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Harmonised system-wide cost-benefit analysis for candidate smart gas grid projects

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Abstract

This report presents the Cost-Benefit Analysis (CBA) methodology for candidate smart gas grids projects, developed in compliance with the requirements set in Regulation (EU) 2022/869.

1 Introduction and scope

Cost–benefit analysis (CBA) is a systematic evaluation tool aimed at determining whether an action/decision/investment is socio-economically desirable namely, if its prospective or potential system benefits (referred in the following as "benefits") outweigh its costs, with the aim of comparing different actions/decisions/investments. A CBA methodology must describe the common principles for undertaking a CBA as well as clarifying the different steps a user must carry out to perform the exercise.

This CBA methodology for candidate smart gas grid projects (in the following, "SGG CBA methodology") has been developed by the European Commission (the "Commission") in compliance with the requirements set in Article 11(8) of the revised Regulation (EU) 2022/869 (in the following, "TEN-E Regulation") [1].

The revised TEN-E Regulation, entered into force on 23 June 2022, lays down principles for the timely development and interoperability of the priority corridors and areas of trans-European energy infrastructure contributing at achieving EU climate and energy targets. An element of innovation of the revised TEN-E Regulation is represented by the inclusion, for the first time in the EU legal framework, of the concept of smart gas grid (paragraph (10) in Article 2), which is defined as "*a gas network that makes use of innovative and digital solutions to integrate in a cost-efficient manner a plurality of low-carbon and particularly renewable gas sources in accordance with consumers' needs and gas quality requirements in order to reduce the carbon footprint of the related gas consumption, enable an increased share of renewable and low-carbon gases, and create links with other energy carriers and sectors, including the related physical upgrades if they are indispensable to the functioning of the equipment and installations for integration of low-carbon and particularly renewable gases*".

The SGG CBA methodology has been developed to ensure a harmonised energy system-wide cost-benefit analysis 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[1].

This SGG CBA methodology has been developed in a transparent manner, including extensive consultation of Member States and all relevant stakeholders, in compliance with Article 11(8) of TEN-E Regulation.

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[2]. 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.

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; and
- provides rules for the cross-border allocation of costs and risk-related incentives for projects on the Union list.

([1]) At the time of writing, the following methodologies developed by the ENTSOs are under public consultation:
- 4th ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects: draft version 4.0 for public consultation (20 December 2022); and
- ENTSOG Single-Sector Cost-Benefit Analysis (CBA) Methodology – Preliminary draft (28 February 2023).

1.2 General criteria for candidate smart gas grid projects

Project promoters of candidate SGG projects must ensure compliance with respect to the general criteria foreseen in Article 4(1) of TEN-E Regulation. In particular, the application for candidate projects shall clearly show that:

- the project is necessary for the priority thematic area "smart gas grids" set out in point 4 in Annex I to TEN-E Regulation, as described in Article 4(1)(a) of TEN-E Regulation; and
- 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. In particular, to verify compliance with this criterion, the application must include the calculation of the *Economic Net Present Value* (ENPV) of the candidate project along the duration of the study horizon (see section 2.1).

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

1. 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
2. be located in the territory of one Member State, either inland or offshore, including islands, and has a significant cross-border impact as set out in point (1)(g) of Annex IV to TEN-E Regulation: "*a project involves TSOs, TSOs and* [sic] *DOS or DSOs from at least two Member States. DSOs may be involved, but only with the support of the TSOs of at least two Member States that are closely associated to the project and ensure interoperability*".

According to the aforementioned options, the application shall clearly describe the level of involvement of gas TSOs and/or DSOs from at least two different Member States or the level of support TSOs in case of projects involving only DSOs.

In order to allow the Commission to verify the compliance with general criteria, project promoters shall provide all the necessary underlying information and details, in line with the provision set in the project submission template for candidate SGG projects.

1.3 Specific criteria for candidate smart gas grid projects

The contribution of the candidate projects to the specific criteria foreseen in Article 4(3) of TEN-E Regulation needs to be demonstrated.

Pursuant to Article 4(3)(f) of TEN-E Regulation, the application shall clearly show how the candidate project contributes significantly to sustainability: in particular, project promoters shall clearly describe how their candidate projects ensure the integration of a plurality of low-carbon and particularly renewable gases, including where they are locally sourced, such as biomethane or renewable hydrogen, into the gas transmission, distribution or storage systems in order to reduce greenhouse gases emissions.

In addition, Article 4(3)(f) TEN-E Regulation, in conjunction with point (6) in Annex IV to TEN-E Regulation, requires that projects contribute to at least one of the following specific criteria:

1. network security, quality and security of supply: project promoters shall clearly describe in their application how their candidate projects improve the efficiency and interoperability of gas transmission, distribution or storage systems in day-to-day network operation by, inter alia, addressing challenges arising from the injection of gases of various qualities;
2. market functioning and customer services: project promoters shall clearly describe in their application how their candidate projects contribute to the improvement of market functioning as well as to what extent customer services are enabled and enhanced;
3. smart energy sector integration: project promoters shall clearly describe in their application how their candidate projects create links to other energy carriers and sectors and how they enable demand response.

2 General approach

In line with the provisions set in Article 11 of TEN-E Regulation and similarly to the methodological approach developed for candidate electricity transmission projects [2] and gas infrastructure projects [3], the assessment of candidate SGG 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 SGG 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 SGG projects, such scenarios shall consider possible development for the electricity, gas and hydrogen systems, energy exchanges within the modelled system (according to the different level of detail, it can encompass the geographical area immediately affected by the project or a wider area) and with the modelled systems. These different future developments can be used as input parameter sets for subsequent simulations and analyses.

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 methodologies developed by the ENTSOs.

The steps for applying the SGG CBA methodology to be carried out by project promoters are described below:

- clear identification of input information for the assessment of the relevant candidate SGG projects, taking into consideration general indications on common scenarios and assumptions, the latest TYNDP scenarios developed by the ENTSOs and other complementary information (see section 2.1);
- description of relevant modelling frameworks[2] used for the evaluation of benefits (see section 3.1) and description of the impact of any simplified assumption on the pertinent calculations;
- calculation of benefits (see section 3.1) within the study horizon in both "with" and "without" cases
- calculation of costs (see section 3.2) within the study horizon; and
- calculation of the Economic Net Present Value and benefit-cost ratio.

2.1 Scenarios, assumptions and sensitivities

A list of common parameters and assumptions ensures consistency across all candidate SGG projects. Some information are provided in the templates for candidate PCI projects; other assumptions and input parameters should be aligned as much as possible with the latest joint TYNDP scenarios. Project promoters can introduce complementary assumptions, in line with the scope of the candidate SGG project: any choice of parameters and assumption from project promoters deviating from values described in joint TYNDP scenarios shall be clearly described and justified.

Below a list of key parameters and assumptions for candidate SGG projects is provided:

— duration of the study horizon. As a general assumption, the duration of 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) No 480/2014[3] [6]. The duration of the study horizon shall not be in any case higher than the study horizon of the harmonised energy system-wide cost-benefit analysis 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. The study horizon shall start the year after the commissioning year.

— natural gas demand: for each Member State and for each year within the study horizon. Simplification related to the geographical scope are allowed, consistently with the geographical scope of the project;

— natural gas price for each Member State and for each year within the study horizon. This assumption should be consistent with the most updated TYNDP scenarios;

(2) While project promoters should choose the most suitable modelling tool for the assessment of the benefits of their candidate SGG projects, it is recommended, when possible and relevant, the use of an open source tool (for instance, PyPSA [4]) to foster transparency.

(3) 25 years.

