FROM POLICY TO IMPACT: RANKING GREEN FINANCE INSTRUMENTS FOR SUSTAINABLE DEVELOPMENT GOALS ACHIEVEMENT

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Anastasia DORAȘ (LISNIC)
West University of Timisoara, Faculty of Economics and Business Administration, Doctoral School of Economics and Business Administration
Timisoara, Romania
Email account: anastasia.doras01@e-uvt.ro
ORCID ID: 0009-0009-8825-2977
Cristina CRISTE
West University of Timisoara, Faculty of Economics and Business Administration, Doctoral School of Economics and Business Administration
Timisoara, Romania
Email account: cristina.criste@e-uvt.ro
ORCID ID: 0009-0008-0631-5595
Cristina-ELENA VOICU
West University of Timisoara, Faculty of Economics and Business Administration, Doctoral School of Economics and Business Administration
Timisoara, Romania
Email account: cristina.voicu86@e-uvt.ro
ORCID ID: 0009-0008-2912-6594
Oana Ramona LOBONȚ
West University of Timisoara, Faculty of Economics and Business Administration, Finance, Business Information Systems and Modelling Department
Timisoara, Romania
Email account: oana.lobont@e-uvt.ro
ORCID ID: 0000-0002-2942-3715

Abstract: *This study proposes identifying and ranking the most effective green finance strategies to support the achievement of the Sustainable Development Goals, using a multi-criteria analysis method (TOPSIS) applied to environmental, economic, and social performance criteria. The dataset is based on a constructed evaluation matrix that assesses six green finance instruments across five performance criteria: environmental impact, private capital mobilisation, economic efficiency, institutional feasibility, and social equity. Scores were assigned using a scale from 1 to 10, based on recent empirical studies and policy reports. The findings suggest that carbon market mechanisms achieve the highest performance, mainly due to their strong economic efficiency and their ability to mobilise private capital. Green investment funds and guarantee instruments also perform strongly, as they effectively attract resources and reduce investment risks. In contrast, green bonds and financial regulations are moderately effective due to their indirect or limited impact on capital mobilisation. Subsidies remain important for early-stage transitions but raise concerns related to fiscal sustainability. The results suggest that no single green finance instrument is sufficient to address the multi-dimensional challenges of sustainable development. Instead, an integrated approach that combines market-based instruments, public support mechanisms, and regulatory frameworks is required. Such a balanced policy mix allows the strengths of each instrument to complement one another, thereby enhancing overall effectiveness, reducing trade-offs across criteria, and accelerating progress toward the Sustainable Development Goals.*

Keywords: *Green finance, Sustainable Development Goals (SDG), TOPSIS, Carbon pricing, Green financial instruments*

JEL: Q56, Q58, G28

Introduction

Green finance plays a vital role in achieving the Sustainable Development Goals (SDGs) of the 2030 Agenda by channelling capital toward projects with environmental and social benefits. Financial sustainability involves integrating environmental, social, and governance (ESG) factors into investment decisions, aligning capital flows with the goals of the Paris Agreement and the SDGs (Sharma and Kautish, 2023). Studies show that sustainable finance directly supports the achievement of the SDGs by directing funds toward projects focused on environmental protection, social inclusion, and economic growth (Ali et al., 2023; Ziolo et al., 2021). However, the funding gap remains enormous: according to the OECD (2018), emerging economies would require investments of approximately $3.9 trillion annually in key SDG sectors, while current investment levels stand at around $1.4 trillion, leaving an annual shortfall of about $2.5 trillion. This gap underscores the urgent need to mobilise private capital on a far larger scale. The UN Secretary-General (2019) warned that if current trends continue, the world will achieve only half of the SDGs by 2030, highlighting the need for a major "investment leap" to accelerate sustainable financing. In September 2018, the United Nations launched a Global Strategy on Financing the 2030 Agenda, calling for the alignment of the international financial system with sustainable development and the promotion of inclusive green investments at the national and regional levels.

