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Renewable Energy as a Driver of Grid Resilience: Evidence and Policy Implications

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ABSTRACT

The increasing penetration of renewable energy sources into power systems makes new grid infrastructure upgrades and more accurate tools for assessing their economic sustainability essential. In this framework, this study examines the economic and financial feasibility of the Sardinia–Corsica–Italy 3 interconnection project using the advanced cost-benefit analysis model (CBA 2.0). The results indicate strong economic convenience: the net present value (NPV) reaches 2110 million €, while the discounted benefit-cost ratio (DBCR) stands at 3.41. The main advantages stem from improved socio-economic welfare and a greater capacity to integrate renewable energy; additional benefits include reduced risks related to energy supply, increased grid resilience, and more efficient management of the Sardinian power system. Sensitivity analyses confirm the robustness of these outcomes, with NPVs ranging between 1977 and 2248 million € and DBCR values between 3.12 and 3.77, variations primarily driven by the discount rate and capital expenditure. The study thus highlights how the central role of renewable energy and grid resilience, combined with advanced CBA methodologies, can support investment decisions consistent with energy transition goals.

Keywords: Cost Benefit Analysis, Economic Analysis, Grid, Renewable Energy, Sustainable Development, Socio-Economic Well-Being
JEL Classifications: O44, Q20, Q40, Q57

1. INTRODUCTION

Cost-benefit analysis (CBA) has established itself as a key tool for supporting public and private decisions in sectors ranging from energy to healthcare, urban planning to new technologies, and even social sciences (Chelli et al., 2025; Dwianika et al., 2024). Its main strength lies in its ability to translate costs and benefits into monetary terms, making complex scenarios comparable and guiding choices towards objectives consistent with sustainable development.

A crucial aspect concerns projects with long-term environmental and social impacts: In these cases, it is necessary to adopt extended time horizons to avoid distortions that favour carbon-intensive or ecosystem-damaging initiatives (O'Mahony, 2021). To address uncertainty, the literature emphasises the importance of scenarios and sensitivity analyses, tools that strengthen the robustness of assessments. At the same time, there is a need to integrate CBA with other methods, such as Life Cycle Sustainability Assessment, to connect micro and macroeconomic perspectives and provide useful indicators for a variety of stakeholders (Padilla-Rivera et al., 2023).

Among the most promising sectors, the energy transition plays a central role. Sustainable Development Goal (SDG7) aims to support the production of clean and affordable energy. Pilot projects have shown that investments in renewables and smart technologies not only reduce emissions but also generate rapid economic returns, lower operating costs and increase system flexibility (Gudlaugsson et al., 2023; Mohnot et al., 2025). Replacing coal with clean energy is proving to be crucial for the profitability of transmission infrastructure, provided that environmental externalities are internalised (Wang et al., 2024). Other experiences, such as innovative network management or active planning, show how CBA helps identify solutions that significantly reduce infrastructure costs, with savings compared to traditional strategies (Anaya and Pollitt, 2022; Rana et al., 2023). Economic analyses show that investments in smart grids can only be justified through rigorous cost-benefit analysis capable of measuring gains in terms of efficiency and reduction of outages (Boateng et al., 2025). Some analysis show that advanced asset management technologies are the most profitable, followed by advanced distribution operations, advanced transmission operations, and advanced metering infrastructure (Alaqeel and Suryanarayanan, 2019).

Emerging technologies are also evaluated using CBA. Hybrid solar-biomass systems, for example, show good potential in terms of energy security and emissions reduction, although they need improvements in efficiency and cost reduction (Fang et al., 2023). Other research integrates CBA with advanced predictive tools, such as optimised neural networks, which can increase the accuracy of financial forecasts and improve energy demand management (Jin et al., 2021; Yang et al., 2024). Digital twins of energy systems are also analysed from a CBA perspective, with applications in renewable energy investments and infrastructure reliability (Bassey et al., 2024).

A further area concerns resilience, reliability and safety. New indicators quantify the impact of line failures on energy not supplied (Chivunga et al., 2025). Other studies highlight the need to consider environmental and social externalities in service disruptions (Siavash-Abkenari et al., 2024). Applications extend beyond electricity: in the gas pipeline sector, CBA defines the optimal target reliability level in relation to asset ageing (Shan et al., 2024); in aquaculture, the tool allows economic, social and environmental costs and benefits to be balanced (Samat et al., 2024).

The social dimension completes the picture. Some studies show that electrolytic ammonia production is only competitive when the social cost of carbon is taken into account, confirming the need to internalise environmental and collective impacts (Cunanan et al., 2025). Similarly, other analyses confirm the economic sustainability of replacing coal with solar power (Sugiyono et al., 2024), while further research combines CBA with the levelised cost of energy to configure photovoltaic systems with storage and achieve net-zero targets (Boruah and Chandel, 2024; Ye et al., 2024).

Finally, the literature highlights how methodological differences between countries make standardisation urgent (Hekrle et al., 2023). Integrated approaches between GIS and CBA show promise in identifying suitable sites for renewable energy plants, offering practical tools for planning and policy (Pojadas and Abundo, 2022). These studies therefore show that CBA is not only a technical tool, but also a common language for assessing economic sustainability, resilience and social impacts, supporting strategic planning in a wide range of sectors - from renewables to smart grids, from critical infrastructure to emerging technologies.

The growing role of renewable energy in the reorganisation of electricity grids requires substantial investments in grid infrastructure and robust methodologies to assess their economic and financial viability. In this context, this research aims to evaluate a project in Southern Europe by applying an advanced cost-benefit analysis (CBA 2.0). The objective is to quantify the economic attractiveness of the project, identifying its main benefits and critical variables. In particular, the study evaluates the net present value (NPV), the discounted benefit-cost ratio (DBCR), the discounted payback time (DPBT) and the internal rate of return (IRR), while verifying the robustness of the results through sensitivity and scenario analyses. The implications of this work aim to provide information on social welfare, renewable energy integration, supply risks and grid resilience, assessing its strategic role in the energy transition.

2. LITERATURE REVIEW

The systematic literature review (SLR) was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The literature search was carried out in the Scopus database on 25 October 2025, using the following all-fields search query - Figure 1:

- "cost-benefit analysis" AND "renewable energy" AND "grid" OR "infrastructure" AND "resilience" AND "sustainable" OR "sustainable development."

The number of articles identified and retrieved from Scopus was 1796. China has 373 documents, followed by United States (320), United Kingdom (199), India and Italy (134). The temporal distribution peaks in 2025 with 475 documents, showing an upward trend: 159 (2021), 205 (2022), 261 (2023) and 365 (2024). Among the journals, Energies stands out with 90, followed by Sustainability (65) and Applied Energy (49).