— 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 the most updated ones[4];

— emission and monetisation factors for non GHG emissions: for each Member State and for each year within the CBA horizon. This assumption should be consistent with the most updated TYNDP scenarios. Examples of reference monetisation values for select pollutants as found in [7] are reported here below:

Table 1. Reference monetisation values for select pollutants

€2015/kg	NOx	NH3	SO2	PM2.5	PM10	VOC
low	24.10	19.70	17.70	56.80	31.80	1.61
middle	34.70	30.50	24.90	79.50	44.60	2.10
high	53.70	48.80	38.70	122.00	69.10	3.15

Source: [7]

— discount rate. As a general assumption, a 4% social discount rate should be assumed, in agreement with the current value assumed for other PCI energy infrastructure categories. The discount rate should in any case be compatible with the same value defined in the harmonised energy system-wide cost-benefit analysis 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; and

— Cost of Disruption of Gas Supply (CODG) for each Member State and for each year within the study horizon.

To increase the validity of CBA results, sensitivity analyses shall be carried out by project promoters to evaluate the impact that the variation of parameters has on the socio-economic desirability of candidate SGG projects. It is important to note that the aim of such sensitivity analyses is not to introduce complete and different scenarios but to understand the resilience of the CBA evaluation with respect to few changes in critical parameters. In order to ensure that sensitivity analyses for candidate SGG projects are carried out at uniform level, project promoter shall align with the approaches followed by the ENTSOs and following the pertinent indications provided in the templates for PCI candidate submission.

The parameters listed below shall be subjected to sensitivity analyses carried out by relevant project promoters for candidate SGG project. The list is not exhaustive and it shall be complemented with relevant information provided in the templates for PCI candidate submission:

— fuel and CO_2 prices;

— climate year: different climatic years result in different temperatures and, consequently, different values demand values;

— natural gas and hydrogen demand, as result of different techno-socio-economic conditions;

— commissioning date of projects: delays in any phase of the realisation of a project might its impact socio-economic desirability. A sensitivity analysis on the commissioning date increases the robustness of the CBA assessment;

— CAPEX and OPEX; and

— discount rate.

(4) In particular Tables 5 and 6 of Commission Notice 2021/C 373/01 [8], in line with the most updated EIB estimates. A review of the current values for shadow cost of carbon is expected in a future EIB Group Climate Bank Roadmap progress report [5].

2.2 Project implementation status

In order to support the process for establishing the regional list of projects pursuant to Annex III to the TEN-E Regulation, project promoters for candidate PCI process shall declare in their applications the level of maturity of the relevant projects, in line with the following stages, consistent with PCI monitoring reports developed by ACER[5]:

— projects "Under consideration";

— projects "Planned but not yet in permitting";

— projects "Permitting"; and

— projects "Under construction"

(5) *PCI monitoring* | www.acer.europa.eu. (2023). https://www.acer.europa.eu/gas/infrastructure/ten-e/pci-monitoring.

3 Project CBA for candidate PCIs

The assessment of candidate PCI SGG project shall be carried out considering the social perspective: candidate projects would be considered sustainable from a social perspective if, 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, outweigh their costs.

Performances of a candidate SGG project must be assessed taking into consideration two configurations, the:

— "with case", where the candidate project is realised, it is inserted in the system and, if socio-economically desirable, realizes during its lifetime system benefits that are larger than total costs; and

— "without case" where the candidate project is not realised.

As said above, the calculation of the difference of indicators between the "with" and the "without" cases allow to calculate benefits. For instance, the amount of renewable gases integrated into the gas network thanks to the candidate SGG project is equal to the difference in consumption in the "with" case (i.e. the SGG is realised) and the "without case" (i.e. the SGG is not realised).

In some cases, the calculation of benefits does not need a complex modelling exercise representing the whole system, while in others extensive modelling activities are required. In some cases, simplifications might be introduced to reduce the modelling complexity, although there is trade-off between modelling complexity and accuracy of the assumption.

Benefits and non-capital costs are calculated for each year of operation of the system, although the technical lifetime of equipment and installation constituting a candidate SGG project could be longer. Consequently, to compare the total benefits generated by the candidate project during the study horizon with the related total costs, this SGG CBA methodology requires the use of the discounted cash-flow method for the calculation of the *Economic New Present Value* (ENPV) of the candidate SGG project: in particular, annual cash flows considering costs and benefits for the system in nominal terms shall be discounted using the discount rate as defined in section 2.1 of this SGG CBA methodology.

3.1 Benefits

While priority should be given to monetized indicators which allow the compliance with the provisions set in Article 4(1)(b) of TEN-E Regulation and the calculation of the ENPV of candidate PCI project, it is observed that not all indicators can be monetized: consequently, the following definitions for indicators are introduced:

— **monetized indicators:** they are expressed in monetary terms;

— **(non monetized) quantified indicators:** they are quantified but not expressed in monetary terms; and

— **qualitative indicators:** they are expressed in qualitative terms (for instance, as percentage values or non-numerical KPIs such as "++", "+", "-", etc.).

Benefits stemming from candidate SGG projects shall be calculated by project promoters with annual granularity within the study horizon, taking into consideration the scenarios and the sensitivities mentioned in section 2.1. If relevant with the scope of the project, project promoters can introduce simplification allowing to assume benefits as constant within specific sub-intervals of the study horizon: in this respect, project promoters shall at least differentiate between:

a. short term (from year 1, starting of the study horizon, up to year 7);
b. mid-term (from year 8 up to year 12)
c. and long term (from year 13 onwards).

Table 2. Summary of benefits considered in the SGG CBA methodology

Benefit [unit]	**Specific criterion - Article TEN-E**
B1- Variation of GHG emissions [€/a]	Sustainability: Article 4(3)(f)
B2- Variation of non-GHG emissions [€/a]	Sustainability: Article 4(3)(f)
B3 – Variation of the share of renewable and low-carbon gases integrated into the gas network [%]	Network security and quality of supply: Article 4(3)(f)(i)
B4 – Detection of methane leakage [%]	Sustainability: Article 4(3)(f)
B5 – Reduction of curtailed gas demand [€/a]	Network security and quality of supply: Article 4(3)(f)(i)
B6 - Increase of socio-economic welfare in the gas system [€/a]	Market functioning and customer services: Article 4(3)(f)(ii)
B7 – Cross sectoral cost savings [€/a]	Smart energy sector integration: Article 4(3)(f)(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.

Member States impacted by the benefits achievable thanks to the candidate SGG project should be identified and disaggregated benefits at Member State level should be provided.

All the benefits should be calculated in the way to avoid double counting. In this respect, project promoters shall clearly describe how this in ensured in the calculation of each benefit.

3.1.1 B1 – Variation of GHG emissions

Benefit Definition:

- Definition: economic valorisation of the variation of greenhouse gases emission achievable thanks to the project.
- Relevance: SGG are key infrastructural projects for integrating and enabling the consumption of low-carbon and renewable gases. In addition, SGG can allow the detection of leakage for gases with GWP potential. Taking this into consideration, a candidate SGG project can reduce greenhouse gases emissions.

Benefit Calculation:

- Modelling needs: an accurate assessment would require a detailed modelling exercise simulating a larger portion of the gas system (both transmission and distribution levels) beyond the project and, if any, of the systems (e.g. electricity and hydrogen) involved in the production and integration of low carbon and renewable gases. The use of methodologies, based on direct calculations and predefined parameters (see "Calculation process"), represents an alternative solution not relying on significant modelling capabilities.
- Data needs: if detailed modelling is introduced, extensive data to simulate a sufficiently large portion of the gas system and, if any, of the systems involved in the production of renewable gases, are needed. In absence of extensive modelling, the benefit can be calculated but using operative data about the estimated amount of equivalent reduced greenhouse gases emissions.
- How the benefit is expressed: first, the benefit is expressed in quantitative terms as tons of equivalent carbon emission savings. Then, the benefit is finally expressed in monetary terms when the tons of CO2 emission savings are multiplied by the shadow cost of carbon defined in the information set accompanying the project submission template.