Over the past decade, there have been positive trends in the green finance market, although volumes remain below what is needed. For example, the green bond market (a key green financing instrument) has grown exponentially: annual green bond issuance reached $167.6 billion in 2018, up from $162.1 billion in 2017, according to Climate Bonds (2019). By the end of 2018, the cumulative volume of green bonds issued globally had exceeded $500 billion, just 11 years after the launch of the first green bond (Flammer, 2020). However, the share of these instruments in the overall bond market remains modest, in 2018, green bonds accounted for less than 0.5% of total global bond issuance. In addition to bonds, other innovative instruments are emerging. For example, the market for green and sustainable loans doubled in the first half of 2018 compared with the entire previous year, signalling increased lender interest in green projects. At the same time, ESG-focused investment funds attracted robust net inflows, reflecting investors' growing appetite for sustainable assets (UN, 2019).

Both market initiatives and public policies drive the development of green finance. Market mechanisms such as carbon pricing have evolved rapidly: in May 2018, the World Bank reported that 45 national and 25 subnational carbon pricing schemes (carbon taxes or ETS systems) were in place, covering approximately 20% of global greenhouse gas emissions, an increase from 2017. The European Union launched the Sustainable Finance Action Plan in 2018, including the creation of a green taxonomy and guidelines for green bonds (European Commission, 2018). These policy measures increase transparency and prevent greenwashing, creating a favourable framework for redirecting capital toward the green economy. Recent data point out that green finance markets have continued to expand significantly after 2020, driven by regulatory developments and increasing investor demand.

The literature highlights the importance of financial innovation and risk-sharing instruments for mobilising private capital for sustainable projects (Raman et al., 2024). For example, guarantees and risk mitigation mechanisms are seen as key means of attracting private investors to climate projects, especially in emerging markets. The Climate Policy Initiative (2025) shows that guarantees can mobilise up to five times as much private capital as direct loans and are the preferred risk-reduction tool for financiers. Such instruments, alongside green investment funds and thematic bonds, expand the capital base available for the green transition. An effective green financing strategy must be

tailored to the local context, combining these pillars to achieve the optimal balance between environmental impact, economic feasibility, and social equity. Despite the growing literature on green finance, there is still limited comparative evidence on the relative effectiveness of different financial instruments across multiple sustainability dimensions. Most studies focus on individual instruments or single criteria, without providing an integrated multi-criteria assessment.

The main research objective of this paper is to identify and rank the most effective green financing instruments for supporting the achievement of the Sustainable Development Goals, using a multi-criteria decision analysis (TOPSIS) based on environmental, economic, and social performance criteria.

To achieve this objective, the study is guided by two research questions that aim to provide a comprehensive understanding of the relative effectiveness of green financing instruments in supporting the achievement of the SDGs:

RQ1: Which green financing instruments are the most effective in supporting the achievement of the Sustainable Development Goals when evaluated across multiple criteria?

RQ2: How do different green finance instruments compare in terms of environmental impact, capital mobilisation, economic efficiency, institutional feasibility, and social equity?

These questions help to structure the comparative assessment and provide a clearer understanding of which instruments generate the strongest contribution to sustainable development outcomes.

The analysis provides a comparative assessment of the main green financing instruments, from green bonds and grants to carbon market mechanisms, dedicated investment funds, guarantee instruments, and green financial regulations, across multiple performance criteria. The selected method for this assessment is TOPSIS, which ranks alternatives according to their similarity to an ideal solution across multiple criteria. The analysis is based on post-2015 Paris Agreement developments and focuses on 2024 trends, adopting a static approach based on single-point scores without capturing temporal dynamics.

This paper contributes to the literature by providing a comparative multi-criteria ranking of key green finance instruments using the TOPSIS method, integrating environmental, economic, and social dimensions into a unified analytical framework. Thus, the study has practical implications for policymakers, financial institutions, and investors seeking to design more effective financing strategies for sustainable development.

