REGULATORY FRAMEWORK

REGULATORY FRAMEWORK FOR GHG ACCOUNTING OF HYDROGEN

– Comparison of EU Regulation and Emerging International Standards –

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1. Digital CO_2 verification as the focus of Work Package 10 of the HydroNet project

The use of renewable or low-CO_2 hydrogen and its derivatives (e.g., e-methanol, e-ammonia, or e-kerosene) is an important building block for the success of the energy transition and for the decarbonization of relevant economic sectors. Since domestic resources in Germany and Europe – even the projected hydrogen production capacities – will likely not cover the planned demand, large-scale production of CO_2-free or low-CO_2 hydrogen products outside Europe is necessary, and international value chains must be established. In order to capture, certify, or in the future also trade the emissions occurring along the value chain in an economically efficient and ecologically sustainable manner, the development of automated CO_2 calculation & verification processes using appropriate digital technologies is required.

As part of the publicly funded research project "HydroNet," a consortium of P3 Energy Solutions, Fraunhofer FIT, and TÜV Nord is developing an end-to-end digital chain for the traceability of hydrogen's CO_2 emissions and those of its derivatives. This reduces the complexity and cost of verification in international value chains. At the same time, verifiable data create greater confidence in labels and certifications and increase the competitiveness of hydrogen.

The goal is to make the digital CO_2 calculation & verification process both technologically open (i.e., avoiding lock-ins to specific technologies and vendors) and methodologically flexible (i.e., integrating existing national guarantees of origin, life cycle analysis (LCA) approaches, and future national as well as international CO_2 accounting and certification standards).

2. Relevance of the Regulatory Analysis and Scope of Study

In order to ensure methodological flexibility in providing evidence within international hydrogen value chains, a high degree of transparency across the various greenhouse gas (GHG) accounting methods is necessary.

Against this backdrop, an analysis of the regulatory landscape is being carried out, focusing on EU legislation and the international standards under development for GHG accounting. The aim of this analysis is to provide transparency on the applicable requirements, identify methodological gaps, and on that basis derive possible courses of action to improve GHG accounting.

Two methodological approaches to accounting for GHG emissions along the hydrogen value chain provide the comparative framework for this systematic study:

- **EU RFNBO methodology according to Delegated Regulation (EU) 2023/1185:** This set of rules defines the calculation basis for GHG emissions and savings from renewable fuels of non-biological origin (RFNBO) under the Renewable Energy Directive (RED). The aim is to establish uniform criteria for crediting GHG reductions when using hydrogen in mobility and fuel applications. The methodology follows a well-to-wheel approach and is closely linked to regulatory requirements for certification and eligibility for funding.
- **ISO methodology according to ISO/TS 19870:2023:** This technical specification, published in July 2023, is based on the established standards ISO 14040, 14044, 14067, and 14083. Although ISO/TS 19870 does not prescribe any thresholds, it offers a consistent, modular methodology for determining emissions along the entire hydrogen value chain – from production through conditioning to transport to the point of use. It is compatible with both attributional and consequential life cycle analyses.

Overall, over **1,000** text passages from five ISO standards were analyzed, of which **515** were identified as directly relevant for WP10. In contrast, only **35** pertinent text sections were found in the EU regulatory framework (primarily in Delegated Regulation (EU) 2023/1185), of which **32** are classified as relevant. Furthermore, it becomes apparent that of the total **432** requirements of the underlying RED III directive, only **five** requirements are directly significant for WP10 – the methodological details are defined almost exclusively by the aforementioned Delegated Regulation.

ISO
GHG assessment as per ISO/TS 19870

Fundamentals	*Identified text passages*		*Derived requirements*		*Relevant for HyN AP10*
ISO 14040 *LCA I*	123	>	25	>	16
ISO 14044 *LCA II*	233	>	152	>	96
ISO 14067 *CFP [Products]*	203	>	123	>	96
ISO 14083 *CFT [Transport]*	309	>	213	>	211
ISO/TS 19870 *CFH [Hydrogen]*	300	>	176	>	96
					∑: 515

RED
GHG assessment as per RED - DA (EU) 2023/1185

Fundamentals	*Identified text passages*		*Derived requirements*		*Relevant for HyN AP10*
RED III (EU) 2018/2001	437	>	432	>	5
RED-DA (EU) 2023/1185	35	>	34	>	32
					∑: 37

Figure 1: *Comparison of the requirements for GHG accounting according to ISO/TS 19870 (including additional ISO standards) and the RED Delegated Act (EU) 2023/1185.*

The assessment of relevance was carried out based on internal project assumptions, according to which certain aspects are not considered within WP10. These include, for example, comparative statements, critical reviews, end-of-life considerations, direct land-use changes, air freight transport, as well as integration with the Union database. This content-based delineation defines the methodological scope of the work package and explains why only a portion of the requirements from the standards and legal acts considered were taken into account for WP10.