Link with specific criteria TEN-E Regulation

- Sustainability: Article 4(3)(f) TEN-E Regulation

The whole EU energy policy is based upon the objective of reducing greenhouse gases (GHG) emissions by achieving intermediate targets towards Union's carbon neutrality in 2050. In this respect, infrastructural projects are key in achieving potential GHG emission reductions and in lowering EU carbon footprint. Integrating low-carbon and renewable gases[6] in the system as well as detecting and reducing gas leakage can reduce GHG emissions due to substitution effects enabled by the reduction of the use of natural gas of fossil origin as well as the reduction of emissions of leaking greenhouse gases in the atmosphere.

For what concern the scope of the SGG CBA methodology and in line with the updated version of the Kyoto Protocol[7], the following greenhouse gases are considered:

- carbon dioxide (CO_2);
- methane (CH_4);
- nitrous oxide (N_2O);
- hydrofluorocarbons (HFCs);
- perfluorocarbons (PFCs);
- sulphur hexafluoride (SF_6); and

(6) At the time of writing, the definition of low-carbon and renewable gases in this methodology are to be intended consistent with the Hydrogen and decarbonised gas market package, proposed by the European Commission in December 2021 and currently being negotiated by the co-legislators. After the entry into force of the Hydrogen and decarbonised market package, the official definitions will apply.

(7) https://unfccc.int/process/the-kyoto-protocol/the-doha-amendment

- nitrogen trifluoride (NF_3)

Calculation process

1. Project promoters shall calculate GHG emissions savings achievable thanks to the candidate SGG project, either from increase of low-carbon and renewable gases integrated in the system or from the reduction of gas leakage.
2. Several approaches must be used for the calculation of GHG emission savings, in line with the type of reduction of GHG emission achievable thanks to the candidate SGG project:
    a. if the candidate SGG project achieves GHG emission savings thanks to the integration of renewable gases of non-biological origin, such emission savings must be calculated by project promoters using the delegated regulation for a minimum threshold for GHG savings of recycled carbon fuels and annex[8];
    b. if the candidate SGG project achieves GHG emission savings thanks to the integration of renewable gases of biological origin, such emission savings must be calculated by project promoters in line with the provisions set in Directive (EU) 2018/2001 (RED II)[9], in particular in Article 31;
    c. if the candidate SGG project achieves GHG emission savings thanks to the integration of low-carbon gases, such emission savings must be calculated by project promoters in line with future provisions set in the Hydrogen and Decarbonised Gas Market Package[10]: until such provisions are not in force, project promoters shall use, in line with the Commission technical guidance on climate proofing of infrastructure [8], the most updated version of the EIB Project Carbon Footprint Methodology [9] to quantify GHG emissions; and
    d. in all other cases, emission savings must be calculated by project promoters using the most updated version of the EIB Project Carbon Footprint Methodology [9] to quantify GHG emissions.
3. GHG emission savings achievable thanks to the candidate SGG project are evaluated by comparing two situations:
    - GHG emissions in the "with case", $emission|_{with}$, and
    - GHG emissions in the "without case", $emission|_{without}$
4. The variation of GHG emissions achievable thanks to the candidate project, expressed in CO_2 equivalent emissions, are converted in monetary terms by using the social cost of carbon.

$$B_1 = \sum \left[emission_{CO_2\_equiv}\big|_{without} - emission_{CO_2\_equiv}\big|_{with} \right] \cdot ShCost_{CO_2}$$

5. The economic present value of the variation of GHG emissions achievable thanks to the project is calculated within the study horizon using the discounted cash-flow approach.

Main elements to consider

— carbon footprint of the renewable and\or low carbon gases integrated in the system thanks to the candidate SGG project

— operational data of the candidate SGG project: efficiency, technical constraints, etc.

(8) https://energy.ec.europa.eu/delegated-regulation-minimum-threshold-ghg-savings-recycled-carbon-fuels-and-annex_en

(9) In May 2022 the European Commission presented a proposal for the amendment of the RED II in the context of the REPowerEU Plan.

(10) Under the European Commission's proposal, a methodology for assessing greenhouse gas emissions savings from low-carbon fuels will be set out in delegated legislation by 31 December 2024.

— CO_2 price is an input to the calculation and it might be subject to sensitivity analysis.

3.1.2 B2 - Variation of non-GHG emissions

Benefit Definition:

- Definition: economic valorisation of the variation of non-greenhouse gases emission achievable thanks to the project.
- Relevance: SGG are key infrastructural projects for integrating and enabling the consumption of low-carbon and renewable gases. By reducing the usage of polluting fuels, SGG can reduce the system environmental footprint by reducing non greenhouse gases emissions.

Benefit Calculation:

- Modelling needs: accurate assessment would require a detailed modelling exercise simulating a larger portion of the gas system (both transmission and distribution levels) beyond the project and, if any, of the systems (e.g. electricity and hydrogen) involved in the production and integration of low carbon and renewable gases resulting in the reduction of non-GHG emissions. An alternative solution without significant modelling requirements would be based on project assumptions and relative calculations, using reputable methodologies.
- Data needs: if detailed modelling is introduced, extensive data to simulate a sufficiently large portion of the gas system and, if any, of the systems involved in the production of renewable gases, are needed. In absence of extensive modelling, the benefit can be calculated but using operative data about the estimated amount of equivalent reduced greenhouse gases emissions.
- How the benefit is expressed: first, the benefit is expressed in quantitative terms as tons of non-GHG emission savings. Then, the benefit is finally expressed in monetary terms when the tons of non-GHG emission savings are multiplied by the relevant monetisation values (see reference values in Table 1).

Link with specific criteria TEN-E Regulation

- Sustainability: Article 4(3)(f) TEN-E Regulation

Further benefits from SGG projects can be realised thanks to the reduction of non-GHG emissions that also contribute to climate change. Non-GHG emissions include direct emissions like particulate matter, or indirect methods that trigger chemical reactions leading to pollution, such as acid rain, also increase pollution levels. To ensure that eventual mitigation effects introduced by candidate SGG projects are accurately evaluated, special attention must be paid to these non-CO2 emissions. This should involve at least addressing the primary emission types of CO, NO_2 (including NO that forms NO_2 in the atmosphere), SO_2, and various particulates (such as PM_2, PM_5, and PM_{10}).

By optimising the use of fossil fuels, SGG projects can reduce such emissions. As elaborated below, effects of potential differences in the assumed social costs of pollutants should be investigated through sensitivity analyses.

Calculation process

1. Evaluation of the amount of non-GHG emissions avoided thanks to the candidate SGG project is based on the following approach:
    a. a detailed modelling exercise is carried out by project promoters, based on the emission factors per pollutant of the various technologies displaced, in which the amount of polluting generation is evaluated in both the “with” and “without” cases. Given the objective function of the optimisation algorithm and the combination of the active constraints of the problem, the model provides as output the variation in non- GHG emissions achievable thanks to the project.
    b. If detailed modelling is not feasible, the approach with simplified assumptions should be followed:
        i. project promoters calculation of the emission factor difference based on the most granular emission intensity data available, and the amount of polluting generation

displaced based on their knowledge of the operational capability of the project. Prospective emission intensities can be imputed by interacting such data with installed generation capacities in the scenarios considered, as compliant with TYNDP scenarios.

2. The variation of emissions for the *g*-th non-GHG pollutant achievable in the *z*-th zone of the modelled/represented system thanks to the candidate SGG project is converted into monetary terms by using the social cost of carbon provided in the information set accompanying the project submission template.

$$B_2 = \sum_g \left[emission_{g,z}\big|_{without} - emission_{g,z}\big|_{with} \right] \cdot emission\_cost_g$$

3. The economic present value of indicator B_2 is calculated within the CBA horizon using the discounted cash-flow approach.

