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**COMMISSION STAFF WORKING DOCUMENT**
*Accompanying the document*

**COMMISSION DELEGATED REGULATION**
**supplementing Regulation (EU) 2021/1153 of the European Parliament and of the Council with regard to the specific selection criteria and the details of the process for selecting cross-border projects in the field of renewable energy**

**Methodologies for assessing the contribution of cross-border projects to the general criteria and for producing the cost- benefit analysis specified in Part IV of the Annex to the Regulation (EU) 2021/1153 establishing the Connecting Europe Facility**

{C(2021) 9875 final}

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# 1 INTRODUCTION

## Scope

According to Article 7(2) of Regulation (EU) 2021/1153 (CEF Regulation) the Commission shall publish the methodologies for assessing the contribution of the cross-border projects in the field of renewable energy (CB-RES projects) to the general criteria and for producing the cost-benefit analysis (CBA) specified in Part IV of the Annex.

This empowerment covers in substance two methodologies which are strictly linked to each other. The first one covers the process of the assessment by the Commission of the compliance of an application to the Union list for CB RES projects with the general criteria referred to in Part IV of Annex to CEF Regulation and further developed in Delegated Act (EU) …/… . The second methodology covers the CBA, which is an integral part of the general criteria referred to in Part IV of Annex to CEF Regulation and further developed in Delegated Act (EU) …/… and translates these criteria into operational analysis. The CBA shall be produced by the project promoters that apply to be selected in the Union list for cross-border projects in the field of renewables. Therefore, this methodology provides guidance to the project promoters on how to prepare the cost-benefit analysis, which is required by the CEF Regulation as a criterion for the selection to the Union list for cross-border projects in the field of renewables.

Both methodologies serve the purpose of assisting project promoters in their preparation for an application to the Union list for CB RES projects and ensuring the predictability, transparency and objectiveness of the assessment process for selecting the cross-border project. Therefore, they are integrated into the current document.

The current methodology builds on existing practices in EU policies such as the Guide to Cost-Benefit Analysis of Investment Projects for Cohesion Policy 2014-2020[1], the cost benefit methodology used for grid investment projects as per Regulation(EC) 347/ 2013[2] and other approaches such as the CBA used at the European Investment Bank (EIB).

## Legal framework

CEF Regulation widens the scope of the instrument beyond trans-European energy networks to renewable energy production and establishes a new category of projects for funding under the Connecting Europe Facility - CB RES projects.

The objectives of these projects cover various aspects, which are set out in the CEF Regulation. According to Article 3 (2)(b) of CEF Regulation the projects have as an overall objective to facilitate cross-border cooperation in the area of energy, including renewable energy. According to Article 7(1), the CB RES projects should contribute to

[1] https://ec.europa.eu/regional_policy/en/information/publications/guides/2014/guide-to-cost-benefit-analysis-of-investment-projects-for-cohesion-policy-2014-2020.

[2] https://eepublicdownloads.entsoe.eu/clean-documents/tyndp-documents/Cost%20Benefit%20Analysis/2018-10-11-tyndp-cba-20.pdf.

decarbonisation, completing the internal energy market and enhancing the security of supply. Furthermore, according to Annex Part IV the objectives of the projects are to promote cross-border cooperation between Member States in the field of planning, development and the cost-effective exploitation of renewable energy sources, as well as to facilitate their integration through energy storage facilities and with the aim of contributing to the Union's long-term decarbonisation strategy.

In addition to the objectives of the CB RES projects, CEF Regulation lays down certain criteria in order for the projects to be selected as cross-border projects and included in a dedicated Union list. These selection criteria are included in Annex Part IV of the CEF Regulation and in Delegated Act (EU) …/….

The first criterion is the requirement that the project is underpinned by a cooperation mechanism that takes form of cooperation between at least two Member States or between at least one Member State and a third country in accordance with Articles 8, 9, 11 or 13 of Directive 2018/2001 (p. 2(a) of Annex Part IV to CEF Regulation).

The second criterion is the requirement that the project should have net benefits (p. 2(b) and (c) of Annex Part IV to CEF Regulation). This means that the project demonstrates that the potential overall cost savings in the deployment of renewables and/or the benefits for system integration, security of supply or innovation that are associated with the project outweigh its costs. The existence of the net benefits is established on the basis of a CBA. This analysis demonstrates the existence of the net benefits in comparison to a similar renewable energy project implemented by one of the Member States participating in the underpinning cooperation agreement and covers 7 elements set out in p. 3 of Annex Part IV to CEF Regulation. Therefore, the two selection criteria in p. 2(b) and (c) of Annex Part IV to CEF Regulation) are tightly linked in a way where the CBA under p. 2(c) is the translation into analytical document of the net benefits in p. 2(b).

**General approach**

The purpose of the assessment approach developed in this methodology - and the CBA as its core element in particular - is to determine whether projects applying for the list of CB RES projects, create value from a holistic, societal perspective. Or framed differently, whether the socioeconomic benefits generated by the project outweigh its costs when comparing it to renewables deployment without cooperation. If this is not the case, the renewables investment is assumed to either be better pursued in a national-only context, commercially or not at all. Therefore, the selection of CB RES projects into the Union list implies that an EU added value of the project is identified.