The ISO standards provide comprehensive technical coverage for a multitude of LCA components, including the definition of goals and scope, system boundaries, allocation procedures, and impact assessment, making them especially valuable for comprehensive and transparent carbon footprint studies.

Section	Subsection	ISO 14040	ISO 14044	ISO 14067	ISO 14083	ISO/TS 19870	RED III	RED-DA	Compatibility (ISO/RED)
General requirements	General	1	2	2	0	0	1	0	Yes
	Application of the CFP-PCR	0	0	5	0	0	0	0	Yes
Definition of the goal and scope of the study	General	0	2	0	0	0	0	0	Yes
	Goal of a CFP study	1	1	2	0	0	0	0	Yes
	Scope of a CFP study	5	19	28	0	22	0	6	To be checked
	Requirements for life cycle stages	0	0	0	211	8	0	17	To be checked
Life cycle inventory	General	0	1	2	0	0	0	0	Yes
	Data collection	2	7	3	0	0	0	0	Yes
	Data calculation	2	11	8	0	0	0	0	Yes
	Allocation	0	12	13	0	27	0	4	To be checked
	Assessment of the time-related impact of emitted and removed GHG quantities	0	0	2	0	0	0	0	Yes
	Treatment of specific GHG emissions and removals	0	0	12	0	32	4	2	To be checked
Life cycle impact assessment	-	0	6	6	0	4	0	1	To be checked
Interpretation	-	1	28	3	0	0	0	0	Yes
CFP study report	-	6	7	10	0	3	0	2	To be checked

Figure 2: *Requirements under ISO/TS 19870 (including additional ISO standards) and the RED Delegated Regulation (EU) 2023/1185, and evaluation of the compatibility of these requirements.*

This comparison illustrates that the EU RFNBO requirements represent a relatively narrowly defined set of rules primarily aimed at certifiability, whereas the ISO standards offer significantly greater methodological depth and flexibility for GHG accounting (especially in the context of comprehensive LCA analyses).

Accordingly, the focus of the analysis is not on evaluating political objectives, but rather on a technical comparison of requirements, accounting approaches, and methodological depth.

3. Analysis Results

On the basis of the defined scope of investigation, the results of the comparative analysis are presented below. The most important methodological differences between the EU RFNBO methodology and ISO/TS 19870 are explained, structured by topic, each with reference to specific requirements of the documents.

3.1. System Boundary and Scope of Accounting

The EU's RFNBO methodology follows a well-to-wheel approach, whereby the use and final combustion of fuels are included in the accounting. The goal is to demonstrate a reduction of total emissions by at least 70% compared to a fossil reference value. This requirement necessitates a continuous, standardized analysis up to the point of final use.

In contrast, ISO/TS 19870 focuses on a well-to-gate system boundary, in which emissions up to the delivery point "consumption gate" are accounted for. As a result, use-phase emissions of the hydrogen are not considered further. This difference in system boundary influences which process steps must be taken into account and impacts comparability with other fuel pathways. For applications outside mobility and fuel applications, the ISO methodology offers greater compatibility due to its neutrality.

3.2. Allocation Methodology for By-products

In the treatment of co-products, such as oxygen from electrolysis, significant differences between the systems become apparent.

- The EU methodology prescribes a mandatory allocation based on energy content (lower heating value). The emissions of the joint process are distributed proportionally between hydrogen and oxygen.

- ISO/TS 19870, on the other hand, allows the choice among several common allocation methods – including allocation by mass, economic value, or energy content – provided this is justified methodologically.

The greater flexibility of ISO/TS 19870 makes it possible to adapt the calculation to real market conditions and the specific objectives of the analysis. For companies, this means concretely: while the EU method provides clear and auditable guidelines, the ISO standard offers more room for project-specific differentiation.

