European Commission

JRC TECHNICAL REPORT

Harmonised system-wide cost-benefit analysis for candidate carbon-dioxide transport networks and storage projects

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[DRAFT FOR PUBLIC CONSULTATION]

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Abstract

This report presents the developed Cost-Benefit Analysis (CBA) methodology for candidate CO_2 transport and storage projects, in compliance with the requirements set in the Regulation (EU) 2022/869. The methodology shall be used for candidate CO_2 transport and storage project appraisals undertaken by project promoters and provides for a societal CBA with the use of monetised, quantified and qualitative indicators.

1 Introduction and scope

This CBA methodology for candidate CO_2 transport and storage projects (in the following, "CO_2 transport and storage CBA methodology") has been developed by the JRC, the European Commission (the "Commission") science and knowledge service, in compliance with the requirements set in Article 11(8) of Regulation (EU) 2022/869 (in the following, "TEN-E Regulation")[1] [1]. The CO_2 transport and storage CBA methodology has been developed to ensure a harmonised system-wide CBA at Union level and it is compatible in terms of benefits and costs with the methodologies developed by the ENTSO for Electricity and the ENTSO for Gas pursuant to Article 11(1) of TEN-E Regulation.

This CO_2 transport and storage CBA methodology has been developed in a transparent manner, including extensive consultation of Member States and all relevant stakeholders.

1.1 The TEN-E Regulation

The Trans-European Networks for Energy (TEN-E) is a policy instrument focused on developing and linking the energy infrastructure of European Union (EU) countries. A well-planned and integrated energy infrastructure is essential to achieve such objectives: energy infrastructure is the part of the system that enables renewable energy to be incorporated into the grid, and then transmits and distributes energy across the EU from the supply source (whether imported or generated within the EU) to the end user, or stores energy until it is needed. Energy infrastructure provides for a reliable and secure energy system that helps to keep energy prices in check[3].

The revised TEN-E Regulation, entered into force in June 2022, lays down guidelines for the timely development and interoperability of the priority corridors and areas of trans-European energy infrastructure contributing at mitigating climate change by supporting the achievement of the EU climate and energy 2030 targets and the EU climate neutrality objective by 2050 at the latest:, and to ensuring interconnections, energy security, market and system integration and competition that benefits all Member States, as well as affordability of energy prices. More specifically, the TEN-E Regulation:

- provides for the identification of projects on the Union list of projects of common interest (PCIs) and of projects of mutual interests (PMIs);
- facilitates the timely implementation of the Union list by streamlining, coordinating more closely and accelerating permit granting processes, and by enhancing transparency and public participation;
- provides rules for the cross-border allocation of costs and risk-related incentives for projects on the Union list.

A project of common interest needs to meet general criteria and is assessed against specific criteria as set out in the TEN-E Regulation.

1.2 General criteria for candidate CO2 transport and storage projects

Candidate CO_2 transport and storage projects need to demonstrate that:

- the project is necessary for the priority thematic area "cross-border carbon dioxide network" set out in point 13 in Annex I to TEN-E Regulation, as described in Article 4(1)(a) of TEN-E Regulation;
- the potential overall benefits of the candidate project, assessed in accordance with the relevant specific criteria, outweigh its costs, including in the longer term, in line with the provisions set in Article 4(1)(b) of TEN-E Regulation

[1] PE/2/2022/REV/1

Pursuant to Article 4(1)(c) of TEN-E Regulation, a candidate PCI project shall either:

i. involve at least two Member States by directly or indirectly, via interconnection with a third country, crossing the border of two or more Member States or

ii. be located in the territory of one Member States, either inland or offshore, including islands, and has a significant cross-border impact as set out in point (1)(i) of Annex IV to TEN-E Regulation: "*the project is used to transport and, where applicable, store anthropogenic carbon dioxide originating from at least two Member States*".