Two exclusion criteria were initially applied:

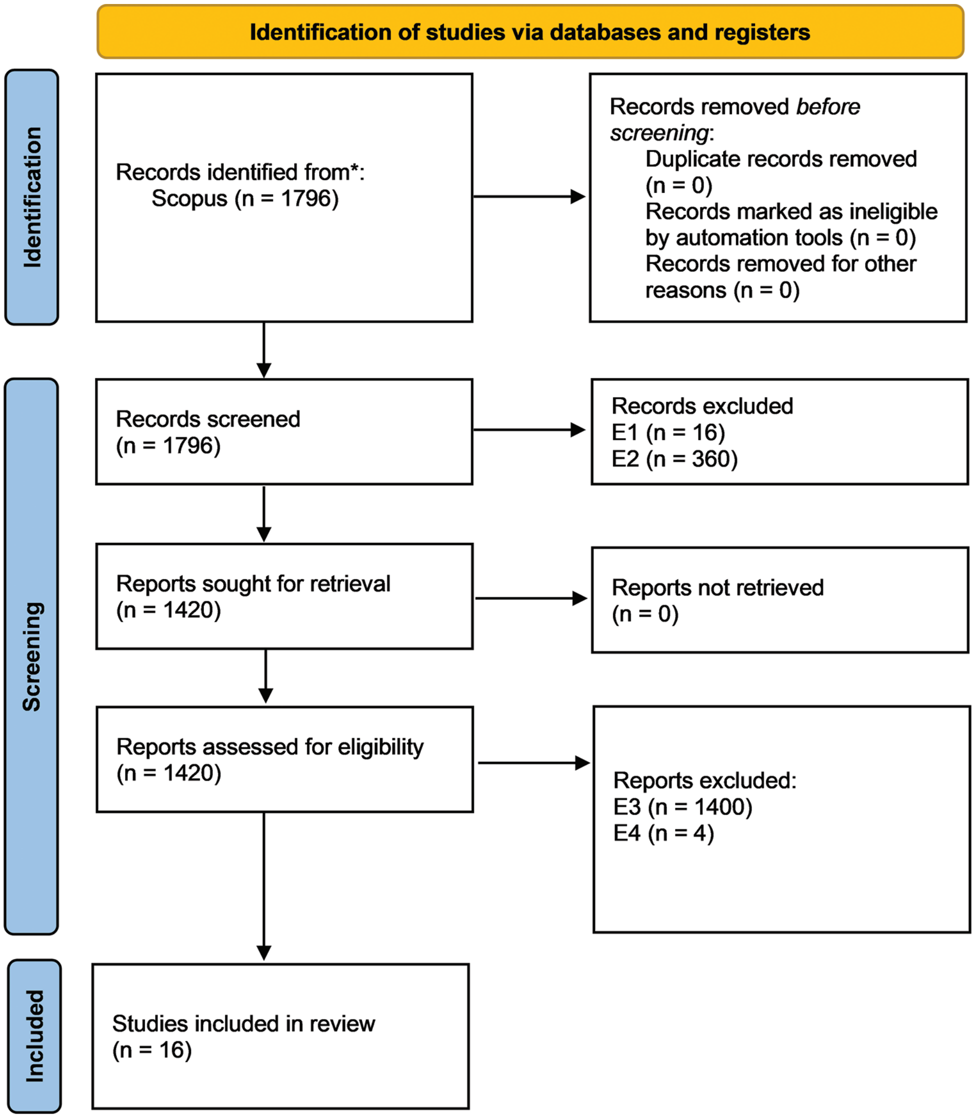
- E1 - The publication was not in English.
- E2 - The publication was not an article or review.

Subsequently, other two exclusion criteria were considered:

- E3 - The previous query by analysing only the title, abstract and keywords fields, rather than all fields.
- E4 - Topic not in line.

The analysis of studies included in review has identified the following aspects. The transition to sustainable energy systems requires an integrated approach that combines technical efficiency, economic sustainability, and environmental and social benefits. Several recent studies have highlighted the need to simultaneously optimise multiple objectives, such as maximising efficiency, improving energy flows, reducing costs, and limiting emissions (Reza et al., 2026). A key aspect that has emerged from the literature concerns the importance of cost-benefit analysis as a

Figure 1: PRISMA scheme



decision-making tool. This approach makes it possible to identify optimal configurations for energy storage and distribution, ensuring coordinated operation between heterogeneous and distributed resources. An application model shows the advantages in relation to water resources (Bofill et al., 2025).

The global transition towards decentralised energy systems represents a structural shift towards more sustainable models (Schnidrig et al., 2024). In the field of decentralised energy management, the use of intelligent control systems has shown considerable potential for increasing resilience and reducing operating costs. The integration of adaptive logic and fuzzy methods allows demand and supply to be dynamically balanced, optimising consumption during peaks and favouring renewable sources at times of greatest economic convenience (Edel Quinn Julin et al., 2025). Biomass hydrogen production systems, analysed using multi-objective optimisation models, also demonstrate the need to balance efficiency, economic sustainability and environmental performance (Moosazadeh et al., 2025). Other studies show that including climate variability in system analyses can reduce operating costs and improve grid stability (Ahmed et al., 2025). Energy resilience is a goal linked to economic optimisation models (Camilo et al., 2023).

Renewable microgrids ensure energy security, local development and better living conditions, maintaining resilience even in the face of climate and cost variations (Ashraful Islam et al., 2024), and scenario assessments also show that optimised configurations can bring benefits in all three dimensions of sustainability (Zhang et al., 2020). Comparative analyses show that combining different renewable energy sources increases energy reliability, reduces grid dependency and improves overall sustainability (Ghiasi et al., 2025).

The sustainability of smart cities requires socio-demographic and environmental analysis of redevelopment proposals to verify whether innovation generates wealth and supports low-emission urban districts. This promotes inclusive and resilient growth, geared towards post-carbon and climate-neutral economies (Deakin and Reid, 2018).

At the same time, technological innovation contributes to long-term cost reduction (A'amar et al., 2025). Although the integration of technologies and the use of appropriate materials in the context of renewables require significant investment, they generate economic and environmental benefits over time (Dabar et al., 2024; Melhim and Isaifan, 2025). In this context, the development of regional circular economies can be based on a mix of energy production and waste management (Valencia et al., 2022).

Traditional economic analyses often fail to fully value indirect benefits such as reliability, energy quality and indoor comfort. An extended cost-benefit analysis that takes these factors into account shows that renewable and efficiency solutions produce higher economic returns than estimated by conventional models (Sklar, 2014). Overall, it is clear that economic and environmental sustainability cannot be separated from an integrated assessment of costs and benefits. Only a holistic approach, capable of including social, ecological and resilience dimensions, can steer policies and investments towards a truly sustainable and equitable energy future.

3. MATERIALS AND METHODS

The cost-benefit analysis used by Terna to evaluate new development projects within the electricity transmission grid is called CBA 2.0. This section provides a general description of this tool and subsequently presents the case study to which it was applied. The documents consulted at this stage are those publicly available on the Terna website (https://www.terna.it/it).

3.1. General Framework

It is important to clarify that the CBA is not only a technical tool for selecting and prioritizing investments, but also an accountability mechanism for the community. Its use ensures that the financial and material resources employed generate effective economic, social, and environmental benefits, and that the success of the investments is measurable and verifiable by users as well (Brent, 2023; Drèze and Stern, 1987; Muhibbullah et al., 2021). In fact, the importance of careful planning of the electricity grid does not exclusively concern the national system operator but is reflected in the efficiency and resilience of the entire energy chain, which extends from producers to final consumers (Dalala et al., 2022; Wu et al., 2021). This process is an essential element for all actors involved, with implications ranging from the operational to the strategic level. A new development intervention on the transmission electricity grid can generate several advantages for the system, among the most important are:

- Increase in welfare system;
- The reduction of congestion within the electricity system;
- The implementation of new technologies that allow for a greater integration of Renewable Energy Sources (RES);
- Ensuring the security and adequacy of the electricity system.