Sensitivity analyses shall be run to check the monetary values of benefits from avoided non-GHG emissions under different assumptions about their social costs (Annex V(2) of the TEN-E Regulation).

3.1.3 B3 – Variation of the share of renewable and low-carbon gases integrated into the gas network

Benefit Definition:

- Definition: increase of the share of renewable and low carbon gases integrated into the gas network achievable thanks to the candidate SGG project.
- Relevance: renewable and low carbon gases integrated in the system thanks to the candidate SGG project contribute at replacing imports with local and sustainable alternatives, reducing extra-EU fuel dependency, increasing quality and security of supply and market functioning.

Benefit Calculation:

- Modelling needs: accurate assessment of the amount of renewable and low carbon gases integrated in the gas network would require a detailed modelling exercise simulating a larger portion of the gas system (both transmission and distribution levels) beyond the project and, if any, of the systems (e.g. electricity and hydrogen) involved in the production and integration of low carbon and renewable gases. An alternative solution without significant modelling requirements would be based on project assumptions and relative calculations, using reputable methodologies.
- Data needs: if detailed modelling is introduced, extensive data to simulate a sufficiently large portion of the gas system and, if any, of the systems involved in the production of renewable gases, are needed. In absence of extensive modelling, the benefit can be calculated but using operative data about the estimated amount of equivalent reduced greenhouse gases emissions.
- How the benefit is expressed: first, the benefit is expressed in quantitative terms as the replaced quantities of fossil gases replaced by renewable and low-carbon corresponding ones. Then, the benefit is finally expressed as a percentage.
- The analysis should provide a breakdown in renewable and low-carbon gases.

Link with specific criteria TEN-E Regulation

- Network security and quality of supply: Article 4(3)(f)(i) TEN-E Regulation

A candidate SGG project can bring to security of supply benefits. This happens, for instance, when renewable and low carbon gases integrated in the gas network replace gases of fossil origin, often imported from outside the EU. Renewable and low carbon gases produced as fuel substitutes can be either consumed locally, stored or injected into the gas network. In this respect, a qualitative benefit can be proposed to measure the variation of the share of renewable and low carbon gases integrated in the gas network achievable thanks to the candidate SGG project. It is important to highlight that this indicator shall not be monetised as the economic impact of the variation of the share of renewable and low-carbon gases integrated into the gas network is already internalised in the indicator "B1 - Variation of GHG emissions [€/a]"

Calculation process

1. By assuming that the gas demand does not change between the "with" and the "without" case, the amount of replaced gas imports is equal to the increased amount of renewable and low carbon gas.
2. The project promoter evaluates the increased amount of renewable and/or low carbon gas integrated into the gas system thanks to the candidate SGG project following one of the two approaches below:
    a. In case a detailed modelling exercise is carried out, the project promoter must evaluate the operation gas system in both "with" and "without" cases. Given the objective function of the optimisation algorithm and the combination of the active constraints of the problem, the model provides as output the variation in renewable and/or low carbon gas production achievable thanks to the SGG project as well as, if any, of the related production costs.

b. In case of simplified assumptions, the project promoter shall calculate the input data required to calculate the indicator using assumptions based on its knowledge of the operational capability of the SGG project. All the assumptions must be duly justified and referenced.

3. The variation of the share of renewable and low-carbon gases integrated into the gas network is expressed, as the weighted average, for each gas *g*, of the variation of the share weighted with the respect the *g*-th gas demand:

$$share_{g,renewable} = \frac{Qgas_{g,renewable}}{Qgas_g}$$

$$share_{g,low\ carbon} = \frac{Qgas_{g,low\ carbon}}{Qgas_g}$$

$$B_{3,g,renewable} = share_{g,renewable}\big|_{with} - share_{g,renewable}\big|_{without}$$

$$B_{3,g,low\ carbon} = share_{g,low\ carbon}\big|_{with} - share_{g,low\ carbon}\big|_{without}$$

$$B_{3,g} = B_{3,g,renewable} + B_{3,g,low\ carbon}$$

$$B_{3,renewable}[\%] = \frac{\sum_g \left(B_{3,g,renewable}\right) \cdot Qgas_g}{\sum_g Qgas_g} \cdot 100$$

$$B_{3,low\ carbon}[\%] = \frac{\sum_g \left(B_{3,g,renewable}\right) \cdot Qgas_g}{\sum_g Qgas_g} \cdot 100$$

$$B_3[\%] = \frac{\sum_g \left(B_{3,g,renewable} + B_{3,g,low\ carbon}\right) \cdot Qgas_g}{\sum_g Qgas_g} \cdot 100$$

where:

- $share_{g,renewable}$ and $share_{g,low\ carbon}$ are the renewable and low-carbon shares used for the *g*-th gas, respectively;
- $Qgas_{g,renewable}$ and $Qgas_{g,low\ carbon}$ [t/a] are the renewable and low-carbon quantities of the *g*-th gas used in the system, respectively;
- $B_{3,g,renewable}$ and $B_{3,g,low\ carbon}$ are the variation of renewable and low-carbon shares integrated in the system for the *g*-th gas, respectively;

Project promoters shall provide the values of the benefit B_2 and the sub-$B_{3,g,renewable}$ and $B_{3,g,low\ carbon}$ as well as all the information needed to check and replicate their calculation.

Main elements to consider

— amount of replaced gas imports
  - data requirement and data granularity are related to the impact of the candidate SGG project on the gas system, in particular with respect to the source and level of integration of local renewable and low-carbon gases, eventual reverse flows from distribution to transmission level.
  - no extensive data requirements if project promoters use assumptions on the operation of the gas system achieved thanks to the candidate SGG project.

3.1.4 B4 – Detection of methane leakage

Benefit Definition:

- Definition: increase of the observability of the gas system functional for the detection of potential methane leakages achievable thanks to the candidate SGG project.
- Relevance: by increasing the observability of the relevant portion of the gas system, a candidate SGG project can support the detection of unintentional leaks of methane, leading to potential reduction of total EU GHG emissions.

Benefit Calculation:

- Modelling needs: none
- Data needs: operational data of dedicated equipment and installations devoted at increasing the observability of the system aimed at identifying potential methane leakage.
- How the benefit is expressed: the benefit is expressed as the percentage increase of the observability of the gas system achievable thanks to the candidate SGG project.

Link with specific criteria TEN-E Regulation

- Sustainability: Article 4(3)(f) TEN-E Regulation

Methane is a powerful greenhouse gas, second only to carbon dioxide in its overall contribution to climate change. It is responsible for about a third of current climate warming. Approximately one third of global anthropogenic methane emissions come from the energy sector. The IEA estimates that 45% of those emissions can be mitigated at no net cost, given the fact that the cost of abatement is lower than market value of the additional gas that could be captured[11].

Maintaining an efficient and an intact gas system entails logistical issues, especially as time progresses and physical assets (such as pipe joints, compressors, pipelines, gas storage elements, etc.) begin to suffer from wear and tear. Methane leakages are therefore inevitable and can never be completely prevented, but rather managed and minimised as best as possible.

In order to be able to detect potential methane leakages, system operators must increase the observability[12] of the elements constituting the gas system. For instance, Leak detection and repair (LDAR) programmes are the primary strategy for addressing fugitive emissions, often involving innovative and digital solutions.

A qualitative benefit is proposed in this SGG CBA methodology to measure the variation of potential methane leakage detection coverage achievable thanks to the candidate SGG project.

Calculation process

1. The detection coverage is defined as the ratio between the length of transmission and/or gas distribution pipelines observable (i.e. where a potential methane leakage is detectable thanks to active methane leakage detection measures activated) and the total length of the transmission and/or gas distribution pipelines in the system:

$$detection\ coverage = \frac{L_{covered}}{L_{total}}$$

2. Project promoter calculate the qualitative indicator B_4 as the relative variation of $detection\ coverage$ between with and without case.

