Recommendations on the methodology to determine the greenhouse gas (GHG) emission savings of low-carbon fuels

Summary of the Zero Emissions Platform (ZEP)'s key recommendations:

- Carbon capture and storage technologies are proven and demonstrated on commercial scale to significantly reduce emissions from the production of hydrogen through steam methane reformation (SMR) and autothermal reformation (ATR) processes.
- "Capture rate" is not a term legally defined and has various interpretations. A limit on total GHG emission intensity from the production of low-carbon fuels is preferable.
- Clarify which competent authority is to assess the natural release of CO_2 from a geological source and what technical specifications must be met to qualify.
- Provide clarity with respect to geological storage of CO_2 in jurisdictions outside the EEA and ensure consistency with the rules of the CCS Directive.
- Provide a level playing field on the monitoring, reporting and verification of the permanent storage of CO_2 for carbon stored in a solid state as is the case for CO_2 stored in geological storage sites permitted under the CCS Directive.

Foreword

Zero Emissions Platform (ZEP) is the trusted advisor to the European Union on industrial carbon management. ZEP runs the European Technology and Innovation Platform (ETIP) under the European SET-Plan and collaborates closely with the European Commission. Our mission is to accelerate the deployment of industrial carbon management and the buildout of CO_2 infrastructure in Europe in line with the EU's climate ambition. Our comprehensive technical work and policy advice builds on a broad, diverse member base, ranging from energy producers and industrial companies to infrastructure and equipment providers, environmental NGOs, academia, and trade unions.

ZEP welcomes the opportunity to provide feedback on the draft methodology that determine the greenhouse gas (GHG) emission savings of low-carbon fuels.

The primary objective of this Delegated Act (DA) must be to reduce GHG emissions, and thus to ensure that the fuels defined as "low-carbon" under the Renewable Energy Directive reflect this and align with the EU climate objectives. To this end, ZEP stresses the need for a robust monitoring, reporting and verification (MRV) framework – including for methane leakage and hydrogen leakage, as mentioned in Article 9(5) of the recast EU Directive on gas and hydrogen markets. This DA act must also establish clear and transparent system boundaries that are consistent with existing EU legislation and that prevent any potential confusion among all stakeholders.

In line with ZEP's focus on industrial carbon management, the recommendations for this DA concern CO_2 capture, transport and storage. ZEP also highlights lessons from existing commercial-scale, hydrogen projects using carbon capture and storage (CCS). More specifically, the focus of this response is on the production of hydrogen and derivatives from processes involving steam methane reformation (SMR) and auto-thermal reformation (ATR) of fossil fuels. Electricity-based production of hydrogen from non-renewable sources, for example nuclear or gas power, is not considered.

1. CO_2 capture

CO_2 is already routinely separated as part of the commercial process to produce hydrogen via SMR and ATR production routes where methane (CH_4) is separated to produce CO_2 and H_2. Importantly, many new projects plan to equip hydrogen production with carbon capture have selected the ATR production process in which the CO_2 can be more easily separated in one process step, versus SMR where different streams of CO_2 are produced through process of SMR and the heat produced through the combustion of methane.

As the background section below (page 7) highlights, achieving very low levels of emissions through the hydrogen production process using CO_2 capture is technically feasible and has been demonstrated at commercial scale. However, this can only be commercially feasible with the right policy, regulatory and economic conditions in place.

1.1. Capture rates

The existing minimum GHG emission savings threshold of 70% for the life cycle emissions of low-carbon fuels currently sets the main baseline where CO_2 capture technologies are used to mitigate emissions from the production of hydrogen with SMR or ATR processes.

The DA does not set a minimum carbon capture rate for hydrogen production with the use of CO_2 capture. As the background section below (page 7) highlights, the term "capture rate" has various interpretations and no single legal definition. This highlights the need for ambitious rules on GHG emissions intensity to ensure as much CO_2 is captured during the capture stage as possible. These rules can also contribute to keeping hydrogen and methane leakage rates to a minimum.

1.2. Natural releases of CO_2 from a geological source

The Annex stipulates that "emissions from inputs' existing use or fate" shall be considered avoided when the input is used for fuel production. More specifically, that this shall include *"the CO_2 equivalent of the carbon incorporated in the chemical composition of the fuel that would have otherwise been emitted as CO_2 into the atmosphere"*, and that this refers to all forms of carbon provided that at least one of several conditions is fulfilled. Among these, the Annex includes:

> *"(e) the captured CO_2 stems from a geological source of CO_2 and the CO_2 was previously released naturally."*

This same condition can also be found in the methodology for determining GHG savings from RFNBOs outlined in Commission Delegated Regulation (EU) 2023/1185. However, neither texts mention which competent authority is responsible for assessing whether CO_2 was previously released naturally from a geological source, nor how this assessment should be conducted, or which minimum conditions must be met to grant this status to a potential exploitation operation.