The assessment of the projects applying to the Union list for cross-border projects is structured around the following elements:

1. The socio-economic, energy market and energy policy context of the project;

2. Cooperation mechanism;

3. CBA.

## 2 SOCIO-ECONOMIC, ENERGY MARKET AND POLICY CONTEXT

All applications are defined by the context and boundaries of the renewables-related provisions in the CEF regulation. However, their specific implementation context will differ strongly as renewables policies, ambitions, revenue and income streams, grid policies and capacities and other factors differ strongly from Member State to Member State and possibly even within a certain Member State.

Therefore, **firstly** the implementation context of a project should be presented to understand which direct and indirect impact the project can potentially develop. Therefore, for all (potentially) involved Member States a description is given, of the socio-economic trend, status quo, energy and climate ambition and target setting (NECP, national energy and decarbonisation strategies, recovery plan etc.) for the energy system, as well as the energy market conditions. The context helps to situate the cooperation project and allows to identify whether the subsequent objective and proposed project is suitable for this context. This helps the project evaluator to understand which direct and indirect impact the project can potentially have; assessment further elaborated in the cost-benefit-analysis. This part of an application should consider and state the following elements for all (potentially) involved Member States:

- Existing and foreseeable renewables energy market conditions such as:
    - Structure of the market: Degree of market liberalization, competition in the sector, and market entry, market rules for storage and flexibility
    - Wholesale market trends (prices)
    - Interconnection between the participating MS, if applicableEnergy Demand analysis: how large is the demand for the project's output? This is especially important when the output of the project includes services beyond energy production (e.g. balancing products or contributions to ancillary services storage etc.)
    - Support frameworks for RES: Support schemes, Auctions, Quotas, Others
    - RES capacity (exisiting and planned) including storage
    - Renewables potential in all (potentially) participating countries
    - Plans of the Member States and or third country to make use of cooperation mechanism and/or the Union Financing Mechanism
    - If applicable, describe the grid-related aspects of the project, including its connection regime, the status of the connection agreement and other relevant elements.

The context helps to situate the project and allows to identify whether the subsequent objective and proposed project is suitable for this context and likely to go ahead, including also the underpinning by a cooperation mechanism which necessitates a bi-or multilateral agreement of the involved Member States.

**Secondly**, the project should present its objectives. The outlined objectives should refer to the objectives mentioned in the CEF regulation for cross-border projects in the field of renewable energy as listed below. As part of this step, the applicant should provide high-level description that explains what the project seeks to contribute to the energy system of the host

Member State (where the renewables generation facility is located), the other participating Member States and the European/regional energy system in a broader sense, if applicable. These aspects are later on reflected in the detailed cost-benefit- analysis.

- **Decarbonisation** (Article 7 (1) and Annex Part IV of the CEF Regulation)

Reduction of GHG emissions linked to additional renewables capacity as they occur during the lifetime of the project. For projects involving storage, evidence should be provided to demonstrate whether the storage will be filled with renewable energy and if so, how this will be ensured.

- **Completion of the internal market** (Article 7 (1) CEF Regulation)

The project's impact on the energy market, market prices, operating costs including market efficiency, balancing and estimated costs of infrastructure development to ensure the integration of the renewable energy generation into the system (covering both internal capacity needs and interconnectors) are described.

- **Security of supply** (Article 7 (1) of the CEF Regulation)

This objective can for example be achieved with a project contributing to a reliable generation capacity, reduced need for capacity from energy efficiency improvements, if applicable, and the relative share of the project's energy output in the amount of imported energy supply of the respective country and/or sector. It can also include the security of supply of raw materials. With regard to storage, it can refer to the increase in secured capacity contribution, including in a secondary sector.

- **Promotion of cross-border cooperation in the field of planning, development and cost-effective exploitation of renewable energy sources** (Annex IV of the CEF Regulation)

This objective in a broader sense is achieved by any cross-border project, however the application should explain how the particular project fits in the picture of cross-border cooperation, e.g. by marking new development or strengthening the existing practices in the field.

- **Facilitation of renewable energy integration** (Annex IV of the CEF Regulation)

This objective should be understood in the context of facilitating the deployment of renewables and their subsequent integration into the energy system. The application should explain how the particular cross-border project and the underpinning cooperation agreement help to boost the renewables deployment and how the integration of the additional quantities of renewable energy is going to be effectively achieved.

**Thirdly**, the application needs to include a high-level description of the project. This should include

- Information and data about the project:

    - Technology used and design: description of the main works components, technologies to be adopted, size
    - Project location, if relevant.
    - Specific engineering features and / or technical characteristics and standards and specifications
    - Type of output and services envisaged (electricity, heating, renewable energy storage, which markets will be served etc.
- Bodies responsible and/or necessary for the project implementation (e.g. the project developer, the Member State, TSO, DSO).
- An implementation plan and milestones: A realistic project timetable together with an implementation schedule, e.g. provided in the form of a Gantt chart or equivalent with the steps planned and the works implementation (if applicable).
- The business model of the project, described by using a standard reference such as the ‘Canvas’ model template, clearly identifying the revenues and costs of the project and the assumptions for these (e.g. projected electricity, capacity and ancillary services revenues, guarantees of origin revenues, projected arbitrage revenues for projects involving storage, CAPEX, biomass or other fuel costs).
- The technical design of the project.
- High-level environmental considerations, including climate change considerations and environmental impact considerations in line with outcome of the Environmental Impact.
- Compliance with applicable Directives on Environmental Impact Assessment (EIA)/Strategic Environmental Assessment (SEA) and similar sector-specific legislation has to be demonstrated.