The complexity and delicacy of the task of evaluating and prioritizing investments in the electricity grid require continuous updates to the methodology. This approach is subject to annual revisions by Terna and important European bodies such as the European Network of Transmission System Operators for Electricity (ENTSO-E) and the Agency for the Cooperation of Energy Regulators (ACER), as well as by research organizations and the Italian Regulatory Authority for Energy, Networks and Environment (ARERA). These adjustments take into account both the dynamic evolutions of the electricity market and the physical progress of the works included in the Transmission Electricity Grid Development Plan. Terna's applied methodology is documented and updated annually through publicly available documents that accompany Terna's Network Development Plan (PdS), and together they offer a complete and transparent view of the Italian electricity system and the interconnection works with other countries managed by Terna.

The application of the CBA 2.0 is divided into four main phases. The process begins with the identification and quantification of benefits in terms of physical quantities, such as MWh. Subsequently, these indicators are monetized by multiplying them by an appropriate coefficient, expressed in € per unit of quantity, in order to obtain an economic evaluation of the effects associated with a specific development intervention. A further step consists of the quantification of costs, an operation that culminates in the calculation of the summary economic indices, such as the DBCR and the NPV. Both indexes are used in the context of energy projects (D'Adamo et al., 2021; Kelly and Leahy, 2020), however, the use of NPV appears to be able to provide comprehensive information to the various stakeholders (D'Adamo et al., 2025a, 2025b; Martins et al., 2023; Shand et al., 2025).

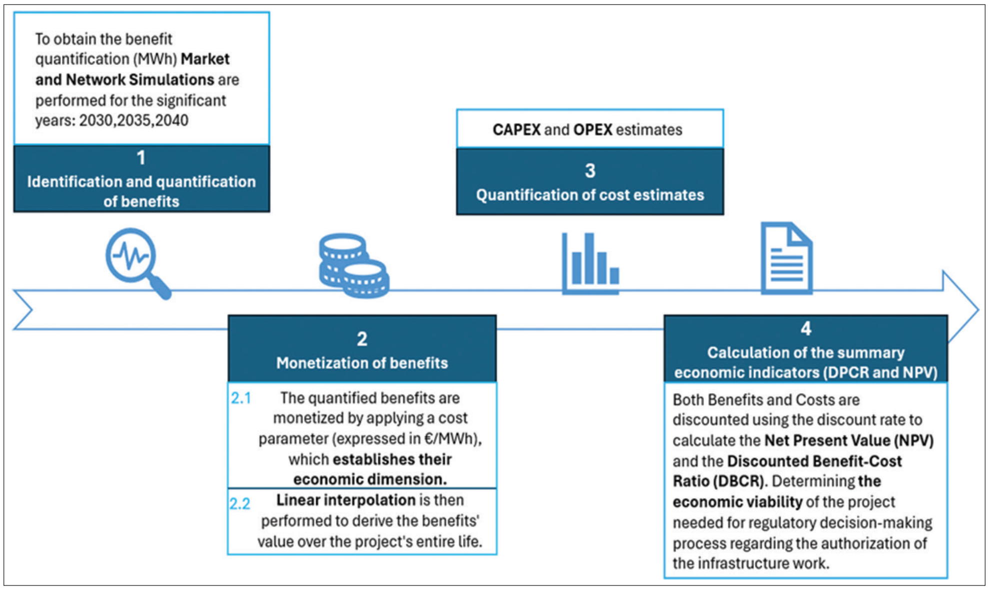
The main steps for the CBA 2.0 application are synthesized in Figure 2. The System Utility Indicator (IUS), commonly adopted by Terna, serves a role comparable to that of the DBCR, as it provides a synthetic measure of the project's overall economic convenience and utility.

For the implementation of this methodology, the grid operator (Terna) has identified three significant evaluation years: 2030, 2035, and 2040. The objective of this choice is twofold. On the one hand, it aims to provide a strategic vision that is in line with the potential future developments of the Italian electricity grid. On the other, it aims to define distinct time horizons—short-to-medium term, medium-to-long term, and long term—to allow for a precise and accurate analysis of the most immediate scenarios while maintaining a forward-looking perspective. The main sub-scenarios used in this analysis are:

- Policy scenarios (PNIEC Policy): These scenarios reflect the implementation of the energy policies outlined in the Integrated National Energy and Climate Plan (PNIEC). They are based on ambitious objectives concerning decarbonization and energy transition and are considered the "reference" scenarios because they align with official commitments.
- Accelerated/deep decarbonization scenarios (GA-IT/DE-IT): These scenarios anticipate an even more pronounced decarbonization, thus representing an optimistic situation in terms of energy transition.
- Slow scenarios (PNIEC Slow): Conversely, this case considers a slower, "decelerated" path with less ambition. It represents a pessimistic scenario that helps to avoid overestimating the profitability of projects.

When referring to the cost-benefit analysis (CBA) for infrastructure development projects, it is appropriate to consider the use of

Figure 2: Main phases of CBA 2.0



two distinct approaches. The first applies to projects related to interconnections and network reductions, both between market zones and intra-zonal, which are evaluated through two contrasting scenarios to ensure a robust analysis. The second approach, on the other hand, applies to all other projects and involves the use of a single reference scenario.

The calculation of benefits is based on the use of sophisticated simulation tools. These models are designed to reproduce both the complex composition of the Italian electricity market and the specific physical characteristics of the entire network. As detailed in the "Methodological document for the application of the cost-benefit analysis applied to the 2025 development plan", these tools can be divided into two main categories:

- Market simulations;
- Network simulations (in static and probabilistic regimes).

The analysis proceeds in a unidirectional and sequential manner, where the network simulator verifies the physical feasibility of the optimal economic scenario provided by the market simulator. This is the standard convention for cost-benefit analyses that separate the economic valuation (market benefits) from the physical valuation. The first simulation tool evaluates the effects of the interventions on the day-ahead market (DAM), allowing for the estimation of the hourly energy price between different market zones. This process subsequently makes it possible to quantify the Producer and Consumer Surplus, as well as to calculate the revenues deriving from network congestion. The information used for modeling the electricity system is varied and includes the consideration of storage systems, ETS (emissions trading system) allowances, and non-programmable renewable energy sources (NP-RES). Also integrated into this analysis is a component related to the costs for network services and for the procurement of resources on the dispatching market. For this specific activity, a distinct tool known as MODIS (market operations and dispatching) is used, which incorporates data related to the Intraday Market and the constraints on the security of the electricity system.

On the other hand, Network simulations use historical data on the unavailability of network elements based on the analysis of past failures. For this type of evaluation, it is possible to adopt a static approach, such as Load Flow, or, more commonly, a probabilistic approach. The evaluations of individual interventions, aimed at calculating the benefits, are mainly obtained by comparing the results of simulations with and without the intervention, a method known as the take one out at a time (TOOT) Approach. The difference in effects between these two scenarios represents the value of the benefit, which can be zero if the variation between the situation with and without the intervention falls within the simulator's tolerance.

3.2. Model

The CBA 2.0 methodology first requires the definition of the analysis's time horizon (equal to the useful life of the investment) and the discount rate. The main reference assumptions adopted are the following:

- Economic life equal to 25 years of operation;
- No residual value at the end of life;
- Real discount rate of 4%.