Basic content

To determine which green financing strategies are most effective for goals, we employed the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method. TOPSIS is a well-established multi-criteria decision analysis (MCDA) method. Originally proposed by Hwang and Yoon (1981). This method selects the alternative closest to the hypothetical ideal solution and farthest from the anti-ideal solution. Essentially, TOPSIS assumes the existence of an ideal composite score, representing the best possible performance on each criterion, and an extreme negative score, representing the most unfavourable levels across criteria. Each real alternative (in our case, each green financing instrument) will be evaluated relative to these two benchmarks, determining a coefficient of relative proximity to the ideal. The method is valued for its intuitiveness and simplicity and is widely applied in sustainability and corporate finance decisions (Lapinskiene and Danileviciene, 2023). TOPSIS was selected due to its ability to simultaneously evaluate multiple conflicting criteria and provide a clear ranking of alternatives, making it particularly suitable for assessing complex sustainability-related decisions.

In fact, TOPSIS has been used in a variety of recent studies in the field of financial sustainability: for example, Yılmaz and İne (2018) assessed banks' sustainability performance using a Balanced Scorecard model integrated with TOPSIS, while other authors have used TOPSIS to rank companies based on ESG scores (Rana, 2024; Reig-Mullor et al., 2022) or to prioritise investments in clean

energy (Kuang, 2021). This research proves the flexibility of the TOPSIS method in solving multi-criteria decision-making problems in the financial sector.
The methodology is designed to directly address the research questions by comparing and ranking green finance tools (Table 1).

Table 1. Mapping of research questions to methodology and underlying theoretical foundations

Research Question	Connection to the methodology	Connection to fundamental theory
RQ1: Which green financing instruments are the most effective in supporting the achievement of the SDGs when evaluated across multiple criteria?	Addressed using TOPSIS to rank instruments based on their relative closeness to the ideal solution, integrating weighted multi-criteria performance.	Sustainable finance theory ESG integration theory Capital allocation efficiency
RQ2: How do different green finance instruments compare in terms of environmental impact, capital mobilisation, economic efficiency, institutional feasibility, and social equity?	Operationalised through a multi-criteria evaluation matrix and TOPSIS aggregation (normalisation, weighting, scoring) to enable systematic comparison of alternative instruments across five performance criteria.	Multi-dimensional sustainability assessment ESG performance theory

Source: Authors

By combining several weighted criteria and using the TOPSIS framework, the analysis offers a clear, structured way to identify the instruments most likely to support progress toward the Sustainable Development Goals.
In our analysis, we considered five criteria relevant to the effectiveness and sustainability of green financing instruments, drawing on both the academic literature and public policy objectives (Table 2).

Table 2. Relevant criteria for the effectiveness and sustainability of green instruments

Criteria	Definition
Environmental impact	The extent to which the strategy contributes to climate change mitigation, environmental protection, and the achievement of the environmental SDGs.
Mobilisation of private capital	The instrument's ability to attract additional private investment.
Economic efficiency and financial sustainability	Assesses whether the tool is cost-effective (e.g., cost per unit of impact achieved) and financially sustainable over the long term.
Institutional feasibility	The extent to which the implementation of the instrument is feasible within the institutional and regulatory context. Here, we consider administrative simplicity, political acceptability, and the necessary legal framework.
Social Impact and Equity	The extent to which the strategy has positive social impacts (e.g., the creation of green jobs, access to clean energy for disadvantaged communities) and distributes costs and benefits equitably.

Source: Original analysis based on collected data

We analysed six major green finance strategies/instruments, drawn from the literature on climate policy and current international practices (Table 3):

Table 3. Strategies and Tools in Green Finance

Tools/Strategies	Definition
Green bonds	debt securities issued by public or private entities to finance projects with environmental benefits (renewable energy, clean transportation, etc.).
Subsidies for renewable energy	financial incentives (grants, feed-in tariff schemes, tax credits) provided for green energy production or energy efficiency. These directly support SDG 7 (affordable and clean energy) and SDG 13 (climate action), but can entail high fiscal costs if not properly phased in.