1.3. Recommendations for aspects related to CO_2 capture

To address the issues ZEP identified in relation to the capture of CO_2, this Delegated Act must:

- Establish robust rules that focus on the GHG emissions intensity of low-carbon fuels production.

- Clarify which competent authority is to assess the natural release of CO_2 from a geological source and what technical specifications must be met to qualify.

2. CO_2 storage

The geological storage of CO_2 in saline formations and depleted hydrocarbon reservoirs has been demonstrated as safe and permanent in over 50 years of activity. In the European Union (EU) and European Economic Area (EEA) the Directive 2009/31/EC (commonly referred to as the "CCS Directive") contains a robust regulatory framework for the geological storage of CO_2 in the EEA and is used by national competent authorities in licensing and monitoring storage sites.[1] Similar legal frameworks exist in other jurisdictions, for example the Class VI regime in the United States. However, the framework conditions do not necessarily reflect the specific conditions with which operational storage sites should abide by as these are determined by regulators on a project-by-project basis.

While this project-by-project based assessment is indeed the case for storage sites seeking an injection permit in the EEA, the CCS Directive provides for a set of criteria which competent authorities must apply to all projects. This creates a level-playing field within the EEA. However, this may not be the case for storage projects outside the EEA, where regulators may operate under different rules than in the EEA.

2.1 Storage outside the European Economic Area (EEA)

The Annex to the draft DA outlines that CO_2 captured and permanently stored in a storage site permitted under the CCS Directive may be eligible. However, the draft also allows for storage sites regulated "under applicable national law in third countries, and which is not used for enhanced oil and gas recovery." The applicability of storage in jurisdictions outside the EEA is not entirely clear. For example, the technical screening criteria for "underground permanent geological storage of CO_2" under the EU taxonomy[2] requires that for exploration and storage activities in third countries, the activity should comply with the international standard ISO 27914:2017.[3]

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[1] Zero Emissions Platform, 'Experience in developing CO_2 storage under the Directive on the geological storage of carbon dioxide' (2022). Available at: https://zeroemissionsplatform.eu/experience-in-developing-co2-storage-under-the-directive-on-the-geological-storage-of-carbon-dioxide/

[2] See section 5.12 in the Annex of: *Commission Delegated Regulation (EU) 2021/2139 of 4 June 2021 supplementing Regulation (EU) 2020/852 by establishing the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for determining whether that economic activity causes no significant harm to any of the other environmental objectives.* Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02021R2139-20240101

[3] ISO (2017) ISO 27914:2017 – Carbon dioxide capture, transportation and geological storage – Geological storage. Available at: https://www.iso.org/standard/64148.html

The draft DA does not make reference to what such "applicable national law" may require and what "third countries" would be eligible based on existing legal frameworks. The draft DA only outlines that for storage outside the EEA "the applicable national law that regulates geological storage sites shall provide for appropriate monitoring, reporting and verification requirements to detect leaks, as well as place legal obligations on the storage operator to ensure remediation in line with the legal provisions applicable in the Union."

The Commission should clarify the following issues:

- What the "appropriate MRV requirements" for storage sites located outside of the EEA are
- Whether a CO_2 storage site outside the Union meets the "appropriate MRV requirements"
- Who will be responsible for this clarification and ongoing monitoring
- How these requirements will be enforced

In particular, the Commission should clarify whether the Commission, regulators in 3rd party countries, and/or national competent authorities in the EEA are responsible for setting these requirements, monitoring and enforcing their implementation and in the case where different entities are responsible for different aspects, how they will cooperate.

2.2 Importance of storage permanence

The Annex to the draft DA outlines that emissions reductions may be accounted for *"where a process for making low-carbon fuels produces carbon in solid state or carbon emissions that are permanently stored in a geological storage site".*

While the CCS Directive outlines a regulatory framework governing the storage media for CO_2 stored in a geological storage site, there is no regulatory framework for the storage of carbon stored in a solid state. To ensure a level playing field, it is necessary to ensure that regulations are consistent in addressing the storage media for CO_2.

Similarly, it is necessary to ensure that EU legislation remains consistent in its use and understanding of the term "permanence" in reference to CO_2 storage. For example, the Commission Delegated Regulation (EU) 2024/2620 on permanent CCU in the EU Emissions Trading Scheme (ETS) defined it as *"at least a period of several centuries or longer"* (Recital 4 and Article 3).

The production of low-carbon fuels involving the use of CO_2 capture and storage should thus ensure that the captured CO_2 is stored in a medium that guarantees equal levels of permanence as the CCS Directive and the Delegated Regulation on permanent CCU in the ETS, and that only permanent storage methods may be discounted from the overall carbon balance calculation.