In line with point (2)(c) of Annex IV to TEN-E Regulation, a project of mutual interest (PMI) in the thematic area of CO2 transport and storage is used to transport and, where applicable, store anthropogenic CO2 originating from at least two Member States and a third country. A candidate PMI shall fulfil the criteria under Article 4.2 of the TEN-E.

In its assessment of applications received, the Regional Group shall check the compliance with respect to the rules in terms of energy infrastructure categories set for CO_2 transport and storage facilities in Annex II(5) to TEN-E Regulation. In particular, project promoters must ensure that their applications are compliant with the following rules:

i. dedicated pipelines, other than upstream pipeline network, used to transport CO_2 from more than one source, for the purpose of permanent geological storage of CO_2 pursuant to Directive 2009/31/EC;

ii. fixed facilities for liquefaction, buffer storage and converters of CO_2 in view of its further transportation through pipelines and in dedicated modes of transport such as ship, barge, truck, and train;

iii. without prejudice to any prohibition of geological storage of CO_2 in a Member States, surface and injection facilities associated with infrastructure within a geological formation that is used, in accordance with Directive 2009/31/EC, for the permanent geological storage ofCO_2, where they do not involve the use of CO_2 for the enhanced recovery of hydrocarbons and are necessary to allow the cross-border transport and storage of CO_2;

iv. any equipment or installation essential for the system in question to operate properly, securely and efficiently, including protection, monitoring and control systems.

1.3 Specific criteria for candidate CO2 transport and storage projects

Pursuant article 4(3)(c) of the TEN-E Regulation, the project promoter shall clearly show how the candidate project contributes significantly to sustainability through the reduction of carbon dioxide emissions in the connected industrial installations and contributes to all of the following specific criteria:

(i) avoiding carbon dioxide emissions while maintaining security of supply;

(ii) increasing the resilience and security of transport and storage of carbon dioxide;

(iii) the efficient use of resources, by enabling the connection of multiple carbon dioxide sources and storage sites via common infrastructure and minimising environmental burden and risks;

2 General approach

The aim of the current CBA methodology is to deliver a general guideline on how to assess CO_2 transport and storage projects from a cost and benefit point of view. In compliance with the provisions about specific criteria set in Article 4(3)(c) of TEN-E Regulation, this CBA methodology is taking into consideration the avoidance of carbon dioxide emissions, the resilience and security of the infrastructure and the efficient use of resources while minimising environmental risks, for developing a systematic method for quantifying the total expected benefits of the CO_2 transport and storage candidate project. Following this process, the potential overall benefits are compared to the projected or estimated costs of the candidate project, as the main purpose of this CBA is to determine whether the total benefits outweigh the total costs.

In line with the provisions set in Article 11 of TEN-E Regulation and similarly to the methodological approach used for candidate electricity transmission projects [2] and gas infrastructure projects [3], the assessment of candidate CO_2 transport and storage projects shall take into consideration pertinent assumptions concerning future scenarios, the definition of the reference network used to assess the impact of the project; and the techniques to be used in calculating costs and benefits for the candidate CO2 transport and storage project.

Scenarios are a description of contrasted yet plausible futures that can be characterised by a combination of demand and supply assumptions. With reference to the assessment of candidate CO2 transport and storage projects, such scenarios shall consider possible development for the European energy system and its carbon emissions. These different future developments can be used as input parameter sets for subsequent simulations and analyses to assess the cost and the benefit of candidate CO2 transport and storage project.

This methodology is based on the multi-criteria approach, which allows to consider and combine monetised, quantified and qualitative benefits. This approach is also consistent with the ENTSOs methodologies.