## 3 UNDERPINNING COOPERATION MECHANISM

Within this element the scope, legal embedding and maturity of the involved cooperation mechanism needs to be described and evidence submitted as part of the application. In particular, project promoters need to identify the applicable cooperation mechanism between Member States as defined in the RED II (statistical transfer, joint project, joint support scheme). Moreover, the status of the cooperation agreement needs to be clearly described, ranging from mere information of the Member States to a signed cooperation agreement or any other kind of arrangement.

Forms of cooperation mechanisms in the Renewables Directive include:

- **Article 8 Statistical transfers between Member States:** Member States may agree on the statistical transfer of a specified amount of energy from renewable sources from one Member State to another Member State, based on an agreed transfer price. Such arrangements may have a duration of one or more calendar years and shall be notified to the Commission not later than 12 months after the end of each year in which they have effect. The information sent to the Commission shall include the quantity and price of the energy involved. Statistical transfers are likely not to be related to specific projects nor does it have to be related to new projects (can be existing ones), although the details of such an agreement can be fully defined by the involved Member States. For this reason, the delegated act allows applications based on statistical transfer only (without it being tied to a new RES generation facility) only for the Article 7 (3) studies.

- **Article 9 Joint projects between Member States:** Member States may implement joint projects, i.e. new renewables generation projects, and subsequently share the costs and benefits of such a project. There might be multi-project arrangements and single-project arrangements. A likely case is to use this Cooperation Mechanism for single projects.

- **Article 11 Joint projects between Member States and third countries:** Member States may also implement projects (including the distribution of costs and benefits) with Third countries. However, such projects can only relate to the electricity sector, a physical link needs to be established with that third country and interconnector capacity needs to be actually booked to ensure an infeed of electricity into the EU electricity system.

- **Article 13 Joint support schemes:** Member States may also decide to join or partly coordinate their national support schemes and agree on the distribution of costs and benefits resulting from this cooperation. Typically, such an arrangement would include a multi-project approach, but it might also be used for a large single project.

Moreover, the status of the cooperation agreement needs to be clearly described and evidenced.

For an application for the list of cross-border projects in the field of renewable energy, a project already needs to provide evidence of a buy-in of at least two Member States and/or a Member State and a third country.

The project promoter also needs to identify the cooperation mechanism to be applied. In addition, he/she needs to make high-level statements on the envisaged set up of the cooperation and may provide general thoughts on the distribution of costs and benefits between the involved Member States (according to their thinking at the time of submitting the proposal).

The Memorandum of Understanding or similar form of written declaration that is required by Article 4 of Delegated Regulation (EU) …/… should specify the basic features of the cooperation mechanism to be used, the project(s) to be covered and/or the selection procedure for projects, the basic understanding of the sharing of the costs and benefits and the statistics that will emanate from the RES generation under the cooperation.

The following elements need to be reflected:

- I. Objective of the cooperation
- II. Specification of the cooperation (e.g. joint project or joint support scheme), e.g.
  - Capacity (amount of MW installed)
  - Eligible technologies
  - Selection procedure for cooperation project / specific project description in case project is already identified
- III. High-level statement on renewable energy target accounting, including envisaged distribution of RES statistics for target contribution purposes (but distribution rule does not have to be agreed yet)
- IV. High-level statement on envisaged sharing of costs and benefits
- V. High-level statements on envisaged monitoring, proof and verification

# 4 COST-BENEFIT ANALYSIS AND EU ADDED VALUE OF COOPERATION

The goal of the CBA is to assess whether benefits of the cooperation project outweigh its cost from a societal and system perspective. Thus, the system-wide costs and benefits are assessed, not only cost and revenues that can be directly attributed to the project itself. To do so, the economic analysis captures the quantifiable EU added value of cooperation to the extent possible, in addition to the qualitative description.

Quantification in the form of simple calculations should give a rough estimate of a project's societal costs and benefits. Project promoters need to describe the net added value of the envisaged cooperation project based on the CBA. The CBA is performed on the basis of the 7 elements set out in Annex Part VI, p. 3 of CEF Regulation (referred to as 'indicators').

## 1. EU added value of cooperation

The added value of a cooperation project will to the extent possible be derived from the cost benefit assessment explained below.

Whilst project costs usually occur in the early stages of a project, e.g. investment costs, the project's benefits will usually be apparent throughout the whole lifetime (see below under section 'Boundary conditions'). Consequently, lifetime benefits and costs need to be aggregated and brought to a comparable base by using the discounted cash flow method. Cash flows, i.e. costs and benefits throughout the lifetime, are discounted to the current year and summed up to calculate their net present value (NPV), similar to the methodology applied for financial modelling of a project. Therefore, costs and benefits that have been monetised only for a few base years have to be extrapolated to the full project lifetime, reasonably by linear interpolation. The lifetime NPV of benefits and costs of the individual indicators is then calculated, as described, via discounted cash flow calculations.