The real discount rate isn't a discretionary choice of the System Operator, but constitutes a binding, defined parametric assumption within the methodological framework of the CBA, as approved by the Italian regulatory authority for energy, networks and environment (ARERA). This value is adopted to guarantee the neutrality and comparability of assessments for development interventions on the National Transmission Grid, aligning with European evaluation standards, indicated by ENTSO-E, for strategically important energy infrastructure investments. The benefits derived from the application of the Italian methodology total fifteen and include various sub-indicators. These primarily relate to the approach used for calculation, which can be based on static or probabilistic analysis. Specifically, for a generic benefit indicated as "BX," the notation "BX.a" is used for probabilistic simulations and "BX.b" for static ones. Terna provides a methodological document on the application of the Cost-Benefit

Analysis every year. The last edition is the "Methodological document for the application of the cost-benefit analysis applied to the 2025 Development Plan." Within it, all the benefits included in the model, which are listed in the Tables 1 and 2, are defined.

The benefits represented in the table are categorized into the following macro-groups (referring to the "Methodological document for the application of the cost-benefit analysis applied to the 2025 Development Plan"):

Table 1: List of benefits

ID	Benefit
B1	Variation (increase) of socio-economic welfare (SEW) related to the functioning of the energy market and to the increase of transfer limits between relevant network zones or at borders
B1.b	Variation (reduction) of generation costs in the case of new interconnections with isolated systems
B2.a	Variation (reduction) of network losses calculated through probabilistic simulations
B2.b	Variation (reduction) of network losses calculated through load flow calculations at peak load and conventional utilization coefficients of peak losses
B3.a	Variation (reduction) of expected Energy Not Supplied (ENS) calculated through probabilistic simulations
B3.b	Variation (reduction) of Energy Not Supplied (ENS) calculated through static load flow simulations
B4	Avoided or deferred costs (or, with negative sign, additional costs) related to generation capacity subject to remuneration schemes that integrate or replace revenues from the energy markets and the dispatching services market, in the absence of double counting with benefits B1 and B7
B5.a	Greater integration of renewable energy sources (RES) production, including the share of local congestions (calculated through probabilistic simulations) solved by development projects
B5.b	Greater integration of renewable energy sources (RES) production calculated through static load flow simulations (local congestions)
B5.s	Greater integration of renewable energy sources (RES) production resulting from the dispatching services market (reduction of system overgeneration), in the absence of double counting with benefits B1, B7, and B8
B6	Avoided investments in electricity transmission infrastructures that would otherwise have been necessary in response to non-deferrable requirements (e.g., compliance with legal constraints)
B7	Variation (reduction) of costs for network services and procurement of resources on the dispatching services market calculated through probabilistic network simulations
B8	Variation (reduction) of costs for network services and procurement of resources on the dispatching services market calculated through dispatching market simulations
B16	Avoided operating costs associated with electricity transmission infrastructures that would otherwise have been necessary in response to non-deferrable requirements (e.g., compliance with legal constraints)
B18	Variation (reduction) of negative externalities associated with the increase of CO_2 emissions, in addition to the impacts already monetized in benefit B1 through the CO_2 price, to account for the social cost of emissions
B19	Variation (reduction) of negative impacts associated with the increase of other emissions, neither CO_2 nor greenhouse gases, such as sulfur oxides and nitrogen oxides

Table 2: Description and computation of benefits

ID	Description	Computation
B1	It is related to the functioning of the energy market and the increase of transit limits between network zones. It represents a direct measure of the greater efficiency of the electricity market.	The indicator is calculated using the Total Surplus Approach (TS) which consists of maximizing the sum of the Consumer Surplus, the Producer Surplus, and Network Congestions.
B1.b	The indicator refers to the interconnection of isolated systems that can generate savings in generation costs through more efficient generation plants.	The benefit is estimated deterministically by calculating the share of energy produced by conventional plants that is replaced.
B2.a	An indicator linked to the improvement of power network flows resulting from the increased meshing of the grid.	The quantification is done through static and probabilistic simulations. For monetization, the value found from the simulations is multiplied respectively by the average PUN and the hourly PUN.
B2.b	It measures the variation of the risk of unsupplied energy (ENF) within the system and can be obtained through a static or probabilistic approach.	The calculation involves estimating and summing the values of unsupplied power for the purpose of calculating the ENF. Monetization is returned by multiplying the value found through the simulations by the Value of Lost Load (VOLL) in the case of static simulations, or by using the average price of the energy market (MGP) for probabilistic simulations.
B3.a	It quantifies the savings or increased costs related to generation capacity that receives a specific remuneration should such capacity be avoided and postponed as a consequence of network development projects. It is linked to tools like the Capacity Market.	The valuation is done either by estimating the costs of essential units for the safety of the electrical system, or by monetizing the necessary thermoelectric capacity in case the development project is not implemented, valuing it at 75 k€/MW, consistent with the Capacity Market.
B3.b	It estimates the potential of development projects in integrating energy from renewable sources through probabilistic and static network simulations. It is a measure related to the reduction of curtailment and the risk of overgeneration in the system. The removal of market constraints allows the system to absorb part of the overgeneration, which can be partially reflected in B1 (the portion related to the DAM) and partly in B5 in addition to the "local" overgeneration.	The quantities found through simulations return the value of integrated energy as the sum of the share of local overgeneration resulting from network simulations (B5.a/B5.b) and system overgeneration resulting from MSD market simulations (B5.s). The resulting energy value is multiplied by the variable cost of marginal thermoelectricity foreseen in the scenario and study year considered.

(Contd...)