2.1 Assumptions

A list of common parameters and assumptions requires consistency across the methodologies. Assumptions should be aligned with the latest TYNDP scenarios:

- duration of the study horizon. As a general assumption, the study horizon should be the minimum between a) the longest technical lifetime of any equipment and b) the maximum reference period for energy projects as referred to in Article 15(2) and Annex I to Commission Delegated Regulation (EU) 480/2014 [4]. The duration of the study horizon shall not be in any case higher than the study horizon of the harmonised energy system-wide CBA methodology for projects on the Union list falling under the energy infrastructure categories set out in point (1)(a), (b), (d) and (f) and point (3) of Annex II to TEN-E Regulation;
- EU Emissions Trading System (EU ETS) carbon price for each year within the study horizon.
- shadow cost of carbon for each year within the study horizon. As a general assumption, values for the shadow cost of carbon within the study horizon should be aligned, where applicable, to shadow cost of carbon values in Tables 5 and 6 of Commission Notice 2021/C 373/01 [5];
- discount rate. As a general assumption, a 4% discount rate should be assumed, in agreement with the current value assumed for other energy infrastructure categories under Annex II;
- emission and, when possible, monetization factors for indirect non-GHG emissions: for each Member State and for each year within the duration of the study horizon;

3 Project CBA for candidate projects

The assessment of candidate CO_2 transport and storage projects shall be carried out taking the societal perspective , in line with the provisions set in Article 4(1) of TEN-E Regulation, their potential overall benefits, assessed in accordance with the relevant specific criteria, shall outweigh their costs.

Performances of a candidate CO_2 transport and storage project must be assessed taking into consideration two configuration:

- "with" case, where the candidate project is realised and inserted in the system, and generates during its lifetime benefits that are larger than total costs; and
- "without" case, where the candidate project is not realised.

The calculation of the difference of indicators between the "with" and the "without" cases allow to calculate benefits. For instance, the amount of CO_2 transported and stored by a candidate project is equal to the difference in production in the "with" case (i.e. the CO_2 pipeline is built) and the "without case" (i.e. the CO_2 pipeline is not built so there is no production). In some cases, the calculation of benefits does not need a complex modelling exercise representing the whole system; in other cases however system modelling activities are required in case of indicators capturing system properties. In some cases, simplifications might be introduced to reduce the modelling complexity (for instance, analysis in specific snapshots extended through duration curves to the whole year of operation), although there is a trade-off between modelling tractability[2] and accuracy of the analysis.

Benefits are calculated for one year of operation, although the technical lifetime of a candidate project is higher. Consequently, to fully capture the net benefits created by the candidate project in time, this CO_2 transport and storage CBA methodology requires the use of the discounted cash-flow method: in particular, annual cash flows considering costs and benefits for the system in nominal terms will be discounted using the discount rate.

3.1 Benefits

While the calculation of each benefit should aim for a monetary value, the lack of data and models may impede in the initial stage the full monetization of some benefits, although such monetization may be feasible in future assessments. In such cases the quantitative/qualitative assessment of the benefits are to be considered.

In general, the indicators can be:

- **Monetised:** they are expressed in monetary terms.
- **(Non-monetised) quantified:** they are quantified but not expressed in monetary terms
- **Qualitative:** they are expressed in qualitative terms (for instance, "++", "+", "0", etc.).

For the sake of simplicity, the monetised, quantified and qualitative indicators are denoted in the following sections of this report by the starting letter "B". In Table 1 we present the indicators and their relevant criterion.

Table 1. Summary of benefits considered in the transport & storage CBA methodology

Benefit [unit]	**Specific criterion – Article TEN-E**
B1 – Variation of GHG emissions [tonnes/a, €/a]	Sustainability – Article 4(3)(c)(i)
B2 – Increase the resilience and the security of the infrastructure	Resilience and security of transport and storage - Article 4(3)(c)(ii)
B3 – Multiple CO_2 sources and storage sites via common infrastructure	Efficient use of resources - Article 4(3)(c)(iii)
B4 – Reduction of the environmental burden and risks	Mitigation of environmental burden and risks – Article 4(3)(c)(iii)

Source: Own elaboration.

The following subsections describe how benefit indicators must be calculated in line with the specific criteria set in Article 4(3) of TEN-E Regulation. . All the indicators should be calculated in the way to avoid double counting benefits.