Important parameters in the assessment of the NPV are the assumptions to be considered for the project's economic lifetime (fixed at 15 years) and the social discount rate (fixed at 4%) (see below under section 'Boundary conditions').

Against this context, the project must have a positive NPV, i.e. the benefits have to outweigh the costs over the lifetime. Furthermore, the project must have higher NPV than the counterfactual, i.e. the overall benefits of the cross-border project should be more than the overall benefits of the counterfactual. To that end, firstly the overall NPV of the reference project is established and then the delta with the counterfactual, instead of establishing the delta between the reference project and the counterfactual for each indicator (see Figure 1).

The NPV can only be calculated taking into account monetised benefit and cost indicators. At the same time, some of the indicators set out in Annex Part IV to the CEF Regulation cannot be monetised in a consistent and objective manner to allow for uniform assessment across projects. Therefore, only a few of the below described indicators can be considered as part of the calculation of the delta NPV values. Notably, the indicators related to the cost of support and to innovation do not feed into the project's NPV.

In order to put equal weight to all seven indicators set out in Annex Part IV to the CEF Regulation, the assessment of the cost-benefit analysis will not focus solely on the NPV as a criterion, but rather will consider all benefits provided by the project, including those which can be quantified and those which are qualitative. Therefore, the non-monetized benefits will also be taken into account. The project promoter is able to substantiate these benefits and the evaluation will consider them, notably in case there the NPV on the basis of the monetized benefits is negative.

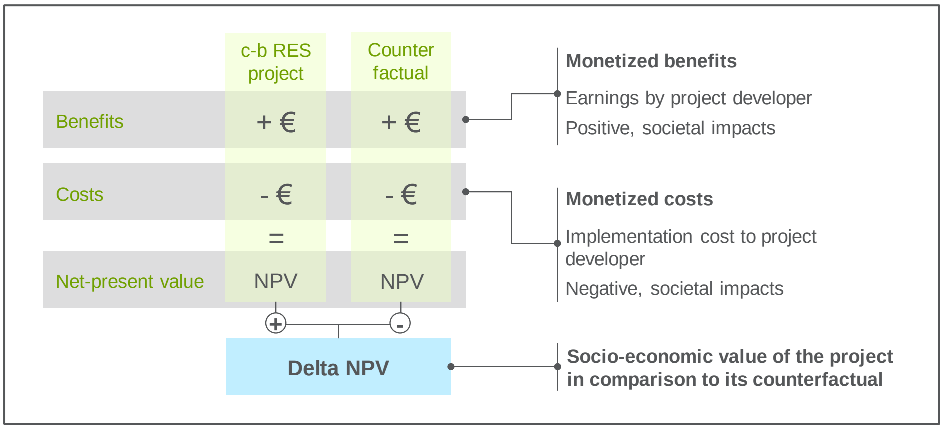


**Figure 1: NPV assessment through comparison of the c-b RES project and its counterfactual**

## 2. Counterfactual

As set out in Annex Part IV, p. 2(b) of CEF Regulation and explained in more detail above in this section, the CBA is to be performed against the counterfactual. The counterfactual means a similar project or renewable energy project implemented by one of the participating Member States alone to which the proposed cross-border project in the field of renewable energy is compared when assessing the potential cost savings or benefits to society. The net value of the cooperation is then the difference between the socioeconomic welfare of the system with the cooperation project and the welfare of the system of the counterfactual project, implemented without cooperation. This difference (a delta) is based on all indicators which can in principle be either positive or negative, or respectively a benefit or a cost.

Therefore, a counterfactual needs to be introduced, allowing for the comparison of a similar project with a case of non-cooperating Member States.

The counterfactual can be a similar project or a renewable energy project implemented by one of the participating Member States alone. Project size and technology of the counterfactual could be different or equal compared to the assessed project. In the counterfactual, a project implemented by one Member State alone could be a project in the off-taking or in the host Member State.

To give an example: Without the cooperation, contributing countries might apply the same RES technology (e.g. use PV in northern Europe instead of southern Europe, coping with lower radiation). In other cases, the off-taking Member State would use a different technology in the non-cooperation case (e.g. onshore wind instead of offshore wind when the off-taking Member State has no coast).

On the basis of Annex Part IV, p. 2(b) of CEF Regulation, the present methodological guidance puts forward two options for identifying a counterfactual: (i) standardized counterfactual and (ii) case-specific counterfactual, as illustrated below:

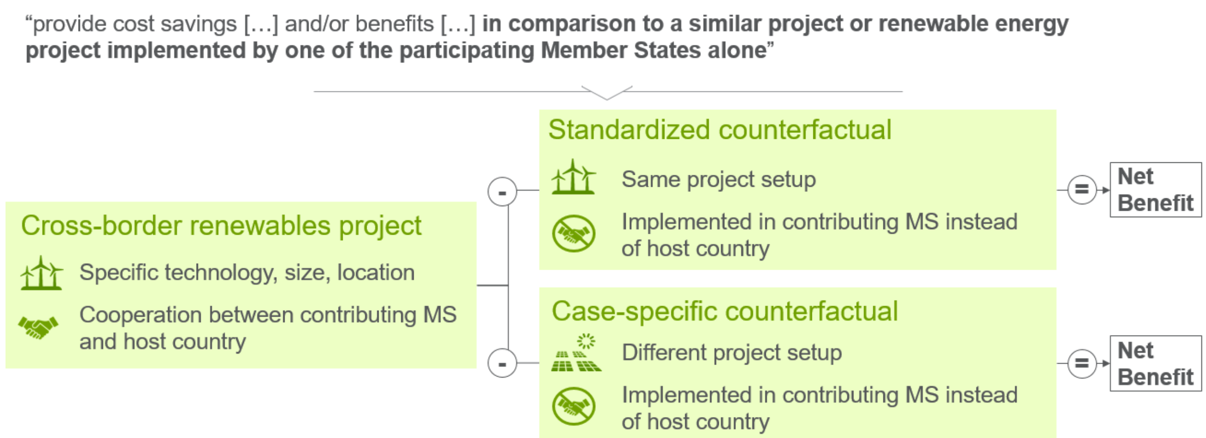


**Figure 2: The counterfactual as part of the CBA**

The assessment using the standardized counterfactual consist of a comparison between the cross-border project applying to the Union list and a project with the same configuration that is implemented by one of the participating Member states alone in case the cooperation didn't take place. The assessment using the case-specific counterfactual consists of a comparison between the cross-border project applying to the Union list and another technological option in the context of renewables deployment that would be implemented in case the cooperation did not take place.

For reasons of increased comparability of applications and more objective assessment across projects, the option of developing the standardized counterfactual should have a priority over the case-spefic counterfactual and should be used in the application whenever possible and relevant.

**Standardized counterfactual**

The standardized counterfactual presents a scenario where the same project (in terms of sized and technological configuarion) takes place in the contributing Member State compared to the host Member State.

If the project involves more than two Member States either as host, or as a contributor, the counterfactual should cover only 1 option. The choice of a Member State where the counterfactual takes place should be based on one of the following criteria:

- Applicability of the same project set-up. For example, if the projects consist of building an offshore wind park, the counterfactual should be developed for a contributing Member State that has access to a territorial sea. If there is more than one such option, the counterfactual should be developed for the contributing Member State with the most similar conditions;

- Level of participation. If none of the contributing Member States has comparable conditions, the counterfactual should be developed for the off-taking Member State with the highest share of participation (in terms of financial contribution or other type of engagement);

- In case of a joint project where the participating Member States are more than two, the applicant has a choice between introducing more than one counterfactual to cover each of the participating countries alone, or one counterfactual to cover only one of the participating countries;

- Alternatively and only if the ones above cannot be used, the counterfactual should be developed for the off-taking Member State with comparable market conditions to the host Member State where the cross-border project will take place. By comparable conditions it is meant the market rules and financial conditions rather than the existing infrastructure.

**Case-specific counterfactual**

Project promoters can deviate from the standard counterfactual, if in the specific case it does not make sense or is not relevant. For example, the standard counterfactual may not always fit the concept of a specific cooperation case (e.g. the cooperation is based on a joint support scheme). Furthermore, there might be no data availability for a standard counterfactual to allow for a proper comparison with the cooperation case. In these cases, the applicant is may come up with a case-specific counterfactual. In any case, the choice of a case-specific counterfactual should be duly justified.

Under the case-specific counterfactual, project promoters need to explain what would realistically happen in each of the participating Member States without the proposed cooperation project.

When providing this explanation, the applicants can choose an option where the counterfactual project provides another solution for RES target achievements. In this case the application can introduce comparison of the cross-border project with another project. The compared project remains in the context of the renewable energy deployment, therefore a counterfactual with a fossil fuel technology is not acceptable. The counterfactual project may deploy different technology or may have different project set-up of cross-border cooperation.

In case of a joint support scheme the applicant can choose the option of ‘the project doesn’t happen at all’.

**Scenario**

With a view to frame the CBA analysis, a scenario ensures that uncertainties in future developments are properly addressed and projects are not evaluated against overly optimistic or pessimistic assumptions related to the seven indicators of the analysis. In the context of cross-border cooperation across Europe, the project should be assessed against a single scenario which reflects the EU policy development under the current evolution.

The baseline for this assessment is the EU Reference Scenario on energy, transport and GHG emissions, prepared by the Commission and showing the fundamental socio-economic, technological and policy developments in the EU. The latest one is published in July 2021[3]. This scenario is one of the European Commission's key analysis tools in the areas of energy, transport and climate action and allows the project promoters to analyse the long-term economic, energy, climate and transport outlook based on the current policy framework at the time of its publication. The EU Reference Scenario can therefore serve as a common EU-wide benchmark against which the CBA analysis will be assessed.

**Boundary conditions**

The scenario needs to respect the following boundary conditions:

**Time horizon:** The minimum time horizon to be considered by the project promoters is at least 15 years, starting with the first year of operation of the project and reflecting the technological lifetimes in order to be in line with the requirement to ensure net benefits also in the longer term. The CAPEX replacement costs are not eligible, therefore the repowering of an installation should not impact the time horizon of the project..

**Discounting:** A social discount rate of 4% is used.

The social discount rate enables to place a **present** value on the **future** costs and benefits of projects and policies that are intended to provide a societal benefit. Bringing all values to a same time basis is needed for their comparison and aggregation. The discount rate specifies the degree to which '**the future is discounted**' in comparison to the present.