Tools/Strategies	Definition
Carbon market mechanisms	include emissions trading systems (ETS) and carbon taxes. These tools put a price on CO_2 emissions, incentivising the market to reduce emissions where the cost is lowest.
Green investment funds	specialised funds (public, private, or hybrid) that invest in portfolios of green projects (e.g., the Green Climate Fund, green sovereign wealth funds, green private equity). Such funds can combine public and private capital (blended finance), offering high mobilisation potential and expertise in evaluating sustainable projects.
Guarantees and risk mitigation tools	instruments through which the public sector or international financial institutions assume part of the risk (political, credit, or currency) associated with green projects to attract private investors.
Green financial regulations	Regulatory measures that require or incentivise the financial system to take sustainability risks and objectives into account. This includes non-financial reporting requirements (e.g., TCFD – Task Force on Climate-related Financial Disclosures), green prudential guidelines (e.g., reduced risk weights for green loans and restrictions on fossil fuel exposures), and the inclusion of ESG criteria in investors' fiduciary duties. Such regulations do not directly mobilise capital (unlike those mentioned above), but they create a coherent framework that redirects financial flows toward sustainable activities in the medium and long term.

Source: Original analysis based on collected data

We constructed an evaluation matrix with the six alternatives in rows and the five criteria in columns. The raw scores for the alternatives across the criteria were derived from existing data and studies (Boyce, 2018; Mahesh et al., 2022; IFC, 2024; Ozili, 2023; Cantale and Gavin, 2024; Network for Greening the Financial System, 2024; Sharma et al., 2024; European Commission, 2025; Raman et al., 2025), using a scale from 1 to 10, where 10 indicates the best performance on that criterion (Table 4 and Table 5). For example, in Environmental Impact, Renewable Energy Subsidies and Carbon Market Mechanisms received relatively high scores (given their high emission-reduction potential). At the same time, Green Financial Regulations have a more indirect environmental impact and were rated more modestly. Under the criterion of Mobilising Private Capital, instruments such as the ETS/carbon taxes (which create new carbon markets) and guarantees (which attract private capital) received top marks, while green bonds, though highly visible, mobilise dedicated capital but still in a small proportion relative to total financial markets (Flammer, 2020).

Table 4. Table of scores and explicit weights

Green Financing Strategies/Criteria	Environmental impact (30%)	Mobilisation of private capital (25%)	Cost-effectiveness/ financial sustainability (20%)	Institutional feasibility (15%)	Social impact and equity (10%)
Green bonds	8	6	7	7	9
Subsidies for renewable energy	9	8	5	6	8
Carbon market mechanisms (ETS and carbon taxes)	8	9	9	7	5
Green investment funds	8	8	7	8	7
Guarantees and risk mitigation tools	7	9	8	6	6
Green financial regulations	6	6	6	9	7

Source: Original analysis based on collected data

The weights were assigned based on a combination of literature insights and policy priorities, reflecting the dominant importance of environmental outcomes and capital mobilisation in the context

of sustainable development. Figure 1 below illustrates the rationale behind the selection of evaluation criteria and their respective weights.

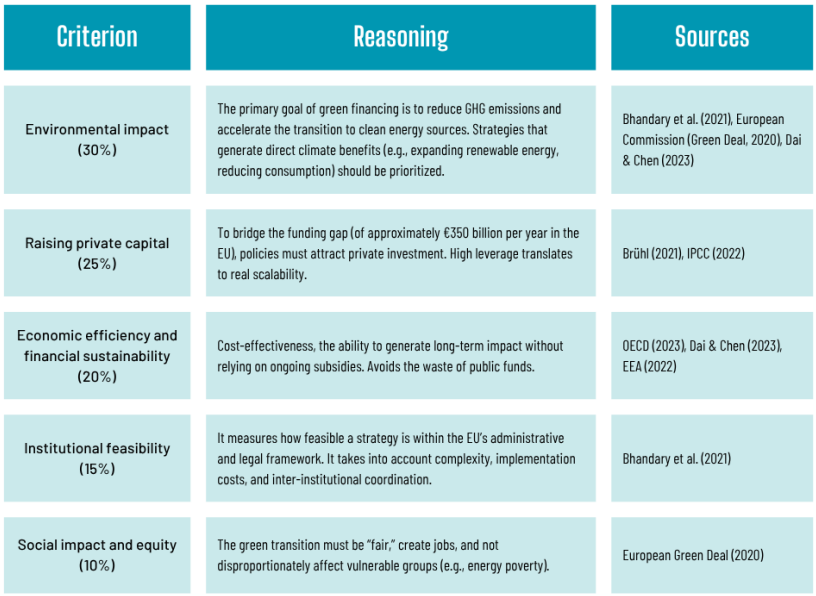

Figure 1. The rationale behind the selection of evaluation criteria (TOPSIS)

Source: Created by the author in Canva

The scores for the green financing strategies were evaluated qualitatively and grounded in theory; the rationale for assigning the scores is presented in Table 5.