3.1.1 B1 – Variation of GHG emissions [tonnes/a, €/a]

It is the monetisation of the net avoidance of CO_2 emissions. It does not only comprise CO_2 but in general the CO_2 equivalent the reduction of all the GHG emission that are obtained thanks to the realisation of the project. Hence, this type of benefit pertains to the sustainability domain as it directly focuses on the climate impacts of the infrastructure. It does not simply refer to the throughput of the infrastructure, as transported for permanent

[2] Model tractability refers to the increased model granularity (e.g. from hours to quarter) which raises the computational time and the requirements

neutralisation, but it takes into account of the entire lifecycle emissions of the projects. It represents the net reduction (deducting GHG emissions that are caused by the project itself).

Moreover, only CO2 from industrial installations are considered (TEN-E, Article.4.(3).(c)), in absence of alternative technological solutions (TEN-E, Annex IV.8.a).

The benefit is calculated as the variation between GHG emissions under the project scenario that implies the capture, transport and injection, and the alternative status quo, that is the reference scenario where sources of emission release in the atmosphere.

The avoided GHG emissions aggregated over the entire lifetime of the project can be calculated according to the following [10][3]:

GHG emission reduction = Reference scenario emissions – Project scenario emissions
$$\Delta GHG_{abs} = \sum_{y=1}^{n} Ref_{release,y} - \sum_{y=1}^{n} (Proj_{pipeline,y} + Proj_{injection,y})$$

Where:

- ΔGHG_{abs} = absolute GHG emissions avoided by the project, in tonnes of equivalent CO_2 emissions over the lifecycle of the infrastructure
- $Ref_{release,y}$ = Amount of CO_2 transferred to the capture installation in year y, in tonnes of equivalent CO_2 emissions, determined in accordance with Commission Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012, especially Articles 40 to 46 and Article 49 and Annex IV, Section 21.
- $Proj_{pipeline,y}$ = GHG emissions from transport of CO_2 by pipelines for the purpose of geological storage in a storage site permitted under Directive 2009/31/EC in year y, in tonnes CO_2e. This includes emissions from combustion and other processes at installations functionally connected to the transport network including booster stations; fugitive emissions from the transport network; vented emissions from the transport network; and emissions from leakage incidents in the transport network. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 22.
- $Proj_{injection,y}$ = GHG emissions from geological storage of CO_2 in a storage site permitted under Directive 2009/31/EC in year y, in tonnes CO_2e. This includes emissions from fuel use by associated booster stations and other combustion activities including on-site power plants; venting from injection but does not include enhanced hydrocarbon recovery operations; fugitive emissions from injection; breakthrough CO_2 from enhanced hydrocarbon recovery operations; and leakages. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 23.
- y = year of operation
- n = 10^{th} year following the start of operation

The corresponding year specific value (optional) can be calculated from the previous formula, as:

GHG emission reduction in year y= Reference scenario emissions in y – Project scenario emissions in y
$$\Delta GHG_{abs,y} = Ref_{release,y} - (Proj_{pipeline,y} + Proj_{injection,y})$$

The economic present value of the indicator B1 is calculated within the CBA horizon using the discounted cash-flow approach. Hence, an annual value of GHG emission avoided is multiplied by the year specific the Shadow Cost of Carbon ($ShCostCO_2$). The value to be applied as monetary amount representing the benefit of avoided GHG emissions:

$$B1_y = \Delta GHG_y \times ShCostCO_2$$

[3] https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/innovfund/wp-call/2021/call-annex_c_innovfund-lsc-2021_en.pdf

The economic present value of the indicator is calculated within the CBA horizon using the discounted cash-flow approach.

