additional" renewables for green hydrogen is then waived.

Due to the quantity of active nuclear generation in France, for example, the country is able to achieve that threshold (next to Sweden). So, the fact that it possesses a significant fleet of nuclear power plants means it will be able to waive the additionality which will benefit the cost competitiveness of domestically produced hydrogen (especially in industry).

Renewable/green hydrogen will only count as green when produced by renewable energy. That has not changed.

Both temporal and geographical correlation requirements will remain applicable to those bidding zones that are excluded from additionality.

4.2. CO2 availability

What is being proposed?

The Draft Delegated Act suggests that CO_2 emissions from industrial sources will no longer be considered as avoided for RFNBOs production as of 2041 (2036 in the case of CO2 arising from the production of electricity).

Indefinite use of CO2 is foreseen only in the case of:

- CO2 is captured from the air (DAC),
- CO2 from the production or the combustion of biofuels, bioliquids or biomass fuels complying with the sustainability and greenhouse gas saving criteria and the CO2 capture did not receive credits for emission savings from CO2 capture and replacement, set out in Annex V and VI of Directive (EU) 2018/2001,
- CO2 from the combustion of RFNBOs or RCFs complying with the greenhouse gas saving criteria, set out in Article 25(2) and Article 28(5) of Directive (EU) 2018/2001 and this Regulation,
- CO2 from a geological source of CO2 if the CO2 was previously released naturally.

What is the rationale behind it?

The EU COM what's to ensure that in long term the use of RFNBOs will contribute to full reduction of CO2 emissions and not just shifting/delaying of those emissions from one sector to another.

Why is it important?

CO_2 emissions from industrial sources – especially process emissions in industry, including hydrogen and ammonia production, contain a highly concentrated stream of CO2 as compared to flue gases from combustion of fossil fuels – and especially compared to DAC. As a result, the CO2 capturing from industrial sources is significantly more efficient (less expensive) than alternative options.

Furthermore, DAC is a technology with a relatively low TRL and high cost while other 'eligible' sources of CO_2 are relatively scarce – thus this rule puts into question the availability of the required amounts of CO_2 sources needed in the coming decades.

The provision also ignores the existence of various unavoidable CO_2 emissions (e.g. cement) as well as CO_2 emissions from waste incineration or gasification. Many of these will have no access to permanent CO_2 storage sites and will therefore require CCU as part of their decarbonisation pathway past the 2036/2041 date.

As a result, the provision directly jeopardises the commercial viability of projects utilising industrial CO_2 that are being launched, and which usually have a payback period of more than 25 years.

Therefore Hydrogen Europe's position on this point remains unchanged, and:

- A grandfathering rule should be introduced to allow CCS projects which come into operation before the 2036/2041 date to continue operation,
- Recognition of unavoidable CO_2 sources,
- Recognition of waste incineration as eligible source of CO_2.

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