(11) https://www.iea.org/reports/methane-emissions-from-oil-and-gas
(12) Observability can be defined as the knowledge of a system that can be inferred from the knowledge of the external factors.

$$B_4[\%] = \frac{detection\ coverage|_{with} - detection\ coverage|_{without}}{detection\ coverage|_{without}} \cdot 100$$

Project promoters shall provide the values of the benefit B_4 and the sub-indicators $detection\ coverage|_{with}$ and $detection\ coverage|_{with}$ as well as all the information needed to check and replicate their calculation.

3.1.5 B5 – Reduction of curtailed gas demand

Benefit Definition:

- Definition: reduction of curtailed gas demand that cannot be satisfied in a given area.
- Relevance: by supporting the integration of local sources of renewable and low carbon gases into the gas system, candidate SGG projects can mitigate the risk of curtailment of gas demand that could occur in moments when the demand of gas is higher than the supply, when storages are insufficient and/or when there is not enough transmission capacity in the gas network to allow gas to flow to local consumption nodes. In this respect, the amount of gas unlocked by a candidate SGG project and integrated in the gas network contributes at reducing increases security of energy supply in the Union.

Benefit Calculation:

- Modelling needs: an accurate assessment would require a detailed modelling exercise simulating a larger portion of the gas system (distribution and/or transmission levels) affected by the candidate SGG project, potentially up to the European level. Simplified approaches might be allowed considering the scale of the candidate SGG project and the related impact on cross-border gas flows.
- Data needs: extensive data requirement to simulate a significant portion of the gas system is required in case of an accurate modelling exercise. In absence of extensive modelling, the benefit can be calculated but using operative data about additional amount of gas unlocked by the candidate SGG project as well as the amount, the timing and the location of unserved gas demand.
- How the benefit is expressed: first, the benefit is expressed in quantitative terms as avoided gas demand curtailment (expressed in ton/a or in GWh/a) achievable thanks to the candidate SGG project. Then, the benefit is finally expressed in monetary terms when avoided gas demand curtailment is multiplied with values of Cost of Disruption of Gas Supply (*CODG*) for each Member State.

Link with specific criteria TEN-E Regulation

- Network security and quality of supply: Article 4(3)(f)(i) TEN-E Regulation

Natural gas represents a significant portion of EU final energy consumption (21.9% in 2020[13]) and many EU Member States import nearly all of their supplies. Some EU countries are also heavily reliant on a single source or a single transport route for the majority of their gas, with extreme repercussions in case the supply from such sources and/or routes are challenged. Gas supply disruptions may result from technical or human failures, natural disasters, cyber-attacks, other emerging risks, and, last but not least, from geopolitical disputes and wars. For instance, after Russia's military invasion of Ukraine in February 2022, several EU countries have experienced unilateral and unjustified cuts of their gas supplies from Russia.

To achieve "security, solidarity and trust", one of the dimensions of the EU Energy Union, it is key to identify to what extent gas demand cannot be supplied and, consequently, there is a risk of demand curtailment in one or more EU Member States. In line with the provisions set in Reg. (EU) 2017/1938 [10] with respect to cooperation among countries in mitigating stress situations, the indicator should be calculated considering cooperation among countries.

Calculation process

The benefit B_5, which is conceptually similar to the benefit "Avoided demand curtailment" considered in the ENTSOG methodology [3], can be calculated as follows:

1. project promoters evaluate the operation of the modelled portion of the gas system in both "with" and "without" cases. Given the objective function of the optimisation algorithm and the balance gas demand

(13) https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220201-1/

constraints, the model provides as output the level of unserved, then curtailed, gas demand, in each modelled zone.

2. The monetized benefit related to the reduction of demand curtailment in the *z*-th zone of the modelled system can be calculated by project promoters as follows.

$$B_5 = \sum_z (gas\_demand\_curtailment_z|_{without} - gas\_demand\_curtailment_z|_{with}) \cdot CODG_z$$

The most updated values for CODG at Member State level shall be provided, for each year within the study horizon.

3. The economic present value of the indicator B_5 is calculated within the study horizon using the discounted cash-flow approach.

<u>Main elements to consider</u>

— Avoided gas demand curtailment
    - the accurate evaluation of unserved gas demand on the relevant portion of the gas system affected by the candidate SGG project requires running a hydraulic gas model simulation;
    - project promoters can use probabilistic approaches to calculate gas demand curtailment in different demand situations, also significant of different climatic stress conditions. For the calculation of B_5, project promoters will use the average value of demand curtailment calculated as value in each demand situation multiplied by probability of occurrence of situation;
    - using assumptions on the operation of the gas system achieved thanks to the candidate SGG project eases the need of running a modelling exercise but it decreases accuracy of the assessment.

3.1.6 B6 – Increase of socio-economic welfare in the gas system

Benefit Definition:

- Definition: increase of socio-economic welfare (SEW) in the gas system achievable thanks to the candidate SGG project.
- Relevance: by fostering the integration of locally sourced low-carbon and/or renewable gases and/or enabling reverse flow from distribution to transmission level, a candidate SGG can increase SEW in the gas system, increasing market functioning and providing services to customers.

Benefit Calculation:

- Modelling needs: an accurate assessment would require a detailed modelling exercise simulating an appropriate portion of the gas system (distribution and/or transmission levels) and gas markets affected by the candidate SGG project.
- Data needs: extensive data to simulate an appropriate significant portion of the gas system and market are required in case of an accurate modelling exercise.
- How the benefit is expressed: the benefit is expressed in monetary terms as reduction of total cost of the gas system achievable thanks to the candidate SGG project.

Link with specific criteria TEN-E Regulation

- market functioning and customer services: Article 4(3)(f)(ii) TEN-E Regulation

Any infrastructural project inserted in the gas system leads at changes in the system through evolutions in prices and flows. Similarly to what happens to project at transmission level [3], a change in the total socio-economic welfare (SEW) can be induced by candidate SGG projects by:

- lifting physical bottlenecks limiting access to a local supply source. In this case, a candidate SGG project can relax local network constraints in the gas system, increasing the efficiency of gas supply service by reducing the cost of remedial actions and reducing cost for the whole society.
- enabling network users to act on short-term wholesale gas markets, with the aim of balancing their portfolios efficiently on trading platforms, in line with the provisions set in Article 7 of the Gas Balancing Network Code [11]. In this case, a candidate SGG project can enable local gas producers to participate in trading platform for gas balancing, potentially increasing the efficiency of gas balancing markets and the SEW for the whole society.
- allowing gas TSOs to access to efficient resources for any residual balancing interventions, in line with the provisions set in Articles 8 and 9 of the Gas Balancing Network Code [11], with the aim of reducing costs for imbalanced network users. In this case, a candidate SGG project can enable local gas producers to procure residual balancing services to connected TSOs, reducing total cost for such procurement for the whole society.

Similarly to ENTSO-E CBA methodology [2], two different approaches can be used for calculating such benefit:

- the total cost approach, which compares the total costs for the gas system in both “with” and “without” configurations; and
- the total surplus approach, which compares the producer, consumer and congestion rents between in both “with” and “without” configurations.

According to economic theory, the two approaches bring to the same result under the assumption of perfect inelastic demand.