3.1.2 B2 – Increase resilience and security of the infrastructure

A critical infrastructure is defined as an asset or a whole system whose continuous operation is deemed essential for the security of public society. Any damage, destruction or disruption occurring to EU critical infrastructure by extreme climate events, natural disasters, terrorism, criminal activity or malicious behaviour, may have a significant negative impact for the security of the EU and the well-being of its citizens. Challenges for critical infrastructures are also arising from the increased digitalisation of systems and networks: this trend makes such systems smarter and more efficient but, on the other hand, it introduces significant risks as an increased exposure to cyberattacks and cybersecurity incidents potentially jeopardises the security of the critical infrastructure.

In this respect, the cross-border CO_2 network has the attributes to qualify as a critical infrastructure: it is a key system to allow the EU to reach its 2050 climate neutrality objective by significantly capture and store in permanent geological storage carbon emissions that cannot be reduced with other reasonable alternatives. At the same time, the cross-border CO2 network introduces the possibility to utilise CO_2 for synthetic fuel gases, with an important impact of energy security of supply.

A full quantitative assessment of the impact that a candidate CO_2 transport and storage project has on resilience and security of the cross-border CO_2 network would need an extensive modelling exercise, able to represent the ability of a candidate project to withstand and recover from extreme climate events, natural disasters, terrorism, criminal activity or malicious behaviour, cyberattacks and cybersecurity incidents.

Taking this into consideration, project promoters shall demonstrate that their candidate CO_2 transport and storage projects are contributing at increasing the resilience and the security of the cross-border CO_2 network. In this respect, the impact of the candidate project shall be evaluated with the following metrics:

- if the candidate project does not change (or changes marginally) the level of resilience and security of the cross-border CO_2 network, it should receive the score "0";
- if the candidate project brings to moderate improvements of the level of resilience and security of the cross-border CO_2 network, it should receive the score "+"; and
- if the candidate project leads to significant improvements of level of resilience and security of the cross-border CO_2 network, it should receive the score "++".

Project promoters shall duly justify, provide references and describe in their applications how significant and impactful are their candidate projects in increasing the level of resilience and security.

3.1.3 B3 – Multiple CO2 sources and storage sites via common infrastructure

This criterion specifically refers to the future potential to connect multiple CO_2 sources and storage sites via the proposed infrastructure. It has both a qualitative and quantitative dimension.

Qualitatively, the project promoter should provide arguments concerning system benefits of CO_2 pipelines to unlock demand for CCS, i.e. multiple potential routes to storage for emission intensive industries and Member States which might not have (permissible) domestic storage capacities. The project promoter could delineate future scenarios in which additional demand for CO_2 transport infrastructure from existing or anticipated developments in adjacent industries or sectors has grown and outline conditions for these industries or sectors to use the relevant transport infrastructure.

Quantitatively, the project promoter should be able to demonstrate the expansion potential of the project and how it is capable of contributing to the generation of a wider network for CO_2 in the region. The demonstration of this benefit can focus on three dimensions which can potentially contribute to the future potential of multiple connections.

- Future connections potential: the project promoter can provide evidence of existing or planned additional CO_2 sources (emitters) within a reasonable distance radius which are not part of the project. This can be done by demonstrating that the proposed CO_2 transport infrastructure is located near potential high emitters (e.g. existing or planned emission-intensive industrial applications, or within an existing or planned industrial cluster).

- Future transport capacity potential: the project promoter can provide evidence that the proposed transport infrastructure (pipeline, ship) has the capacity to transport more CO_2 from additional sources. The evidence should include a calculation concerning the possible price-savings for future CCS projects due to the over-sizing of the infrastructure project at hand.
- Future storage potential: the project promoter can provide evidence of network expansion potential by demonstrating that there is planned additional CO_2 storage capacity in the vicinity of the originally envisaged storage site using figures, maps or reports regarding other possible CO_2 sinks in the area. Estimates regarding the potential additional storage capacity and the distance to the original storage site should be provided

In summary, project promoters should at a minimum show that their project is not only a point-to-point project and how it contributes to the enablement of a network. They should provide a qualitative (geographical) study / assessment concerning the potential for future connections (e.g. list of emitters/storage opportunities in the area etc.) and, if possible, a business case-type argument. Any initiatives or existing and anticipated industrial activity in the vicinity of the project should be noted in this assessment.