3.3. Considering the Source of Electricity

Emissions from electricity consumption are decisive in hydrogen production via electrolysis. According to Delegated Regulation (EU) 2023/1185, there are several options for determining the emission factor:

1. **Renewable electricity:** If exclusively additional renewable power is used, and the criteria of additionality, temporal correlation, and geographic correlation are met, then the electricity can be accounted with zero emissions.
2. **Grid electricity:** When using grid electricity, the regulation permits three methods: (1) standard values according to Annex C of the regulation, (2) the loading hours method, or (3) the emission factor of marginal electricity generation at the time of production, if publicly available.
3. **Special rules:** In bidding zones with over 90% renewable share or during periods of very low wholesale electricity prices, grid electricity can also be assigned a low emission value.

ISO/TS 19870 does not make any prescriptions on this, but allows both location-based and market-based emission values – ranging from conventional to fully renewable. What is crucial is transparent documentation. Thresholds or funding criteria are not part of the standard. Thus, ISO focuses on traceability and technology neutrality, whereas the EU requirements deliberately privilege certain electricity qualities for policy reasons.

3.4. Global Warming Potentials and Emission Factors

For converting individual greenhouse gases into CO_2 equivalents, the two methods use different Global Warming Potential (GWP) factors and in part also different default emission factors.

- The EU method relies on the 4th IPCC Assessment Report (AR4) and uses, for example, the factors CH_4 = 25 and N_2O = 298 (unit: CO_2-eq).
- ISO/TS 19870, on the other hand, references the more recent 5th IPCC report (AR5) and uses, among others, CH_4 = 28 and N_2O = 265 (unit: CO_2-eq).

These differences become particularly noticeable when non-CO_2 gases such as methane or nitrous oxide play a role in the process. In practice this means that, depending on the chosen methodology, identical processes can result in different total emissions, which impairs the comparability of certificates. For a harmonized European GHG accounting, aligning the GWP values used would therefore be necessary.

3.5. Data Requirements and Granularity of Accounting

The ISO standards impose high requirements on data quality, representativeness, and documentation. Primary data should be collected as comprehensively as possible; assumptions and secondary data must be transparently justified.

The EU RFNBO methodology offers significantly less depth in this regard: it allows the use of default values (e.g., for electricity or natural gas emissions) and is therefore simpler to implement. The price for this, however, is a lower level of detail, which reaches its limits especially in international comparisons or when communicating to stakeholders.

3.6. Auditability and Verifiability of Results

The EU methodology is embedded in a mandatory certification system – without confirmation by an accredited body, crediting is not possible. ISO/TS 19870, in contrast, provides for voluntary verifications (e.g., according to ISO 14064-3 or ISO 14071). Such verifications can be used to build credibility, but are not a prerequisite for applying the ISO methodology.

In summary, the ISO approach offers more flexibility here, whereas the EU requirements, through mandatory certifications, ensure a higher formal consistency and comparability of the results.

3.7. Modularity and Breadth of Application of the Methodology

ISO/TS 19870 has a modular structure and can be applied to various hydrogen production processes, forms of transport, and derivatives. The emissions of individual process modules (e.g., electrolysis, liquefaction, transport) are each accounted for separately and then consolidated at the end.

The EU methodology is much more narrowly defined: it explicitly refers to *green hydrogen* for use as a fuel in the sense of the RED and primarily pursues the goal of making GHG reduction quotas creditable. This results in a limited applicability of the EU RFNBO methodology for industrial or cross-sector applications beyond mobility and fuel applications.

4. Implications for Practice and Policy

The parallel existence of two different methods for GHG accounting leads in practice to additional effort and inconsistencies. Companies that market hydrogen both within and outside Europe must prepare their GHG balances according to both systems, thereby accepting redundant effort and inefficiencies.

In particular, the limited methodological depth and flexibility of the EU RFNBO methodology forces users to make additional assumptions or to carry out parallel alternative calculations for external purposes. This creates uncertainties – both regarding the validity of the results and the acceptance by other actors or markets.

The limited comparability of the certificates further complicates market integration and hinders the international tradability of hydrogen products. For regulatory authorities and certification bodies, the challenge arises of managing different data formats and accounting logics in parallel, which in the long term means a significantly increased administrative effort.

Moreover, the structural and content-related incompatibility of both systems makes direct mapping of the respective requirements difficult – relevant elements must be selectively extracted and adapted to the other framework.

At the same time, feedback from the market shows that there is an increasing demand for a more use-case-based, delivery-specific CO_2 proof with a specific emission value – not just a blanket sustainability label. ISO/TS 19870 provides a methodological basis for this, allowing product- and process-specific differentiation and thus opening up new avenues for CO_2-based market mechanisms.