Calculation process

The benefit B_6, is conceptually similar to the benefit "SEW benefit" considered in ENTSO-E CBA methodology [2], can be calculated as follows:

1. project promoters define the extend to the benefit, in terms of components considered (i.e. SEW increase for reduction of physical congestions, SEW increase in short-term wholesale gas markets, SEW increase in residual balancing procuring);
2. project promoters define a simulation model for gas system and market compatible with the extent of the approach followed in point 1.
    a. project promoters simulate the model described in point 2. in both "with" and "without" configurations;
    b. project promoters calculate the indicator B_6:
        i. under the total cost approach, for the *m* components defined in point 1. above:

$$B_6 = \sum_m (Total\ cost|_{without} - Total\ cost|_{with}) =$$

        ii. under the total surplus approach, for the *m* components defined in point 1. above:

$$B_6 = \sum_m (SEW|_{with} - SEW|_{without})$$

3. as alternative to point 2. above, project promoters can use assumptions to calculate variation of total SEW achievable thanks to the addition of the candidate SGG project to the gas system.

$$B_6 = \sum_m (SEW|_{with} - SEW|_{without})$$

   All the assumptions must be duly justified and referenced

4. The economic present value of the indicator B_6 is calculated within the study horizon using the discounted cash-flow approach.

<u>Main elements to consider</u>

An accurate characterization of the indicator B_6 would require a detailed representation of:

— portion of the physical gas system affected by the candidate SGG project;

— short-term balancing gas market and trading platform where local actors enabled by the candidate SGG project are expected to participating;

— approaches used by transmission system operators to perform balancing actions and procure balancing services in line with the provisions set in Articles 8 and 9 of the Gas Balancing Network Code [11].

Given the different options pursued by project promoters, extensive modelling and data requirement, in terms of temporal granularity, spatial granularity and problem formulation might arise.

3.1.7 B7 – Cross sectoral cost savings

Benefit Definition:

- Definition: cost savings enabled by the candidate SGG project by enabling cross-sectoral flexibility.
- Relevance: by enabling services such as demand response and energy storage, candidate SGG projects can realize total savings (both capital and operative savings), creating synergies and benefits for the Union.

Benefit Calculation:

- Modelling needs: in order to fully capture the cost savings enabled by candidate SGG projects, a detailed modelling exercise encompassing all the relevant sectors (for instance but not limited to, power, gas, hydrogen, heat, transport and industry) is necessary. The level of representation shall be consistent with the specific characteristics of the project as well as the necessary temporal and spatial granularity and the cross-sectoral interactions among the sectors. Different modelling approaches are possible taking into consideration with the alternatives in terms of interaction among the different dimensions of the energy system, leading to different trade-off levels between complexity and accuracy.
- Data needs: extensive data requirement to allow the simulation of the operation of the integrated energy system, with a level of detail, in principle, considerably higher than the one necessary for the simulations of electricity and gas sectors alone.
- How the benefit is expressed: the benefit is expressed in monetary terms as difference between total costs in "without" case and the "with" case.

Link with specific criteria TEN-E Regulation

- Smart energy sector integration: Article 4(3)(f)(iii) TEN-E Regulation

To ensure a cost-efficient, fair and inclusive energy transition, it is necessary that all relevant sectors, such as gas, electricity, industry, transport, and heat are considered in a more integrated perspective: the transition to a more integrated, holistic and optimised system can be achieved only if the role of assets able to act along different dimensions of the one energy systems is emphasized, creating opportunities for cross-sectoral cost efficiencies arising by stressing the "energy efficiency first" principle.

In this respect, candidate SGG projects play a key role in unlocking such efficiencies, by enabling flexibility services facilitating links among the different energy carriers and. Cost savings can also arise in terms of reduction of capital expenses in several sectors enabled by candidate SGG projects.

A proper characterisation of cost savings cannot neglect the required level of detail of needed modelling exercises and data gatherings, which can increase more than linearly with the number of sectors represented and potentially be more extended and cumbersome than the one related to the integrated model as referred in Article 11(10) of TEN-E Regulation. In this respect, the level of detail used by project promoters shall reflect the level of implementation of the best practice developed by the ENTSOs with respect the implementation of the integrated (electricity, gas and hydrogen) energy model.

Calculation process

For each year within the study horizon, project promoter shall evaluate the cross-sectoral cost savings achievable thanks to candidate projects as follows:

1. In case of complete integrated model, project promoters of candidate projects shall calculate the benefit as variation of annual total costs (both operational and capital, if the model can also be used for investment decision) that can be achieved thanks to the candidate SGG project in all the *s* sectors which is directly calculate by the integrated model from both "without" and "with" simulations of the integrated model;

$$B_7 = Total\ cost(s)|_{without} - Total\ cost(s)|_{with}$$

2. In case of separate simulation of different systems, project promoters of candidate SGG projects shall identify proper values for boundary conditions necessary to ensure consistency between the results calculate by the separate models: such values might come as output of a simplified integrated model from separate studies or assumptions from project promoters: in case of separate studies or assumptions from project promoters, exogenous information must be duly justified and referenced by project promoters. For project promoters following this approach, the benefit is calculated as the estimated variation of annual total costs (both operational and capital, if the models can also be used for investment decision) of the used models that can be achieved thanks to the candidate SGG project in all the sectors

$$B_7 = \sum_s [Total\ cost_s|_{without} - Total\ cost_s|_{with}]$$

3. If no simulations are carried out, project promoters of candidate SGG projects may estimate cost the benefit as the estimated variation of annual total costs (both operational and capital, if the models can also be used for investment decision) of the used models that can be achieved thanks to the candidate SGG project in all the sectors. Exogenous information must be duly justified and referenced by project promoters

$$B_7 = \sum_s [Total\ cost_s|_{without} - Total\ cost_s|_{with}]$$

5. The economic present value of the indicator B_7 is calculated within the study horizon using the discounted cash-flow approach.

The broad perspective that this indicator has calls for a clear description, from the project promoters, of all cross-sectoral cost savings that the candidate SGG project can bring to the system.

Given the fact that this indicator can, in principle, encompass all the others, it is important that no double counting with the latter exists: in this case, project promoter should clearly identify these risks and remove the share of the indicator which is already accounted in another one.

3.2 Costs

Project promoters shall provide relevant costs for each year analysed in the study horizon accompanied with assumptions on the duration of authorisation, construction time and decommissioning phases. In particular, project promoters shall take into account the following cost elements:

- capital expenditure costs;
- operational and maintenance expenditure costs;
- costs induced for the related system over the technical lifecycle of the project;
- decommissioning and waste management costs; and
- other external costs.

Project promoters shall clearly describe what cost elements are incurring within the study horizon, taking into consideration the specificities of equipment and installations constituting the pertinent candidate SGG project.

Costs occurred before the study horizon shall be actualised at using as reference year the year after the adoption of the relevant Union list of PCIs and PMIs (e.g. 2024 is the reference year for the first Union list of PCIs and PMIs under the revised TEN-E Regulation, see section 3.4).

Member States impacted by the costs related to a candidate SGG project should be identified and disaggregated costs at Member State level should be provided.

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). Confidentiality of sensitive information must be ensured in line with the provisions of TEN-E Regulation.

3.3 Residual impacts

When dealing with the potential adverse impacts of a project, the primary approach is to prevent such impacts from occurring in the first place, for instance by optimising the routing of the project. When this is not possible, mitigation measures can be put in place and, in certain cases, compensatory measures may be legally mandated. When the project planning has advanced enough, the expenses associated with these measures can be accurately estimated and are included in the overall project costs (see section 3.2). When the required information for such cost internalisation is not available yet, however, , project promoters shall evaluate the any residual impact not considered in benefits and costs, in line with the approaches developed by the ENTSOs in their respective methodologies (see footnote 1). In particular, project promoters for candidate SGG projects shall evaluate, when relevant:

— S1 (Residual Environmental Impact);

— S2 (Residual Social Impact); and

— S3 (Other Impacts).

3.3.1 S1 – Residual Environmental Impact

In line with the approach developed by ENTSO-E in its updated CBA methodology (see footnote 1), project promoters for candidate SGG projects shall evaluate the residual environmental impact of a candidate SGG project by identifying:

— stage of the candidate project, in line with the project implementation status, see section 2.2;

— potential impact, i.e. to what extent the candidate SGG project impacts on nature and biodiversity (length and surface area of infrastructure located within an environmental sensitive area); and

— type of sensitivity, i.e. rationale on why the area is considered sensitive (e.g. biodiversity, habitat, etc.)