Table 2: *(Continued)*

ID	Description	Computation
B4	It estimates the potential of development projects in integrating energy from renewable sources through ancillary services market simulations (post-MSD system). The analysis for determining overgeneration is performed using the MSD simulator on a predictive network.	The quantities found through simulations return the value of integrated energy as the sum of the share of local overgeneration resulting from network simulations (B5.a/B5.b) and system overgeneration resulting from MSD market simulations (B5.s) with a deterministic approach. The resulting energy value is multiplied by the variable cost of marginal thermoelectricity foreseen in the scenario and study year considered.
B5.a	This indicator quantifies the investment costs that the development project allows to avoid, such as the restructuring of the existing network or maintenance activities that would have otherwise been necessary as a response to unpostponable needs. If B6 is valued, the significance of operational costs can also be evaluated through indicator B16.	The analysis provides the economic valuation of the indicator, the year in which the investment would have been made, and the number of years of deferral in the case that the investment was deferred.
B5.b	The implementation of development projects (which avoid network overloads, maintain adequate voltage profiles, and ensure secondary or tertiary reserve margins) allows for the reduction of costs for resources procured on the MSD. An intra-zonal reinforcement primarily reduces the movements on the MSD necessary to eliminate congestion in the specific market zone it affects.	The deterministic simulations performed using MODIS return the upward and downward movements on the MSD. In the case of movements due to FER plants, the quantity moved for the related cost is captured within B5, and for this reason, this latter quantity is subtracted from B7 to avoid double counting. The resulting quantity from the MSD simulator is multiplied by the estimated costs of procuring resources on the services market.
B5.s	The implementation of development projects (which avoid network overloads, maintain adequate voltage profiles, and ensure secondary or tertiary reserve margins) allows for the reduction of costs for resources procured on the MSD. An inter-zonal project, in addition to increasing transit limits, can help make contiguous resources available, which reduces movements on the MSD.	The deterministic simulations performed using MODIS return the upward and downward movements on the MSD. In the case of movements due to FER plants, the quantity moved for the related cost is captured within B5, and for this reason, this latter quantity is subtracted from B7 to avoid double counting. The resulting quantity from the MSD simulator is multiplied by the estimated costs of procuring resources on the services market.
B6	If significant, the costs related to the operational charges and ordinary maintenance (OPEX) of the assets that would have been necessary in the absence of the project are also considered.	The analysis provides the economic valuation of the indicator, the year in which the investment would have been made, and the number of years of deferral in the case that the investment was deferred.
B7	It measures the reduction of CO_2 emissions associated with factors not linked to B1 (impact of emissions on public health, impact of emissions on the environment).	The variation in emissions is linked to the change in the production mix. These variations are calculated through market simulations. To obtain the economic value of the indicator, the resulting quantity from the simulations is multiplied by the social cost of CO_2 net of the price of CO_2 emissions already considered.
B8	It measures the reduction of emissions such as NOx, SO₂, PM2, and PM10 associated with factors not linked to B1 (impact of emissions on public health, impact of emissions on the environment).	The quantification is done in the same way as B18 with the exception that, due to the predominantly local effects of the pollutants considered, the emissions considered are confined to the Italian perimeter. Monetization is calculated using the economic value of other gases.
B16	It is related to the functioning of the energy market and the increase of transit limits between network zones. It represents a direct measure of the greater efficiency of the electricity market.	The indicator is calculated using the Total Surplus Approach (TS) which consists of maximizing the sum of the Consumer Surplus, the Producer Surplus, and Network Congestions.
B18	The indicator refers to the interconnection of isolated systems that can generate savings in generation costs through more efficient generation plants.	The benefit is estimated deterministically by calculating the share of energy produced by conventional plants that is replaced.
B19	An indicator linked to the improvement of power network flows resulting from the increased meshing of the grid.	The quantification is done through static and probabilistic simulations. For monetization, the value found from the simulations is multiplied respectively by the average PUN and the hourly PUN.

- Benefits on the day-ahead market (DAM) - this category includes all benefits that manifest through the optimization and improvement of the functioning of electricity markets. Benefits B1, B1.b, B2, B4, B6, B8, and B16 are part of it.
- Benefits on the ancillary services and dispatching market (MSD) - this type concerns the savings or additional costs incurred by Terna to manage and balance the electricity system in real time through the Ancillary Services Market. Benefit B7 is included within it.
- Benefits on the integration of RES - This class measures the contribution of a grid project to maximizing the production and use of energy from renewable sources. It is represented by benefit B5.
- Environmental and Social Benefits - This category includes the positive (or negative) impacts that a project generates on the environment and on society in general, beyond the direct economic market benefits. It is realized in benefits B18 and B19.
- Benefits on service quality and security - This category unifies the impacts that improve the reliability and robustness of the electricity system, guaranteeing the continuity and quality of energy supply. The main benefit is linked to the reduction of service disruptions and supply interruptions and is reflected in B3.

The benefits of a specific project are calculated starting from the year after it goes into service. For evaluation, the values of the benefit indicators calculated for three reference years (2030, 2035, and 2040) are used; the values for intermediate or subsequent years are estimated through a linear interpolation process according to predefined rules:

- For the interval between the expected completion date and the first study year (inclusive) - the value of the benefits obtained for the first study year;
- For the interval or intervals between two study years (exclusive) - linear interpolation of the benefits obtained in the two study years;
- For the interval after the last study year considered - the value of the benefits obtained in the last study year considered.

In this way, a benefit value is defined for each year of the project's useful life. Finally, the cost section is fundamental for establishing the bases on which the economic costs of each project are evaluated. Two main classes of costs are defined: Capital expenditure (CAPEX) and operational expenditure (OPEX). For the estimation of these items, specific criteria are used that also consider contingency costs, which are those additional amounts intended to cover unforeseen events during the various phases of project development, ensuring a more realistic and complete financial evaluation. As for costs, the investment cost (CAPEX) of a project is conventionally attributed to the year it goes into service and is discounted to the year the reference Development Plan is prepared. Operating and maintenance costs (OPEX), on the other hand, are conventionally considered for a time frame of 25 years, starting from the year following the one it goes into service, and they are also discounted to the year the Plan is drafted (Reference Plan).

In the process of evaluating a project, not all potential benefits are monetized. Instead, a targeted quantification approach is adopted, which focuses specifically on the objectives that a project aims to achieve through its implementation in the grid.

This approach is evident in the development plans, where the methodology used by Terna associates each individual project with one or more purposes (or "drivers") that indicate the main benefit the works are intended to produce. These purposes include:

- Decarbonization;
- Security and resilience;
- Market efficiency;
- Sustainability.

3.3. Case Study and Input Data

Within this article, a specific transmission electricity grid development project was selected for in-depth economic analysis, with the aim of evaluating the robustness of the results obtained by applying the cost-benefit analysis (CBA) 2.0 methodology. The practical example of this analysis, provided by Terna, examines the SA.CO.I.3 project, a strategic link that connects Sardinia, Corsica, and Italy. The significance of this work transcends the national context and holds considerable importance at a European level as well. This specific intervention - the revitalization and upgrade of the historical link between the Italian mainland, Corsica, and Sardinia - was selected due to its profound impact on electricity market efficiency and the completeness of its associated cost-benefit documentation. The project holds paramount importance for the reduction of electric system congestions, as the upgraded system substantially increases the transfer capacity between these strategic islands and the mainland, directly addressing historical grid limitations. This increase facilitates more efficient energy flows, particularly from RESs generated in Sardinia, and ultimately promotes price convergence across the linked market zones, thereby enhancing overall system flexibility and reducing the operational costs borne by consumers. Furthermore, from a practical analytical perspective, SA.CO.I 3 is an ideal case study because it features extensive and detailed monetization of benefits. The project's assessment incorporates a high number of quantifiable benefits mandated by the regulatory framework, including market efficiency improvements, security of supply enhancement, and reduced emissions. This comprehensive valuation allows our research to obtain an almost complete quantitative picture of all the advantages that a major electrical transmission intervention can entail, providing a robust foundation for testing the constraints and limitations of the current CBA methodology. Finally, the significance of this work transcends the national context and holds considerable importance at a European level as well, as the link connects three distinct control areas (Italy, France, and a sub-zone of the Italian market), contributing directly to the European goal of building an integrated, resilient, and decarbonized single energy market.

Sardinia is currently the subject of numerous and costly electricity grid enhancement projects, among which the Tyrrhenian Link stands out.

Regarding this project, it is important to specify that each of the projects contained within the development plan has two fundamental identifying keys:

- PdS identifier - a unique code identifying the project in the Development Plans;
- PCI identifier - a unique code identifying the project in the Union List of Project of Common Interest (EU 869/2022), where applicable.

The SA.CO.I.3 is a project that consists of the modernization and strengthening of the already existing interconnection between Sardinia, Corsica, and Italy (SA.CO.I 2), which has now reached the end of its useful life. As a PCI, the development of this project is also aimed at achieving the decarbonization objectives of the European electricity system. The SA.CO.I.3 project represents a fundamental initiative for the strengthening and modernization of the existing electrical interconnection between Sardinia, Corsica, and Italy, known as SA.CO.I.2, which is now reaching the end of its useful life.