The reason a social discount rate of 4% is applied is derived from the past experience of CEF programme. This value was extensively used in the first programming period of 2013-2020 for CEF energy projects and the experience build around such value justifies its application also in the new programming period in 2021-2027 for cross-border projects in the field of energy.

## CBA BASED ON THE SEVEN ELEMENTS OF THE CEF REGULATION

[3] reference to the publication to be added

The CBA is to be carried out at least for the following elements set out in Annex Part IV of the CEF Regulation. These seven indicators try to capture all impacts, positive and negative, of the project on the socioeconomic welfare.

## 3. Cost of energy generation

The levelised cost of energy (LCOE) is the price of generating energy. The LCOE is a measure of an energy source that allows comparison of different methods of energy generation on a consistent basis. The LCOE can also be regarded as the minimum constant price at which energy must be sold in order to break even over the economic lifetime of the project.

In RES projects, LCOE is calculated on the basis of the below formula:

$$\text{LCOE}[\frac{€}{MWh}] = \frac{Investment\ cost + \sum_n^N \frac{O\&M\ cost}{(1+r)^n}}{\sum_n^N \frac{Energy\ Produced}{(1+r)^n}}$$

Where ‘r’ is the financial discount rate and ‘n’ is the year[4]. The LCOE is always pre-tax.

To calculate the total cost of the energy system generation and derive a monetized value, the LCOE should be multiplied by the expected output (P50) of the project (MWh).

## 4. System integration

Under the first element of the CBA methodology (cost of energy generation), the LCOE covers only the direct generation costs for a given project. The second element, namely system integration costs, should therefore encompass the wider costs of the overall system for integrating that generation.

Integration costs of variable/interment RES can be defined as all additional system costs induced that are not directly related to RES generation costs. This includes expenses for grids, balancing services, reserve requirements, and more flexible operation of thermal plants. Integration costs can be decomposed according to three intrinsic properties of variable RES: variability, uncertainty and location-specificity. In order to calculate the total system integration cost, the following costs should be considered:

- **Profile costs**: They occur because RES are variable. In particular at higher shares of RES penetration withtout adequate storage capabilities, this leads to increasing mismatches in the ability to match load. Backup capacities are needed to ensure

[4] If a financial discount rate is not available the applicant can use the WACC to approximate it.

reliable supply if load exceeds the ability of RES to provide energy at a given point in time. Conversely, variable RES supply might exceed load, leading to curtailment. The overall impact on other dispatchable generation is an increase in the need to ramp up or down, and a general reduction in full-load operating hours, both at increased cost. Profile costs are basically the cost of providing backup capacity and flexibility to meet demand at all times/at peak.

- **Balancing costs**: They are required by Regulation (EU) 2019/943 (Electricity Regulation), occur because renewable supply is uncertain and are born by the operator of the renewable facility. Day-ahead forecast errors of short term fluctuations in RES generation cause unplanned intra-day adjustments of dispatchable power plants and require operating reserves that respond within minutes to seconds. Balancing costs are linked to short term fluctuations and uncertainty in RES generation.
- **Grid-related costs:** They are twofold. Firstly, the availability of good renewable resource (e.g. wind, solar) may be geographically far from load centres, possibly requiring investments in transmission grids to connect and transport energy to where it is needed. Secondly, as RES penetration increases withtout adequate storage capabilities, the variable nature of generation might lead to changes in flow patterns in the overall system, which in turn can lead to increased congestion, with associated increases in system costs.

In practice, for the CBA these costs can be estimated as follows:
**Profile costs** are the result of the temporal mismatch in renewable energy production and reflect the need for medium/long-term flexibility. These costs are effectively the project's share of system costs for flexibility, which can be estimated based on system operator projections or by using as a proxy the LCOE of a marginal peaking unit in the system where the project is installed[5].
**Balancing costs** are the result of forecasting errors of the renewable energy production and reflect the need for short term flexibility. These costs are effectively the project's share of system costs for reserve and can typically be estimated on the basis of system operator projections, the historic balancing charges for similar projects, or historicaly reserve capacity auctions.
**Grid-related costs**, if directly attributable to a project are typically covered by grid connection charges. Other, wider grid reinforcement costs are covered by the general system operator network charges, which cover investments and operating expenses of the network. These are set out in the regulated tariff methodologies of each Member State for a given regulatory period. This typically also includes tariff projections.

[5] literature values for different technologies can be used, e.g. https://neon.energy/Hirth-Ueckerdt-Edenhofer-2016-Wind-Coal-Economics-Electricity-Generation.pdf and https://neon.energy/Ueckerdt-Hirth-Luderer-Edenhofer-2013-System-LCOE-Costs-Renewables.pdf

## 5. Cost of support

The objective of this component is to measure changes in the amout of support, considering all types of public transfer to the project promoter, required by the project. The support measures that should be taken into account for this indicator are not limited to direct RES generation support schemes. Indeed, they include tax exemptions, investment aid and any other non-repayable support.

The counterfactual of the analysis will include all potential national or joint support schemes for RES that the project may take advantage of.

The simple approach to estimate the annual costs of support is to look at the expected annual energy output of the counterfactual project and multiply it with the average per-MWh-support. The total cost of support is calculated projecting the annual cost into the full time horizon of the analysis. The cost of support for the c-b RES project will include the potential/requested CEF grant in addition to any national support in the host Country.