For candidate SGG projects in the “permitting” or “under construction”, the elements listed should be reported based on the current data of the project promoter, also referencing the environmental impact assessment performed to identify those elements. When a project is not sufficiently mature (“planned, but not yet in permitting”' or “under consideration”) and when the aforementioned elements are not available the project promoter shall clearly state that an environmental assessment is not yet available due to the low degree of maturity of the candidate project and that the actual routing of the project is not defined yet.

3.3.2 S2 – Residual Social Impact

Similarly to what described in section 3.3.1 and in line with the approach developed by ENTSO-E in its CBA methodology (see footnote 1), project promoters for candidate SGG projects shall evaluate the residual social impact of a candidate SGG project by identifying:

— stage of the candidate project, in line with the project implementation status, see section 2.2;

— potential impact, i.e. to what extent the candidate SGG project impacts on densely populated areas or protected areas (length and surface area of infrastructure located within an socially sensitive area); and

— type of sensitivity, i.e. rationale on why the area is considered sensitive (i.e. population density, landscape, etc.)

For candidate SGG projects in the “permitting” or “under construction”, the elements listed should be reported based on the current data of the project promoter, also referencing a social impact assessment performed to identify those elements, when required by the legislative framework. When a project is not sufficiently mature (“planned, but not yet in permitting”' or “under consideration”) and when the aforementioned elements are not available the project promoter shall clearly state in its application that a social assessment is not yet available due to the low degree of maturity of the candidate project and that the actual routing of the project is not defined yet.

3.3.3 S3 – Other impacts

Any other impact (positive or negative) not covered in S1 and S2 shall be included in S3. Project promoter shall ensure that any impact already accounted in S1 and S2 is not considered in this indicator.

3.4 Project value calculation

The Economic Net Present Value (ENPV) represents the difference between the present value of all monetised benefits and the present value of all costs, discounted using the discount rate.

$$ENPV = \sum_{y=0}^{T} \frac{TotB_{mon,y} - TotC_{,y}}{(1+r)^{y}}$$

where:

- T is the study horizon;
- y represent the year within the study horizon when benefits and costs occur;
- $TotB_{mon,y}$ is the sum of monetized benefits for the y-th year;
- $TotC_y$ is the sum of total costs for the y-th year;
- r is the social 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[14]

$$BCR = \sum_{y=0}^{T} \frac{TotB_{mon,y}}{(1+r)^y} \Bigg/ \sum_{y=0}^{T} \frac{C_y}{(1+r)^y}$$

Benefits and costs shall be actualised at using as reference year the year after the adoption of the relevant Union list of PCIs and PMIs (e.g. 2024 is the reference year for the first Union list of PCIs and PMIs under the revised TEN-E Regulation).

4 Transparency and confidentiality

In submitting their CBA application, project promoters for candidate energy storage 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 ENPV and BCR calculations.

([14]) More detailed information on the project value calculation can be found in the latest CBA methodology developed by the ENTSOs [2], [3].

References

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

[4] T. Brown, J. Hörsch, D. Schlachtberger, PyPSA: Python for Power System Analysis, 2018, Journal of Open Research Software, 6(1), arXiv:1707.09913, DOI:10.5334/jors.188.

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[9] European Investment Bank. Methodologies for the assessment of project greenhouse gas emissions and emission variations. Version 11.3. January 2023.

[10] Regulation (EU) 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard the security of gas supply and repealing Regulation (EU) No 994/2010.

[11] Commission Regulation (EU) No 312/2014 of 26 March 2014 establishing a Network Code on Gas Balancing of Transmission Networks.

List of abbreviations and definitions

BCR	benefit-cost ratio
CBA	Cost Benefit Analysis
EIB	European Investment Bank
ENPV	Economic Net Present Value
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
ICT	Information and Communication Technology
EU	European Union
IEA	International Energy Agency
JRC	Joint Research Centre
NRA	National regulatory authorities
PCI	Project of Common Interest
SEW	Socio-Economic Welfare
SGG	Smart Gas Grids

List of tables

Annex 1. Modification of the methodology due to the contributions received from the public consultation.

1. Introduction

The consultation on the draft SGG CBA methodology is part of the process for development of methodologies for a harmonised energy system-wide cost-benefit analysis at Union level pursuant to Article 11(8) of the revised TEN-E Regulation. Concerning the SGG CBA methodology, the consultation started on 7 October 2022 and ended on 6 January 2023. The consultation has been carried out through EUSurvey[15], the European Commission's official survey management tool. Moreover, it is worth mentioning that, in May 2022, the Commission organised a technical workshop, open to all interested stakeholders, to share its first views concerning the development of the SGG methodology.

The objective of this consultation was to seek input from stakeholders on the draft SGG CBA methodology published on 7 October 2022, who were invited to answer questions for the overall approach of the methodology as well as questions for each individual indicator of the methodology.

The public was consulted on the following general question:

— *In your view, to what extent does the draft methodology allow for a harmonised energy system-wide cost-benefits analysis at Union level?*

— *Do you have any feedback regarding the assumptions considered in the draft methodology? (Section 2.1)?*

Concerning the specific indicators proposed, the public was consulted on the following questions for each individual indicator, respectively:

— *In your view, is the benefit well described in line with the legal base?*

— *Do you have suggestions for data sources which could be used for the calculation of this benefit?*

— *Suggestions for data sources which could be used for the calculation of this benefit?*

2. Consultation results

One response from a Transmission System Operator has been received via EUSurvey.

In addition, a joint ACER-NRAs document have been submitted to the Commission via email in response to the public consultation on the draft SGG CBA methodology. This document was complemented with another one raising horizontal elements for all CBA methodologies developed by the Commission pursuant to Article 11(8) of the revised TEN-E Regulation.

3. Summary of changes due to input received from the public consultation

Number Comment	**Respondent's comments**	**Outcomes**
1	The indicators "Variation of GHG emissions" and "Increase of socio-economic welfare in the gas system [€/a]" are considered in line with the legal basis and adequate	-
2	The indicator "Variation of the share of renewable and low-carbon gases integrated into the gas network" is considered not useful as the real underlying benefit is already accounted in	Improved the text by specifying that there should not be any monetized double counting between the two indicators. At the same time the indicator should be

(15) https://ec.europa.eu/eusurvey/home/about

Number Comment	Respondent's comments	Outcomes
	the benefit "Variation of GHG emissions".	maintained in line with the provisions set in paragraphs 8(a) on Annex IV to revised TEN-E Regulation.
3	The indicator "Cross sectoral cost savings" is considered too vague.	Improved the text calling for sufficient clarity from the project promoters in identifying and explaining all possible sources and impact of cross-sectoral cost savings. At the same time, the broad description of the pertinent energy infrastructure category, provided in point (2) of Annex II to revised TEN-E Regulation, represents a limitation in being specific without risking to be too limitative. Being this the first methodological proposal for the evaluation of candidate SGG projects, it is important to ensure to project promoters the possibility to highlight any possible benefit resulting from the realization of their projects, provided that such description is duly explained, motivated and verifiable. In the future versions of this methodology, in case robust practices arise from the application in PCI processes, this indicator can be further improved.
4	Assumptions and calculations are almost entirely left to project promoters, based on a very general guide. There is a significant risk that promoters may choose assumptions favouring their projects and that the methodology would be implemented in an inconsistent manner. Also, there is no practical step-by-step guidance on how the CBA methodology would be applied to specific projects.	Improved the text in section 2.1 by specifying that assumptions should either come from TYNDP scenarios or information provided in the template for the project submission. At the same time the project promoters shall be entitled to introduce complementary assumptions and use pertinent calculations approaches, in line with the scope of the candidate SGG project, provided that such deviations and modelling/simplification assumptions are clearly described and justified. It is important to highlight, in fact, that the scope of the data developed in the context of TYNDP-based processes might not be fully in line, given the different scope of the involved energy infrastructure categories, with the one related to candidate SGG projects. This compromised position would allow sufficient flexibility, when needed, to project promoters, without being detrimental to the comparability of projects.
5	ACER and NRAs are in favour of centralised assessment of projects, having one central entity applying the CBA methodologies at least within the same project category, using same approach for all candidate projects, based on same assumptions, using same criteria and models.	A centralised assessment of the projects is beyond the scope of the revised TEN-E Regulation: in particular, the Regulation does not identify a central authority for the assessment of the benefits and the costs for SGG project like, for instance, in the context of electricity and hydrogen candidate

