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

[DRAFT FOR PUBLIC CONSULTATION]

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Joint Research Centre

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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 profitable (namely, if its benefits outweigh its costs) or to provide a base for 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.

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

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 *Net Present Value* (NPV) of the candidate project along the whole duration of the technical lifetime of the project.

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 ENTSOs methodologies.

2.1 Scenarios and 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 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[1] [4]. 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;

— 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;

— 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 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;

— natural gas demand: for each Member State and for each year within the study horizon; and

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

(1) 25 years.

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 profitable, realizes during its lifetime 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 is longer. Consequently, to compare the total benefits generated by the candidate project during its lifetime with the related total costs, this SGG CBA methodology requires the use of the discounted cash-flow method for the calculation of the *New Present Value* (NPV) 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 NPV 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.).

Table 1. 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 the share of renewable and low-carbon gases integrated into the gas network	Network security and quality of supply: Article 4(3)(f)(i)
B3 – Detection of methane leakage	Sustainability: Article 4(3)(f)
B4 – Reduction of curtailed gas demand [€/a]	Network security and quality of supply: Article 4(3)(f)(i)
B5 - Increase of socio-economic welfare in the gas system [€/a]	Market functioning and customer services: Article 4(3)(f)(ii)

B6 – 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. All the indicators should be calculated in the way to avoid double counting benefits.

3.1.1 B1 - Variation of GHG emissions [€/a]

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: 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. 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 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 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.

The Greenhouse Gas Protocol[2], the most widely used international accounting tool for quantifying and measuring GHG emissions, breaks down emissions in three categories:

— scope 1 emissions, that are defined as those caused directly by an activity;

— scope 2 emissions, which count indirect emissions resulting from energy consumption or energy efficiency; and

— scope 3 emissions, defined as all other indirect emissions caused along the whole value chain.

(2) https://www.ghgprotocol.org/

In the context of evaluating the variation of GHG emissions achievable thanks to candidate SGG projects, project promoters shall take into consideration scope 1 and scope 2 emissions.

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. In line with the Commission technical guidance on climate proofing of infrastructure [5], project promoters should follow, where applicable, the EIB Project Carbon Footprint Methodology [6] to quantify GHG emissions.
2. If project promoters decide to not use the EIB Project Carbon Footprint Methodology, they shall duly describe in their application their reasons. In alternative, GHG emission can be calculated using the following approaches:
   a. methodology referred to in Article 28(5) of Directive (EU) 2018/2001 [7];
   b. the standard ISO 14067 "Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification"3;
   c. the standard ISO 14064-1 "Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals"4; and
   d. Innovation Fund methodology for GHG emission avoidance calculation [8].
3. GHG emission savings achievable 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 converted in monetary terms by using the value of social cost of carbon.

$$B_1 = \sum [emission|_{without} - emission|_{with}] \cdot ShCost_{CO_2}$$

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.

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

(3) https://www.iso.org/standard/71206.html
(4) https://www.iso.org/standard/66453.html

3.1.2 B2 – 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 in relative and therefore qualitative terms.
- 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.

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:

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

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

$$B_{2,g,renewable} = share_{g,renewable}\big|_{with} - share_{g,renewable}\big|_{without}$$

$$B_{2,g,low\ carbon} = share_{g,low\ carbon}\big|_{with} - share_{g,low\ carbon}\big|_{without}$$

$$B_{2,g} = B_{2,g,renewable} + B_{2,g,low\ carbon}$$

$$B_{2,renewable} = \frac{\sum_g (B_{2,g,renewable}) \cdot Qgas_g}{\sum_g Qgas_g}$$

$$B_{2,low\ carbon} = \frac{\sum_g (B_{2,g,renewable}) \cdot Qgas_g}{\sum_g Qgas_g}$$

$$B_2 = \frac{\sum_g (B_{2,g,renewable} + B_{2,g,low\ carbon}) \cdot Qgas_g}{\sum_g Qgas_g}$$

Project promoters shall provide the values of the benefit B_2 and the sub-indicators $B_{2,renewable}$ and $B_{2,low\ carbon}$ 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.

3.1.3 B3 – 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 in qualitative terms as the 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[5].

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[6] 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 ration 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_3 as the relative variation of $detection\ coverage$ between with and without case.

$$B_3 = \frac{detection\ coverage|_{with} - detection\ coverage|_{without}}{detection\ coverage|_{without}}$$

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

Project promoters shall provide the values of the benefit B_3 and the sub-indicators $detection\ coverage|_{with}$ and $detection\ coverage|_{with}$ as well as all the information needed to check and replicate their calculation.

3.1.4 B4 – Reduction of curtailed gas demand [€/a]

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[7]) 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 [9] with respect to cooperation among countries in mitigating stress situations, the indicator should be calculated considering cooperation among countries.

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

Calculation process

The benefit B_4, 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 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.

$$B_4 = \sum_z (gas\_demand\_curtailment_z|_{without} - gas\_demand\_curtailment_z|_{with}) \cdot CODG_z$$

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_4 is calculated within the study horizon using the discounted cash-flow approach.

Main elements to consider

— 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,
  - 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.

3.1.5 B5 – Increase of socio-economic welfare in the gas system [€/a]

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 [10]. 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 [10], 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_5, 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_5:

        i. under the total cost approach, for the m components defined in point 1. above:

$$B_5 = \sum_m (Total\ cost|_{without} - Total\ cost|_{with}) =$$

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

$$B_5 = \sum_m (SEW|_{with} - SEW|_{without})$$

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.

$$B_5 = \sum_m (SEW|_{with} - SEW|_{without})$$

All the assumptions must be duly justified and referenced

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

Main elements to consider

An accurate characterization of the indicator B_5 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 [10].

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.

3.1.6 B6 – Cross sectoral cost savings [€/a]

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;

$$B_6 = \sum [Total\ cost(s)|_{without} - Total\ cost(s)|_{with}]$$

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

$$B_6 = \sum_s [Total\ cost_s|_{without} - Total\ cost_s|_{with}]$$

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

$$B_6 = \sum_s [Total\ cost_s|_{without} - Total\ cost_s|_{with}]$$

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

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

The project promoter shall provide CAPEX and OPEX for each year analysed in the study 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). Confidentiality of sensitive information must be ensured in line with the provisions of TEN-E Regulation.

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[8].

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 NPV and BCR calculations.

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

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) 2019/944, and repealing Regulation (EU) No 347/2013.

[2] 3rd ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects – Draft version – 28 January 2020.

[3] 2nd ENTSOG Methodology for Cost-Benefit Analysis of Gas Infrastructure Projects – October 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, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund.

[5] Commission Notice - Technical guidance on the climate proofing of infrastructure in the period 2021-2027 (2021/C 373/01)

[6] European Investment Bank. Methodologies for the assessment of project greenhouse gas emissions and emission variations. Version 11.2. February 2022.

[7] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast).

[8] European Commission. Methodology for GHG emission Avoidance Calculation. Innovation Fund Small Scale Projects. Version 2.0. February 2021.

[9] 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.

[10] 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

CBA	Cost Benefit Analysis
EIB	European Investment Bank
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
PCI	Project of Common Interest
SEW	Socio-Economic Welfare
SGG	Smart Gas Grids

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