This project has a dual identifier: it is recognized as 301-P in the Development Plan (PdS) and as 1.10 in the European Union's list of Projects of Common Interest (PCI). As a PCI, the project takes on considerable importance at a continental level, directly contributing to the achievement of the European electricity system's decarbonization goals.

The SA.CO.I.3 affects the regions of Sardinia and Tuscany, operating in the Sardinia and Central-North market zones (Figure 3). Its main purposes, or "drivers," are multiple and interconnected. It aims to improve the security and resilience of the system, promote the integration of RES, and strengthen interconnections between different areas. Additionally, the project is oriented towards sustainability, the improvement of connections to the National Transmission Grid (NTG), and the integration of the Italian Railway Network (RFI). The entire initiative is included in the 2023 Development Plan, confirming its strategic importance for the energy future of the country and of Europe.

The project was conceived with an entry into service in 2027, but the completion of the work has recently been postponed by two years. In this regard, the data used for the upcoming analyses (Benefits, Costs, Entry into service, etc.) refer to Terna's 2023 development plan, and therefore the entry into service year considered is 2027. The benefits for this project, estimated for the years 2030, 2035, and 2040, are presented in Table 3.

As can be observed, for any given project, it is not necessary to quantify and monetize all the benefits available in the CBA methodology, nor is it mandatory to calculate the indicators for every equivalent year. In this case, in fact, the linear interpolation is done using the years 2030 and 2040 as endpoints. Moving on to costs, it is noted that for some projects, within the development plan's data sheets, OPEX is reported as a percentage of the estimated CAPEX. In this specific case, the costs are illustrated in Table 4.

4. RESULTS

This section presents the results obtained from the CBA for the case study. Starting from the base case analysis, the summary indicators NPV and DCBR are highlighted. Consequently, additional analyses are conducted through sensitivity and scenario analysis, evaluating alternative scenarios.

Figure 3: Framing of SA.CO.I.3

4.1. Baseline Scenario

Table 5 details the application of linear interpolation to accurately quantify the annual benefits spanning the project's entire useful

Table 3: Benefits for SA.CO.I.3

Benefits	2030 [M€]	2035 [M€]	2040 [M€]
B1	68	/	85
B2	/	/	/
B3.a	2	/	−1
B4	/	/	/
B5.a	117	/	52
B6	/	/	/
B7	−1	/	/
B8	132	/	/
B16	/	/	/
B18	2	/	27
B19	−3	/	1

Table 4: Costs for SA.CO.I.3

Costs	M€
CAPEX invested	181
CAPEX estimated	950
OPEX (as CAPEX percentage)	0.5%/year

Table 5: Linear interpolation of benefits

Project phases	Years	Project schedule	Gross Benefit [M€/year]	Discounted benefits [M€/year]
Development Plan	2023			
	2024			
	2025			
	2026			
Start of operations	2027	0		
	2028	1	317	260.55
	2029	2	317	250.52
	2030	3	317	240.89
	2031	4	301.4	220.23
	2032	5	285.8	200.79
	2033	6	270.2	182.53
	2034	7	254.6	165.38
	2035	8	239	149.27
	2036	9	223.4	134.16
	2037	10	207.8	119.99
	2038	11	192.2	106.72
	2039	12	176.6	94.288
	2040	13	161	82.65
	2041	14	161	79.47
	2042	15	161	76.41
	2043	16	161	73.47
	2044	17	161	70.65
	2045	18	161	67.93
	2046	19	161	65.32
	2047	20	161	62.80
	2048	21	161	60.39
	2049	22	161	58.07
	2050	23	161	55.83
	2051	24	161	53.68
End of life	2052	25	161	51.62
Total			5195	2983.73

life. Subsequently, these benefit values, alongside the associated costs, were subjected to a discounting process to facilitate the calculation of the project's definitive summary indicators. Table 6 presents the aggregate value of the discounted costs for each typology (CAPEX and OPEX), culminating in the final determination of the NPV and the DBCR.

As evidenced by Table 7, the project proves to be highly profitable, given that it presents a Net Present Value significantly greater than zero and a DBCR greater than one. The benefits that have the greatest impact on the final result, or those with the most relevant contribution, are Variation (increase) of Socio-Economic Welfare (B1) and Greater integration of RES production (B5). It should also be noted that the interconnector will contribute to reducing the risks of unsupplied energy (B3), limiting blackouts and interruptions, especially in the 2030 scenario, with a considerable benefit for consumers.

Finally, the new grid infrastructure will optimize the Sardinian system, enable more effective management of excess energy production and reduce reliance on certain fossil fuels, all aimed at ensuring a more efficient and secure operation. Furthermore, the project generates an economic return within a few years. As illustrated in Figure 4, the cumulative flows of costs and benefits become positive as early as the fourth year. Precisely the DPBT is equal to 4 years and 6 months. Additionally, the project's IRR was calculated, reaching 30%. This high value is highly significant as it substantially exceeds the 4% real discount rate used in the CBA framework. An IRR of 30% strongly confirms the project's economic viability, indicating that the intervention generates substantial returns well beyond its capital costs.

4.2. Alternative Scenarios

In this subsection, a detailed analysis is conducted on the results obtained in the base case to verify the robustness and validity of the findings. Sensitivity analysis examines how a project's economic outcomes change as its key parameters vary, such as costs, revenues, implementation times, and the cost of capital. This process is crucial for identifying areas of greater uncertainty and for preparing adequate measures in advance to minimize potential negative effects. It's a procedure that the network manager frequently performs to prove the reliability of the results, typically by varying the most significant benefit by a certain percentage. In the analysis discussed here, all inputs were varied by ±10%, in specific when a benefit is increased of 10% it configures an optimistic case study, while a decrease of 10% represents a pessimistic case study, vice versa for costs (CAPEX and OPEX) and the discount rate. The results obtained from the sensitivity analysis are represented in Tables 8 and 9.

In Figure 5, the most relevant impacts on the NPV generated by the input variation are represented. As expected, the increase in welfare (B1) and RES integration (B5) are undoubtedly the benefits that impact the calculation of NPV and IUS the most. In addition to this, percentage changes in CAPEX and the discount rate also led to significant variations in the summary indicators, though in any case confirming the project's profitability and undertaking. The variation of Energy not supplied (B3) is also reported, however