Number Comment	Respondent's comments	Outcomes
		projects. The SGG CBA methodology is in line with the provisions set in the revised TEN Regulation and, in particular, with the process for establishing regional lists described in Annex III.
6	Practical examples of application to dummy projects would contribute to a more consistent implementation of the CBA methodology. We propose that a spreadsheet template (calculator) is developed and made available for project promoters to ease its application.	The comment does not involve the theoretical framework developed in the SGG CBA methodology.
7	Suggestion to use common assumptions	See comment 4.
8	Clear rules on the study horizon and discount rate: 25 years from the start of the operation of the project and 4%. Recommendable to give guideline on how to treat years before the start of operation of the project (in particular concerning already incurred costs).	Improved the text in section 2.1. The benefits shall be accounted from the year after the commissioning year (first full year of system benefits). Itincludes guidance on how to actualise costs occurring before the start of operation of the project (see sections 3.2 and 3.4).
9	In case a project promoter decides to go with simplified approach for assessment of benefits, there should be a clear guidance in which cases certain approach should be followed how it should be done. An ideal solution would be to use common and open-source tools.	See comments 4 and 5. While we support the use of open-source tools to carry out the modelling, it also observes that project promoters shall be entitled to use the best model able to reflect the specificities of their candidate projects. Improved the text of the SGG methodology mentioning the use of open-source tools (see footnote in section 2).
10	Improve terminology: a. refer to "socio-economically desirable" rather than "profitable", as later is more a term used in business analysis b. refer to Economic Net Present Value (ENPV) as CBA is an economic analysis of a project and not a financial analysis	Improved the text accordingly in section 3.
11	For qualitative indicators no methodology is proposed to apply an "appreciation scale" making impossible to compare different projects.	We observe that proposed qualitative indicators such as "Variation of the share of renewable and low-carbon gases integrated into the gas network" and "Detection of methane leakage" are expressed as percentage, which inherently allows an appreciation to compare different projects.
12	Cost distribution and socioeconomic impacts per Member State should be provided. The impacted Member States should be identified.	Improved the text accordingly in section 3.1.
13	Avoiding double counting is mentioned in the	Theverification process of non-double

Number Comment	Respondent's comments	Outcomes
	proposed methodology, anyhow description of the verification process for double counting seems to be missing.	counting shall be carried out in line with the provisions set in point (2) of Annex III to the revised TEN-E Regulation.
14	There are no definitions nor references of low carbon gases (reference to REDII / REDIII Delegated acts)	Improved the text accordingly via footnote in section 3.1.1.
15	With respect to the benefit "Variation of GHG emission": a. the methodology should clearly list all the GHG to be considered in the assessment; b. the methodology should indicate a default option for the calculations; c. sources should be updated; and d. a sensitivity on CO2 prices shall be mandatory;	a. agree and improved the text accordingly in section 3.1.1. b. agree and improved the text accordingly in section 3.1.1 by providing clear rules on what approaches to use; c. agree and improved the text accordingly in section 3.1.1 by providing updated references; and d. accept the comment and improved the text in section 2.1
16	With respect to the benefit "Variation of the share of renewable and low-carbon gases integrated into the gas network": a. indicators shall be calculated by a central authority; and b. description of the indicator is too vague	a. refer to comment 5; b. agree and improved the description in "Calculation process".
17	With respect to the benefit "Detection of methane leakage": a. concern on the use of a qualitative benefit for the evaluation of projects; b. add expression as a percentage	a. take stock of the comment but observes that the benefit has been introduced in line with the provisions of Article 4(3) and Annex IV to revised TEN-E Regulation. In the context of the assessment of candidate SGG projects for specific PCI/PMI processes the Commission will identify multi-criteria approaches to contextually use monetized, quantitative and qualitative indicators; and b. agree and added the percentage symbol in the description of the indicator.
18	With respect to the benefit "Reduction of curtailed gas demand": a. centralised approach is suggested, taking into consideration the scale of SGG projects. Objective function and optimisation algorithm to be used in analysis should be prescribed. Guidance on the assumptions on the operation of	a. refer to comments 3 and 5. Effect of scale assumptions are inherent to simplification assumptions (see summary text box at the beginning of the indicator) and b. observe that the text already aligns the proposed indicator with the relevant ENTSOG's Gas CBA

Number Comment	Respondent's comments	Outcomes
	the SGG shall be provided; and b. better description and use of climatic stress conditions, in line with ENTSOG's Gas CBA Methodology [3].	Methodology [3]. In addition, the text has been improved in "Main elements to consider" to explicitly reference the use of probabilistic approaches to calculate gas demand curtailment in different demand situations, also as result of different climatic stress conditions
19	With respect to the benefit "Increase of socio-economic welfare in the gas system": a. centralised approach is suggested, taking into consideration the scale of SGG projects; b. better description of SEW and guidance	a. refer to comments 3 and 5. Effect of scale assumptions are inherent to simplification assumptions (see summary text box at the beginning of the indicator); and b. observe that the description is of possible sources of SEW increase are provided in section 3.1.6.
20	With respect to the benefit "Cross sectoral savings": a. To define how double counting of benefits will be prevented. b. Certain verification process should be established and defined.	a. observe that the need to avoid double counting is reiterated in the text of the SGG CBA methodology in several parts; and b. refer to comment 13.
21	The definition of Costs is aligned with Regulation 2022/869, Annex V, also to ensure a harmonised approach among all the CBA methodologies.	Improved the text accordingly in section 3.2.
22	The formula of the Economic Benefit/Cost ratio is missing.	improved the text accordingly in section 3.4.

Short view of changes due to input received from the public consultation

Number Comment	Consultation results	Actions after consultation
2	Major improvement requested	Without changes
3	Major improvement requested	Without changes
4	Major improvement requested	Clarification provided
5	Major improvement request	Without changes (out of scope)
6	Major improvement request	Without changes (pertinent but to different document)

Number Comment	Consultation results	Actions after consultation
7	Improvement request	Clarification provided
8	Improvement request	Modification implemented
9	Improvement request	Minor Clarification provided
10	Minor improvement request	Modification implemented
11	Minor improvement request	Clarification provided
12	Minor improvement request	Modification implemented
13	Minor improvement request	Clarification provided
14	Minor improvement request	Clarification provided
15	Improvement request	Modification implemented
16	Improvement request	Modification implemented
17	Minor improvement request	Clarification provided
18	Major improvement request	Clarification provided Modification implemented
19	Major improvement request	Without changes
20	Improvement request	Clarification provided
21	Improvement request	Modification implemented
22	Minor improvement request	Modification implemented

4. Other important changes

This section briefly describes important changes implemented by the Commission to the text of SGG CBA methodology, compared to the version submitted for public consultation. These changes have been introduced to increase consistency with other TEN-E methodologies, in line with the provisions of Article 11(8) of the Regulation.

— introduction of the benefit “B2 - Variation of non-GHG emissions”; and

— introduction of approaches for the evaluation of residual impacts (see section 3.3).

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