Another aspect of this criterion is the possibility of extension of the asset's economic or regulatory lifetime. This can be examined under two situations:

- The current regulatory, political and / or economic situation is such that, without CCS, the asset will not be profitable and / or required to close down before reaching the end of its physical lifetime.
- The current situation does not warrant the closure of the asset before reaching the end of its physical lifetime. Yet, there are reasonable grounds to expect that the regulatory, political and/or economic circumstances will change within the asset's lifetime and CCS will become important to the asset's continued existence.

In the first situation, the benefit arising from the CCS project can be quantified and monetised. In the case of an energy asset, the applicant needs to provide evidence that, without the CCS project:

- the plant will not be profitable due to the (expected) CO_2 price at a certain time t, resulting in closing down the plant before the asset's physical lifetime is reached, resulting hence in a loss of its book value;
- the plant will be closed down before reaching its physical lifetime at a certain time t in the future due to CO_2 emission regulation, which will lead to a loss of its book value.

The application of CCS will hence result in the extension of the economic or regulatory lifetime of existing energy or industry assets. In accordance with the guidelines on the project-specific benefits, the present value of future cash flows related to the extended lifetime of the facility need to be computed.

A prospective CO_2 storage site can also be considered an asset under this benefit: it may be the case that it would be preferable to proceed to the use of the storage site now rather than in the future for a number of reasons, including the avoidance of depreciation of ancillary infrastructure associated with the storage site (e.g. platforms with respect to explored gas fields).

It is acknowledged that the economic and regulatory life of assets is determined by multiple factors, often beyond the control of the project promoter. Political discussions regarding the phase-out of coal-fired power plants are an example for regulatory interventions changing the expected life of a generation asset. Similarly, the economic lifetime of other (industrial) assets is conditioned on many factors, such as the relative profitability of investments in other assets within or outside the EU for instance. Hence, in the second situation when the duration of a given asset's lifetime is not directly threatened by political, regulatory or economic factors at the time of application, the deployment of CCS can nevertheless provide an additional rationale for the continued existence of the asset in the future, especially in the face of evolving regulatory or economic conditions.

3.1.4 B4 – Mitigation of environmental burden and risks

The permanent neutralisation via storage of CO_2 in geological formations is an option to mitigate industrial emissions and, eventually, to remove carbon from the atmosphere when the CO_2 is captured directly from the atmosphere (Direct Air Carbon Capture and Storage, DACCS) or from the combustion or fermentation of biogenic carbon (BECCS). The development of this type of carbon removal should however be sustainable and prevent negative impacts on biodiversity and ecosystems, particularly arising from CO_2 leakage.

Directive 2009/31/EC ("CCS Directive")[4] provides the legal basis for the selection by Member States of geological storage sites: in particular, it describes that a site should be selected as a CO_2 storage site only if there is no significant risk of leakage, and if in any case no significant environmental or health impacts are likely to occur.

In this respect, a candidate CO_2 transport and storage project can contribute at mitigating such environmental burden and risks, for instance by implementing design and/or planning corrective solutions aimed at reducing the probability of occurrence and/or the magnitude of a damage such as CO_2 leakage, loss of biodiversity and impairment of ecosystems.

Taking this into consideration, project promoters shall demonstrate that their candidate CO_2 transport and storage projects are contributing at mitigating environmental burden and risk via permanent neutralisation of CO_2. In this respect, the impact of the candidate project shall be evaluated with the following metrics:

- if the candidate project does not reduce (or reduces marginally) environmental burden and risks related to CO_2 leakage, biodiversity and ecosystems, it should receive the score "0";
- if the candidate project slightly reduces environmental burden and risks related to CO_2 leakage, biodiversity and ecosystems, it should receive the score "+"; and
- if the candidate project leads to significant reduction of the environmental burden and risks related to CO_2 leakage, biodiversity and ecosystems, it should receive the score "++".