Figure 4: Break-even analysis: Cumulative flows

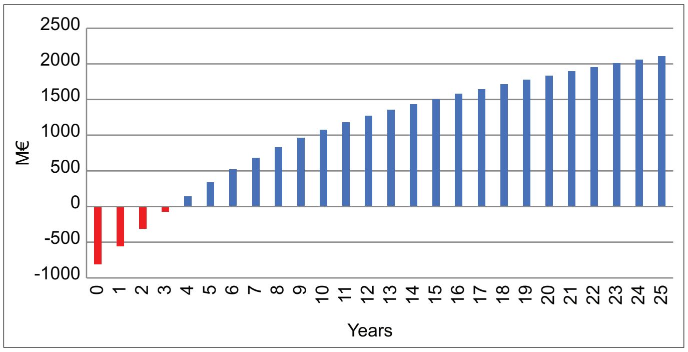


Figure 5: Sensitivity analysis: impact on the NPV

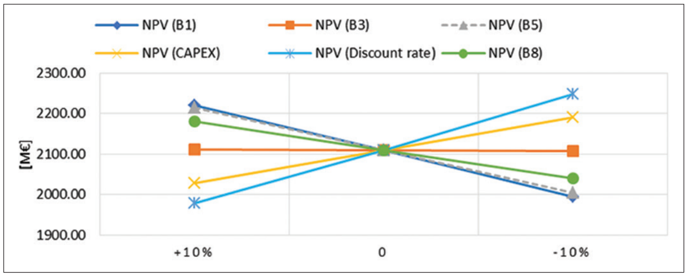


Table 6: Values of discounted CAPEX and OPEX

Parameters	M€
Total CAPEX discounted	812.06
Total OPEX discounted	61.67

Table 7: NPV and IUS values

Parameters	Results
NPV [M€]	2110
DBCR	3.41

Table 8: Sensitivity analysis results: NPV

NPV (Modified variable)	Pessimistic case study [M€]	Baseline scenario [M€]	Optimistic case study [M€]
NPV (B1)	2215	2110	2004
NPV (B3)	2112	2110	2108
NPV (B5)	2214	2110	2005
NPV (B7)	2107	2110	2112
NPV (B8)	2180	2110	2040
NPV (B18)	2111	2110	2109
NPV (B19)	2111	2110	2109
NPV (CAPEX)	2191	2110	2028
NPV (OPEX)	2116	2110	2103
NPV (discount rate)	2248	2110	1977

Table 9: Sensitivity analysis results: DBCR

DBCR (modified variable)	Pessimistic case study	Baseline scenario	Optimistic case study
DBCR (B1)	3.51	3.4	3.29
DBCR (B3)	3.40	3.4	3.40
DBCR (B5)	3.50	3.4	3.30
DBCR (B7)	3.40	3.4	3.40
DBCR (B8)	3.49	3.4	3.33
DBCR (B18)	3.40	3.4	3.40
DBCR (B19)	3.40	3.4	3.40
DBCR (CAPEX)	3.77	3.4	3.12
DBCR (OPEX)	3.44	3.4	3.39
DBCR (discount rate)	3.52	3.4	3.30

in this specific case has a negligible impact on the project's profitability being relatively insignificant, just as the variation of the other benefits (B7, B18, B19) and OPEX.

Following the sensitivity analysis, a scenario analysis was carried out on the CBA 2.0 values of SA.CO.I.3. Scenario analysis is a tool that assesses the evolution of economic and financial indicators by simulating different possible trends of certain key variables, considered simultaneously.

Based on the results of the sensitivity analysis, it was decided to vary only the most critical variables for the intervention, namely the increase of socio-economic welfare (B1), the greater integration of RES production (B5), CAPEX, and finally the discount rate. Moreover, given the robustness of the results of intervention 301-P, whose economic viability proved solid even under percentage changes of the inputs, it was deemed sufficient for the scenario analysis to consider a single alternative pessimistic case study (Worst Case).

In line with what was done in the previous analysis, the applied variations are consistently 10% on the critical variables (−10% for B1 and B5, and +10% for CAPEX and the discount rate) as shown in Tables 10 and 11.

Figure 6 shows how, in a pessimistic case study, the change in the critical variables leads to a significant reduction in NPV and DCBR. However, this result confirms the economic robustness of the project, since its indicators remain at levels that justify its implementation (NPV >0 and DBCR >1).

5. DISCUSSION

The analysis conducted on the case study confirms the economic soundness of the intervention as it identifies the wider social benefits, in line with recent literature on the application of Cost-Benefit Analysis. This method is widely used in the energy sector literature, combining economic and financial perspectives based on various indicators (Carlini and Gadaleta, 2017; D'Adamo et al., 2021). In the baseline scenario, the NPV and DBCR indicators reflect the profitability of the project. These elements are essential for providing guidance not only to investors but to all stakeholders. Renewable energy projects have changed decision-making processes, leading to decision-making approaches that must include these aspects, which are revolutionising the energy sector to combat climate change (Biancardi et al., 2024; Molica et al., 2025; Tushar et al., 2022). This is bringing about profound changes in electricity grids (O'Shaughnessy et al., 2021), requiring flexible strategies (Shahzad and Jasińska, 2024) that also take into account the growing interest in energy communities (Sousa et al., 2023), where multi-criteria methods can prove important (Troncia et al., 2018). However, economic choices must be framed within an energy policy that combines technologies (Biancardi et al., 2025) and defines how to create an innovative ecosystem (Chatzinikolaou et al., 2025). It is clear that the process of disseminating knowledge related to energy innovations has a positive impact on combating climate change (Aldieri et al., 2022). Furthermore, the increased supply of green energy promotes employment (Aldieri et al., 2021).

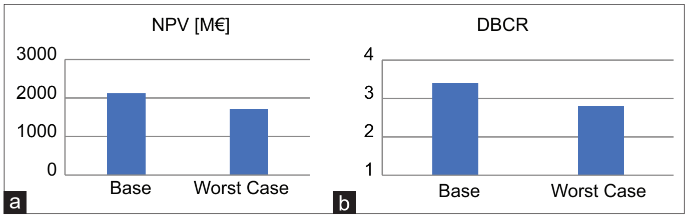
Table 10: Variation of critical variables

Input	Baseline scenario	Worst case scenario
B1 [M€] (year)	68 (2030); 85 (2040)	61.2 (2030); 76.5 (2040)
B5[M€] (year)	117 (2030); 52 (2040)	105 (2030); 46 (2040)
Discount rate [%]	4	4.40
CAPEX [M€]	950	1045

Table 11: Scenario analysis results

Input	Baseline scenario	Worst case scenario
DBCR	3.4	2.81
NPV [M€]	2110	1700

Figure 6: Scenario analysis results: (a) NPV comparison between baseline and worst-case scenario; (b) DBCR comparison between baseline and worst case



The CBA method, typically used in the transport sector (Koopmans and Mouter, 2020), needs to be integrated into a system that includes artificial intelligence models (de la Hoz et al., 2025; Hernandez Palma et al., 2024) and covers stakeholders with different needs (D'Adamo et al., 2025b, 2025a). The pragmatic model of sustainability is based on quantitative analyses that support decision-makers in order to reach SDG7.

The main benefits identified include increased socio-economic well-being and greater integration of renewable sources, two factors recognised in the literature as central to the energy transition (Crago et al., 2025; Sohail et al., 2025; Tian et al., 2023). In addition to these, there are systemic effects such as reduced risk of supply failure, limited blackouts and decreased dependence on fossil fuels, all of which contribute to making the system more efficient and resilient, in line with recent studies on storage technologies and digitised networks (Barić et al., 2024; Leiva Vilaplana et al., 2025). Sensitivity and scenario analyses further reinforce the credibility of the results. This aspect is considered essential to strengthen the methodological recommendations to consider uncertain scenarios (Vagdatli and Petroutsatou, 2023).

These results are fully in line with the evolutionary path of CBA 2.0 (Carlini and Gadaleta, 2017), which introduced dynamic and probabilistic tools capable of capturing otherwise overlooked benefits and ensuring greater transparency. In this light, the present study confirms that the adoption of advanced methodologies is now essential for guiding investment decisions towards innovative and sustainable solutions.