2.3 Recommendations for addressing the storage of captured CO_2

To address the issues with storage of captured CO_2 in jurisdictions outside the EEA, solutions could include the preparation of:

- A detailed list of criteria laid down in the CCS Directive by which storage operators and regulatory authorities in third party countries should abide (to be included in the DA).

- An assessment of the jurisdictions in which storage sites are located, which may ex-ante be eligible for the same regulatory treatment as storage sites in the EEA.

- An ex-ante examination of the storage permit and monitoring plan for the relevant storage site in third party countries.

- Regular communication between regulatory authorities in third countries and the Commission (with assistance from the CO_2 storage expert group) to ensure consistency and compliance with the MRV criteria set out in this DA.

- With respect to the storage of CO_2 in a solid state, the same rules governing the monitoring, reporting and verification of the permanent storage of CO_2 in geological storage sites permitted under the CCS Directive should be applied.

Background: Existing hydrogen projects using carbon capture and storage

Evidence shows that hydrogen production via SMR and auto thermal reformation ATR can lead to the production of low carbon hydrogen with low carbon footprint.[4] This requires capture of most CO_2 emissions produced during the production process. The contribution of CCS to reduce CO_2 emissions from the use of fossil fuels are often discussed in terms of the 'capture rate' they achieve, which generally refers to the amount of CO_2 they capture as a percentage of what they were intended to capture. However, this term is not strictly defined legally, with many different interpretations provided by projects in the industry as shown in Table 1.[5] This creates issues with regards to setting a capture rate for the production of low carbon gases and fuels.

Table 1: The different ways in which the term 'capture rate' is used[5]

Definition	Comments	Example
The percentage of CO_2 the capture equipment separates from the exhaust gas it receives.	Sometimes known as capture efficiency, this measures how well the capture equipment works when it's operating, but doesn't account for periods when the equipment is offline. CCS projects often report a target for this value, which is typically 80-95%.	The Boundary Dam CCS project separates on average around 90% of the CO_2 from the gas it treats.
The percentage of CO_2 the capture equipment separates as a proportion of all CO_2 produced by the targeted exhaust stream.	This accounts for any periods when CO_2 is emitted due to capture equipment being offline. It is the best way to assess the performance of the capture project.[37]	The Boundary Dam CCS project is often not able to process all the exhaust gas it was designed for, and has also been offline more than expected for maintenance and upgrades.
The percentage of CO_2 the capture equipment separates as a proportion of all CO_2 produced by the target source.	This penalises capture projects that were not designed to deal with all the gases produced by a single polluting source. This can be due to diverse factors including available funding or technical challenges. It should not be used to assess project performance, but may provide important context for how easily a given application of CCS could be used to approach zero emissions.	The Brevik CCS project in Norway is designed to process 50% of the exhaust gases from a cement kiln. This is determined by the waste heat energy available from the cement plant. Treating all the gas is technically possible, but would require additional energy costs.
The percentage of CO_2 the facility captures as a proportion of all CO_2 produced by the industrial site.	This penalises capture projects located in larger industrial sites with several sources of emissions. This is not usually informative, as the other sources would typically require separate capture equipment.	The Illinois Industrial CCS project is designed to take all the CO_2 from the fermentation of corn sugars to ethanol at ADM's Decatur plant. However, the whole industrial site produces several million tonnes of other CO_2 emissions, largely associated with fossil fuel combustion for heat and power.

[4] See for example: Bauer et. Al (2022) 'On the climate impacts of blue hydrogen production', *Sustainable Energy Fuels* 6, p. 66-75. Available at: https://pubs.rsc.org/en/content/articlelanding/2022/se/d1se01508g ; IEAGHG (2022) 'Blue Hydrogen: Beyond the Plant Gate'. Available at: https://ieaghg.org/news/new-ieaghg-technical-report-2022-06-blue-hydrogen-beyond-the-plant-gate/