The project benefit in terms of cost of support is calculated as the difference between the cost of support in the reference case (c-b RES) and the counterfactual case. The indicator will be positive (negative cost) if the grant of the c-b RES project is lower than the potential national support schemes available in the counterfactual scenario. If the c-b RES solution requires a larger public contribution than the national solution the indicator is negative.

Despite being expressed in euro, the cost of support indicator shall not be incorporated in the overall NPV of the project.[6] It will contribute to the overall assessment by providing an insight in terms of effectivenes of public budget spending (i.e. a form of cost effectiveness of c-b RES funds in comparison to national supports).

In case the c-b RES project is a support scheme the cost of support shall be estimated as the total volume of the support scheme.

## 6. Greenhouse gas emissions

In line with the delegated act, all greenhouse gases, are to be considered.

Larger emissions of GHGs lead to higher concentrations in the atmosphere. The concentration of carbon-based GHGs such as carbon dioxide (CO2) and methane (CH4) in the atmosphere are central to the greenhouse effect.

EU GHG emissions mainly come from the following GHGs: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), as well as F-gases (hydrofluorocarbons or HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6). To allow for aggregation of the climate impact of emissions of different GHGs, EU legislation bases itself on agreed standard

[6] The traditional approach in CBA is to exclude public transfers from the analysis. This is because transfers paymenst are only a change of control on some resources from one group of society to another. They do not entail real economic costs or benefits and adding them to the overall measurement of wealth change is a mistake.

conversion factors, the so called Global Warming Potential (GWP) factors, to express all GHG effects in in CO2 equivalent terms.

Reference GWP values to be used are the over a 100 year time horizon values published in the 5th Assessment Report (AR) of Intergovernmental Panel on Climate Change (IPCC) [7].

The emission savings of the project are defined by the difference between the main emissions from the project activity, and the emissions that would occur in its absence for the generation or use of the same amount of energy using conventional technology or fuel.

$$\Delta \text{GHG Emissions} = \left(\sum_n^N Ref\ GHG\ in\ contributing\ country - counterfactual\ GHG\right) - \left(\sum_n^N Ref\ GHG\ in\ host\ country - cb\ RES\ GHG\right)$$

In case of RES project in the electricity sector, for the calculation of the reference GHG emission it is recommended to use the Country Specific Electricity Emission Factors and/or fuels default emission factors as presented in the EIB Project Carbon Footprint Methodologies.[8] In case of RES project in the heating and cooling sector, a natural gas boilder with 90% LHV efficiency shall be adopted as a benchmark.[9]

Furthermore, the avoided GHG emissions (the difference between the cooperation and the counterfactual) can be monetised by cost of carbon estimates.

This guidance recommends the cost of carbon estimates published by the EIB in its Climate Bank Roadmap 2021-2025[10] as the best available evidence on the cost of meeting the temperature goal of the Paris Agreement (i.e. the 1.5ºC target).

The table below provides the interpolated annual values as proposed by the Commission guidance on Climate proofing of infrastructure[11]

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[7] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R1044&from=GA

[8] Methodologies for the Assessment of Project GHG Emissions and Emission Variations https://www.eib.org/attachments/strategies/eib_project_carbon_footprint_methodologies_en.pdf

[9] Corresponds typical EU grid emissions during in 2030 according to the Commission's PRIMES/EUCO3232.5scenarios

[10] https://www.eib.org/attachments/thematic/eib_group_climate_bank_roadmap_en.pdf

[11] Commission notice on technical guidance on the climate proofing of infrastructure in the period 2021-2027

**Carbon prices per year in €/tCO2e, 2016-prices**

| Year | €/tCO2e | Year | €/tCO2e | Year | €/tCO2e | Year | €/tCO2e |
|---|---|---|---|---|---|---|---|
| 2020 | 80 | 2030 | 250 | 2040 | 525 | 2050 | 800 |
| 2021 | 97 | 2031 | 278 | 2041 | 552 | | |
| 2022 | 114 | 2032 | 306 | 2042 | 579 | | |
| 2023 | 131 | 2033 | 334 | 2043 | 606 | | |
| 2024 | 148 | 2034 | 362 | 2044 | 633 | | |
| 2025 | 165 | 2035 | 390 | 2045 | 660 | | |
| 2026 | 182 | 2036 | 417 | 2046 | 688 | | |
| 2027 | 199 | 2037 | 444 | 2047 | 716 | | |
| 2028 | 216 | 2038 | 471 | 2048 | 744 | | |
| 2029 | 233 | 2039 | 498 | 2049 | 772 | | |

## 7. Security of supply

The security of supply element should be understood as diversification of energy sources and supply from third countries, the purpose of which may be to reduce energy import dependency.

Therefore, the project’s contribution to security of supply should be assessed by estimating the value of changes in energy imports in the primary energy consumption of the respective sector (electricity, transport, heating and cooling) and country where the c-b project is located. The data on primary energy imports can be derived from the national energy and climate plans or from alternative reliable source as the national energy balances or the annual 'EU energy in figures statistical pocketbook'.[12] The energy prices should be based on the latest historic national annual average import prices for each energy source. It should be established how much (in terms of EUR) the imports are lowered by the energy input of the project as a domestic sourse of energy, assuming that the quantities of produced renewable energy and fully consumed domestically.