Project promoters shall duly justify, provide references and describe in their applications how significant and impactful are their candidate projects in terms of environmental burden and risks.

Regarding PMI candidate projects for the storage of CO_2, only projects necessary to allow the cross-border transport and storage of CO_2 should be eligible, provided that the third country where the project is located shall have an adequate legal framework based on demonstrated effective mechanisms to ensure standards and safeguards preventing any leaks and concerning climate, human health and ecosystems as regards the safety and effectiveness of the permanent storage of CO_2 are at least at the same level as those provided by the Union law. It should be presumed that the European Economic Area meets those standards and safeguards.

3.2 Costs

The project promoter shall provide CAPEX and OPEX for each year analysed in the CBA horizon, assumptions on authorisation, construction time and decommissioning (if relevant). Information shall be provided in a format allowing the Commission to check and verify the impact of the assumptions and the relevant calculations (e.g., Excel spreadsheet).

3.3 Project value calculation

The Net Present Value (NPV) represents the difference between the present value of all monetised benefits and the present value of all costs, discounted using the discount rate. Another indicator to be calculated is the benefit-cost ratio (BCR), which is the ratio between the present value of all monetised benefits divided by the present value of all costs[5].

3.4 Transparency and confidentiality

In submitting their CBA application, project promoters for candidate energy projects must provide all the necessary information with the appropriate level of transparency, also taking into consideration the provisions of the TEN-E Regulation, to allow the Commission to be able to rebuild the NPV and BCR calculations. Confidentiality of sensitive information is ensured in line with the provisions of TEN-E Regulation.

[4] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 (europa.eu)

[5] More detailed information on the project value calculation can be found in the latest CBA methodology developed by the ENTSOs.

References

[1] *Regulation (EU) 2022/869 of the European Parliament and of the Council of 30 May 2022 on guidelines for trans-European energy infrastructure, amending Regulations (EC) No 715/2009, (EU) 2019/942 and (EU) 2019/943 and Directives 2009/73/EC and (EU) 2019/94.*

[2] ENTSO-E, *3rd ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects – Draft version –,* 2020.

[3] ENTSOG, *2nd ENTSOG Methodology for Cost-Benefit Analysis of Gas Infrastructure Projects,* 2018.

[4] *Commission Delegated Regulation (EU) No 480/2014 of 3 March 2014 supplementing Regulation (EU) No 1303/2013 of the European Parliament and of the Council laying down common provisions on the European Regional Development Fund, the European Social Fund, th.*

[5] *COMMISSION NOTICE - Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (2021/C 373/01) .*

[6] EC, *Innovation Fund (InnovFund) Annex C: Call for proposals Methodology for GHG Emission Avoidance Calculation,* Innovation Fund Large-scale Projects InnovFund-LSC-2021, 2022.

List of abbreviations and definitions

ACER	European Union Agency for the Cooperation of Energy Regulators
CBA	Cost-benefit analysis
CCS	Carbon Capture and Storage
CCU	Carbon Capture with Utilization
DICE	Dynamic Integrated Climate-Economy
EC	European Commission
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
FUND	Framework for Uncertainty, Negotiation and Distribution
GHG	Green House Gas
EHR	Enhanced Hydrocarbon Recovery
EOR	Enhanced Oil Recovery
H&DG	Hydrogen and Decarbonised Gas Package
IAM	Integrated Assessment Models
IPCC	Intergovernmental Panel on Climate Change
JRC	Joint Research Centre
PAGE	Policy Analysis of the Greenhouse Effect
PCI	Projects of common interest
RES	Renewable Energy Sources
SCC	Social Cost of Carbon
TEN-E	Trans-European Networks for Energy

List of Tables

Table 1. Summary of benefits considered in the transport & storage CBA methodology 4

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.