Economic analyses of this kind are not confined solely to the national context. To ensure consistent and comparable electricity grid planning across the continent, the European Union, through bodies such as ENTSO-E and ACER, publishes uniform guidelines for the CBA of grid development projects. These directives provide a crucial common framework for the evaluation of cross-border projects and for alignment with European decarbonization targets. Despite this commitment to harmonization, however, notable differences in application and metrics persist, reflecting an ongoing methodological development process.

A direct comparison between the Italian CBA methodology and the European framework reveals some discrepancies. First, the Italian methodology defines a wider set of benefits, while some of the ENTSO-E indicators still lack a standardized computational process, meaning that not all of them are monetized in practice. Furthermore, the Italian methodology reflects local regulatory priorities and constraints, for example by introducing a specific benefit for peninsular areas or by using market-based mechanisms such as the Capacity Market for monetization purposes. As a matter of fact, the majority of benefits are aggregated and counted directly within the Socio-Economic Welfare (SEW) parameter. In contrast, the Italian methodology offers a more granular approach, allowing it to capture a wider range of effects outside the main welfare calculation. For example, the Italian CBA 2.0 effectively quantifies the monetary impact of RES integration, not only on the wholesale energy market but also on related markets such as the ancillary services and dispatching market, providing a more detailed assessment of system-wide economic effects. On the other hand, the ENTSO-E framework introduces several interesting novelties. For example, the SEW benefit is uniquely defined as the methodology's first transectorial parameter, linking the electric sector directly with the emerging Hydrogen sector through a dual-system approach. Furthermore, the ENTSO-E framework places significant focus on security of supply, proposing distinct benefits to measure system frequency, stability, and adequacy. This underscores a continuous commitment to service safety and efficiency. Unlike the benefits related to frequency and stability, which are still relatively immature and lack a clear monetization procedure, the adequacy benefit is fully monetized through the value of lost load (VOLL). Although this benefit is present in the Italian CBA 2.0 as well, the indicators employ different VOLL. Consequently, these discrepancies significantly affect the CBA results: in the Italian methodology, VOLL values are generally higher than those adopted in the European framework, which tends to capture less of the welfare loss associated with supply interruptions. This discrepancy is highly significant, since the literature emphasizes that VOLL is a highly variable parameter, with values differing substantially between countries but remaining central to the economic quantification of outages and blackouts. For instance, several studies highlight how VOLL estimations differ not only according to the sector considered but also depending on the methodological approach (Schröder and Kuckshinrichs, 2015): Some analyses apply production-function models to estimate the loss of economic output during outages (Li et al., 2024) while others rely on consumer surveys that elicit willingness-to-pay (WTP) for avoiding supply interruptions (Matsubara et al., 2025). Furthermore some authors (Castro et al., 2016) show that in Portugal VOLL varies not only across sectors but also with the time and duration of interruptions, confirming that a one-size-fits-all European parameterization risks overlooking important national dynamics.

6. LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The CBA 2.0 methodology adopts a highly focused and constrained approach to valuation. This framework monetizes only the benefits explicitly linked to the project's core drivers. Consequently, it does not quantify all potential positive system-wide impacts. This deliberate limitation is enforced to uphold the methodological integrity of the assessment, specifically by preventing the double counting of benefits (i.e., avoiding the aggregation of effects that stem from the same underlying mechanism). While this strategy ensures rigor and avoids overestimation, it concurrently risks leading to an underestimation of the overall societal welfare generated by the project. Therefore, the CBA results should be viewed as a conservative estimate of the project's true value.

Furthermore, it is crucial to note that this entire analytical process is not a discretionary exercise. The analysis is strictly governed by and conforms to the regulatory methodological framework approved by the relevant national authority. This mandated alignment ensures that all infrastructure proposals are evaluated using consistent, standardized criteria, promoting transparency and comparability across the sector.

Building upon the findings and limitations of the current study, future research should pursue several directions to deepen the understanding of strategic infrastructure valuation and its cross-border implications.

A key area for investigation involves conducting a comparative case study on project valuation standards, specifically by analyzing the impact of different methodological frameworks - comparing the Italian national CBA rules (ARERA) against the European standards established by ENTSO-E. Furthermore, this comparison should extend to the perspective of other European Transmission System Operators, such as examining the economic parameters used by other countries and contrasting them with the ENTSO-E perspective, to gain critical insight into how the location and regulatory lens influence the project's perceived viability and value, illuminating potential biases between national and pan-European valuation. In addition, to overcome the constraints of current static assumptions, the research must also move beyond simple linear extrapolation and focus on developing methodologies for a more dynamic and realistic valuation of key economic parameters. This would involve exploring stochastic methods to model the non-linear evolution of both benefits and costs over the project lifetime, replacing current linear interpolation techniques with more sophisticated forecasting methods that reflect market volatility, the non-linear nature of technological adoption curves, and the inherent uncertainty in long-term energy planning.

Finally, it would be highly valuable to further explore how differences in benefit valuation and monetization methodologies impact the project assessments carried out by various European TSOs. Such a comparative analysis would help identify specific aspects of the current frameworks, both the national and the ENTSO-E models. Ultimately, this deeper investigation could inform future regulatory updates, ensuring that CBA frameworks evolve to incorporate more sophisticated evaluation techniques and accurately reflect the total societal value generated by strategic transmission investments across Europe.

7. CONCLUSION

The Cost-Benefit Analysis carried out for the case study highlights the strong economic and strategic value of the proposed intervention. The baseline scenario confirms the strong economic attractiveness of the project, with a NPV significantly positive (2110 million €), a relevant DBCR (3.41), a DPBT equal to 4 years and 6 months and IRR of 30%, supported primarily by socio-economic welfare gains and the integration of RES. The infrastructure also contributes to greater system reliability, reducing the risks of unsupplied energy and enhancing operational efficiency in the Sardinian grid. Moreover, the sensitivity analysis demonstrates that the project's results are robust even under variations of key parameters. Although changes in CAPEX, the discount rate, and major benefits such as socio-economic welfare gains and the integration of RES substantially influence the summary indicators, the project consistently remains profitable (NPV between 1977 and 2248 million €). Similarly, the scenario analysis confirms that even in a pessimistic configuration, the economic viability is preserved, as both NPV and DBCR remain at levels that justify implementation. Overall, the findings indicate that the project not only delivers a rapid payback period but also ensures long-term socio-economic and environmental benefits. These results validate the strategic importance of the interconnector, reinforcing its role as a reliable, efficient, and sustainable solution for the future energy system.

The analysis carried out in this work and its results also lead, in our opinion, to further reflections on the value that the systematic and shared use of Cost-Benefit Analysis can bring to the identification of policies. It has been noted previously, for example, that CBA is not only a technical tool but also a common language for assessing economic sustainability. This analysis also represents a tool for accountability for the community. It is clear that there are many aspects of this methodology that need to be managed appropriately, for example, the calculation of socio-economic benefits. Despite this, widespread and shared use of CBA is a fundamental tool for enabling rational dialogue between the parties involved and allowing everyone to make decisions on a quantitative and verifiable basis. Policies can only benefit from this.

The energy system requires significant changes, and replacing fossil fuels with renewable sources is a process that cannot be postponed. Energy issues also have geopolitical dimensions, and it is necessary for every country to contribute to the achievement of sustainable development at a global level. This project supports SDG 7 and provides a solid methodology to support the viability of a project capable of providing benefits to civil society.

8. ACKNOWLEDGMENTS

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