Under this approach, countries with a higher import dependency would profit more of a c-b RES project, that lowers energy imports.

## 8. Air and other local pollution

Under this element of the CBA, the air and other local pollution should be monetised to represent their external cost and impact on socioeconomic welfare. The benefits of the

[12] https://ec.europa.eu/energy/data-analysis/energy-statistical-pocketbook_en

project are then estimated as the impact of the project in terms of reduction of the air and other local pollution.

The information on other local pollution, for example on local water resources or land, is usually locally relevant and therefore might allow for arbitrary choice of a location of a counterfactual. Furthermore, the data availability for other local pollution might not be available for the counterfactual, therefore posing a risk on the comparability and objectiveness of CBA assessment across projects. Lastly, the monetization of these effects might be extremely difficult due to the lack of a unified set of data on the values attached to the units of local pollution. As a result, and in order to reflect duly the requirements of the CEF Regulation, the effect on other local pollution of the project and of the counterfactual may be justified in a quantitative manner by the project promoter. However, these effects will not be monetized and will not be included in the calculation of the NPV of the project.

Hence, only air pollution will be calculated in a qualitative manner and included in the NPV. Air pollution refers to the air pollutant emissions of three major regional pollutants: NOx, PMx, and SO2. Local pollution refers to the scope of impacts, which is limited to a certain region for these air pollutants compared to GHG with a global impact.

In order to estimate a project's impact on air and local pollution, firstly the project's lifetime RES production is determined. This estimation of that production should be consistent with the estimation under the indicator Cost of energy generation (see section 4.4.). Secondly, the RES production over the project's lifetime is multiplied by the difference between the system's average emission factor and the project's emission factor. The result is the increase/reduction of air pollutant emissions if the project is integrated into the system.

The emission factor (in kg/kWh) refers to the specific emissions of an air pollutant per kWh of electricity produced. The project's emission factor means the specific emissions of an air pollutant per kWh of electricity produced from the generation technology considered for the project (e.g. offshore wind or biomass CHP).The system's average emission factor means the average value for specific emissions of air pollutants per kWh of electricity produced from a countries overall generation portfolio. Emission factors for NOx, PMx, and SO2 can be retrieved from literature. A reliable source of data on this factor is the EMEP/EEA air pollutant emission inventory guidebook[13].

In order to estimate the costs/benefits of the air pollution emissions, the increase/reduction (in tons NOx, tons PMx, or tons SO2) of air pollutant emissions is multiplied by the economic unit cost of each pollutant (in EUR/t_NOx, EUR/t_PMx, EUR/t_SO2). Economic unit cost as a monetary value reflecting the pollution cost can be taken from the impact

[13] http://efdb.apps.eea.europa.eu/

assessment report accompanying the revision of the Energy Taxation Directive[14], ExternE studies, NEEDS study, or EEA.[15]

## 9. Innovation

This indicator merits only a qualitative assessment, covering two aspects: (i) technological innovation and (ii) policy innovation. Both of them will have only a qualitative description, will not be monetized and will not be included in the NPV calculation.

As regards the technological innovation, the application should describe the alignment of the project's innovation with national research targets as outlined in each country's NECP within the dimension research, innovation and competitiveness. In addition, a description of the alignment of the project's innovation with research roadmaps at national and EU level, contribution to the creation of strategic value chains for renewables in Europe and advancing EU Renewables Technology leadership in either public or private domain. The Integrated Strategic Energy Technology (SET) Plan could be considered as an EU-wide strategic roadmap covering research and innovation to accelerate the energy transition. In particular, a project's contribution towards the SET key actions areas on renewables[16] could be outlined, thus technological leadership through highly performant RE technologies and their system integration, as well as a reduction of the cost of key technologies. In addition, a project's contribution to achieving the technology-specific strategic targets should be emphasised.

As regards the policy innovation aspect, the application should describe how the c-b RES project overcomes some of the existing barriers to cross-border cooperation in the field of renewables. Such barriers can have political, technical and legal nature where concrete examples of obstacles can be found in studies on cooperation between Member States under the Renewable Energy Directive.[17] By addressing the barriers the project effectively contributes to the harmonisation of policies and regulations, exchange of good practices or innovative policy approaches. This could for example be  the extent of alignment between support schemes or other regulatory conditions and reduction of cross-border distortions.

A qualitative description of both aspects shows the existence of EU added value of the cross-border cooperation at technological and policy level which justifies the related benefits of the project. Therefore, despite the lack of monetisation of this element, it serves an important role in the assessment by the Commission.

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[14] Impact assessment report - SWD(2021)641  English - 1/3, Table 4 of Section 5.2, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12227-EU-Green-Deal-Revision-of-the-Energy-Taxation-Directive_en

[15] See EEA (2014) - Costs of air pollution from European industrial facilities 2008–2012; CE Delft (2010) – External Costs and Benefits of Electricity Generation; CE Delft (2008) – External costs of coal. Global estimate; ExternE project site; NEEDS project site

[16] https://ec.europa.eu/energy/topics/technology-and-innovation/strategic-energy-technology-plan_en#key-action-areas

[17] https://ec.europa.eu/energy/sites/default/files/documents/2014_design_features_of_support_schemes_task1.pdf ; Section 3