Outside Europe, ISO/TS 19870 has not yet been applied on a broad scale. Nevertheless, the standard is already receiving international attention: for instance, Australia plans, as part of its intended *Guarantee-of-Origin* program for hydrogen, to report GHG emissions on a production-specific basis, without setting rigid thresholds for “green” or “low-carbon” hydrogen. This transparent guarantee-of-origin system is conceptually based on the ISO approach and leaves it to the buyers to decide based on the stated emission value. In addition, in December 2023, over 30 countries signed a joint declaration at the UN Climate Conference COP28 on the mutual recognition of hydrogen certification systems. In this COP28 *Declaration of Intent*, ISO/TS 19870 was explicitly highlighted as a global reference standard for determining the GHG footprint of hydrogen. This suggests that the ISO methodology could play a key role in the future in the international harmonization of hydrogen certifications.

5. Recommendations for Harmonization

The analysis makes it clear that harmonization of the GHG accounting methodology between the EU regulation and international ISO standards is urgently needed. From the results, the following recommendations for action can be derived:

1. **Recognition of international standards:** ISO/TS 19870 should be adopted as a methodological reference in European legislation, for example through an optional equivalence provision within the RED.
2. **Integration via pilot projects:** Pilot projects like HydroNet should be used to test the ISO methodology under real conditions and to serve as a model for a possible transfer into regulatory requirements.
3. **Blueprint CountEmissionsEU:** The example of ISO 14083, which is to be legally anchored as part of *CountEmissionsEU*, shows that standards can be successfully transferred into European law.
4. **Linking transparency and certifiability:** A harmonized GHG accounting must ensure that both the transparency and methodological detail of the ISO standards are maintained, and that auditable documentation in accordance with RED requirements is guaranteed.
5. **Reduction of complexity in GHG calculation:** The methods should be designed such that they are both auditable and operationally feasible. In particular, digital applications – which are indispensable for the efficiency of the certification process in complex international hydrogen value chains – benefit from clear, modular, and transparent requirements, including with respect to data collection and granularity.
6. **Uniform GWP factors:** Aligning the climate impact factors used on the basis of current IPCC reports would significantly improve the comparability and scientific validity of the results.

In sum, the analysis shows that a coordinated further development of both systems can lead in the long term to greater efficiency, trust, and marketability in CO_2 calculation and verification.

6. Conclusion and Outlook

The study underscores the need for closer alignment between European regulations and international standards for GHG accounting of hydrogen. The RFNBO methodology does fulfill its role as a regulatory minimum standard, but it exhibits substantive deficits in terms of data quality, flexibility, and comparability. ISO/TS 19870, in contrast, offers a normative framework with significantly greater methodological depth that is also suitable in the medium term for integration into regulatory contexts. The transition to a harmonized methodology can be supported by the further development of the ISO standards, by their incorporation into European certification processes, as well as through accompanying pilot projects like HydroNet.

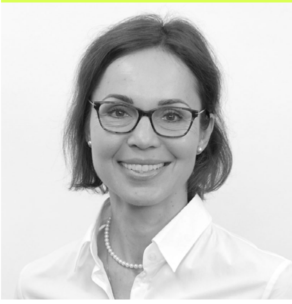
For a harmonized accounting methodology, it must also be ensured that the transparency and level of detail of the ISO standards are preserved and that auditability and certifiability in line with RED requirements are guaranteed.

The introduction of consistent, cross-border recognized accounting standards would overall be a central building block for a trustworthy and marketable scale-up of the hydrogen economy.

7. Sources

- 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 fuels of non-biological origin and from recycled carbon fuels
- ISO/TS 19870:2023 – *Greenhouse gas management and related activities – Life cycle assessment – Methodology for determining the greenhouse gas emissions associated with the production, conditioning and transport of hydrogen to consumption gate*
- ISO 14040:2006 + Amd 1:2020 – *Environmental management – Life cycle assessment – Principles and framework*
- ISO 14044:2006 + Amd 1:2017 + Amd 2:2020 – *Environmental management – Life cycle assessment – Requirements and guidelines*
- ISO 14067:2018 – *Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification*
- ISO 14083:2023 – *Greenhouse gases – Quantification and reporting of greenhouse gas emissions from transport chain operations*

Do you need more information regarding GHG accounting of hydrogen?



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