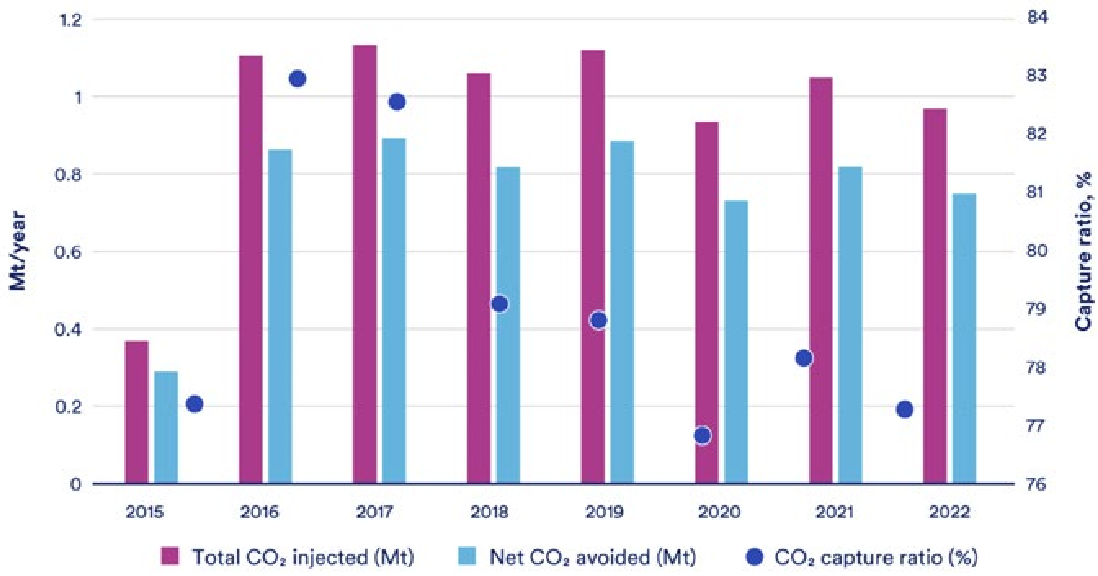
[5] Clean Air Task Force (2024) 'Carbon capture and storage: What can we learn from the project track record?', p.16. Available at: https://www.catf.us/resource/carbon-capture-storage-what-can-learn-from-project-track-record/

Globally, several hydrogen and fuel production plants employ the use of CO_2 capture and storage as a means to reduce emissions from the production thereof. Three case studies have shown the successful use of CCS to reduce some CO_2 emissions from these plants, namely:

1) Quest (Canada)

Quest produces hydrogen from SMR production where the hydrogen is used for the refining of oil from Alberta's oil sands. The capture project is designed to capture 80% of the CO_2 in the syngas produced by the three reformers with a target of 1 million tonnes per year, based on the assumption they will run for 90% of the year.

The project started capturing and storing CO_2 in August 2015 and has consistently captured and stored close to the 80% of emissions targeted, with an average capture rate of 79% over the period 2015-2021 for which data is publicly available.[6]



Importantly, Quest was driven by the favourable funding environment created by the Alberta government and Shell's strategic interest in developing CCS, as well as a specific interest in improving the greenhouse gas emissions of oil sand production, which is significantly worse than conventional production.[7]

2) Port Arthur, United States

The Port Arthur CCS project, led by Air Products, began the capture of at least 90% of the CO_2 from two SMR units at Valero's oil refinery. However, data on the performance of the plant is not publicly available.

[6] Alberta Department of Energy (various dates) Quest annual summary reports. Available at: https://open.alberta.ca/publications

[7] Clean Air Task Force (2024) 'Carbon capture and storage: What can we learn from the project track record?', p.16. Available at: https://www.catf.us/resource/carbon-capture-storage-what-can-learn-from-project-track-record/ p.18.

Notably, the project received funding from the U.S. Department of Energy (DOE) for industrial carbon capture and storage (under the American Recovery and Resilience Act). During the three-year demonstration period required by the U.S. DOE, the project met its performance requirements.[8]

3) Alberta Carbon Trunkline

The Alberta Carbon Trunkline connects two projects where low carbon fuels are produced from both a fertiliser plant (Nutrien Redwater) and a refinery (NWR Sturgeon) in Alberta, Canada.

Despite initial difficulties caused by the production process itself, over the first two full years of operation, the CO_2 capture equipment at the refinery has been available 97% of the time, while the CO_2 dehydration and compressor used at the fertiliser plant recorded over 99% availability, according to publicly available data.[9]

Lessons from the production of low-carbon fuels with CCS

- Carbon capture and storage can abate significant amount of CO_2 emissions from the production of hydrogen with fossil energy.

- The production of hydrogen and capture, transport and storage of CO_2 at commercial scale uses proven technologies and can be done so safely and efficiently.

- "Capture rate" is not a term legally defined and has various interpretations. A legal limit on total CO_2 emissions from the production of hydrogen from fossil fuels is preferable.

- Sufficient policies and regulations are needed to ensure the maximum climate benefits provided by CCS in abating emissions from hydrogen production.

- A comprehensive regulatory framework must be put in place to ensure the safe permitting, operation, closure and post-closure monitoring of geological storage sites.

[8] Air Products and Chemicals, 'Demonstration of Carbon Capture and Sequestration of steam methane reforming process gas used for large-scale hydrogen production, Final report to the Department of Energy' (2018) Available at: https://www.osti.gov/servlets/purl/1437618

[9] Alberta Carbon Registries (2024) Enhance Energy CO2-EOR project at Clive Field. Available at: https://alberta.csaregistries.ca/GHGR_Listing/AEOR_ListingDetail.aspx?ProjectId=157