Table 5. Qualitative assessment of the main strategies in relation to the selected criteria

Green Financing Strategies/ Criteria	**Environmental impact**	**Mobilisation of private capital**	**Economic efficiency/financial sustainability**	**Institutional feasibility**	**Social Impact and Equity**
Green bonds	It allocates funds to green projects, but some of these initiatives have no additional impact (greenwashing).	It attracts private capital, but at a moderate level relative to total climate finance needs.	Low cost to the government; attractive to investors; reporting and verification costs (to ensure funds are used for green purposes) slightly reduce overall efficiency.	Easy to implement in developed markets; EU standards help.	They contribute to the well-being of society as a whole (by reducing pollution, creating green jobs, and improving infrastructure) and, unlike some market mechanisms, do not impose direct costs on vulnerable populations.
Subsidies for renewable energy	They directly encourage the deployment of renewable energy capacity; facilitate the energy transition; and reduce pollution.	It provides a steady income, reduces risk, and attracts investment.	It may be ineffective if the rate is not properly calibrated; there is a risk of high budgetary costs.	This requires detailed regulation and monitoring.	They help create jobs in the green energy sector and can reduce inequalities in access to energy resources while lowering consumers' energy bills in the long term.
Carbon market mechanisms (ETS and carbon taxes)	The price signals emission reductions, but the effectiveness depends on the price level and the cap.	A carbon price creates incentives for green investments without directly allocating funds.	Cost-effective: it enables emissions reductions where costs are lower.	The ETS operates in the EU but expanding it to other sectors is a complex undertaking.	It may adversely affect vulnerable groups lacking compensatory mechanisms.

Green Financing Strategies/ Criteria	Environmental impact	Mobilisation of private capital	Economic efficiency/financial sustainability	Institutional feasibility	Social Impact and Equity
Green investment funds	It can fund strategic projects with a significant impact (e.g., green infrastructure).	High leverage effect through public-private co-financing.	Competitive performance managed prudently, although there may occasionally be additional costs and short-term fluctuations in returns due to non-financial criteria.	These tools already exist in many EU countries; they can be expanded and widely adopted.	They may target social projects, but it depends on how the funds are allocated.
Guarantees and risk mitigation tools	It facilitates the financing of projects that would otherwise not receive loans.	They reduce the risk for banks and are considered the most effective means of mobilising private capital.	Low cost to the government if they are properly calibrated; risk if guarantees are triggered.	It requires robust administrative structures and risk assessment.	Less focused on the social aspect, but they can be directed toward it.
Green financial regulations	It indirectly contributes to the efficient allocation of capital.	It boosts confidence in green projects, but does not attract capital on its own.	Compliance costs; indirect benefits.	The EU already has the framework in place; expansion is straightforward.	It ensures transparency, but without a direct social focus.

Source: Original analysis based on collected data

After establishing the initial evaluation matrix, the steps of the TOPSIS analysis were as follows, in accordance with the standard methodology (Hwang and Yoon, 1981):

- Normalisation of the decision matrix (Table 6) to bring the criteria onto a comparable scale (equation 1).

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad (1)$$

Where: r_{ij} represents the normalised value; x_{ij} is the value of alternative i for criterion j.

We used vector normalisation, dividing each value by the square root of the sum of the squares of the values in that column. Thus, for each criterion, the scores of the alternatives were converted into dimensionless values between 0 and 1. Table 5 presents the matrix of normalised values obtained by applying the vector normalisation formula. This step enables comparability of the alternatives by eliminating scale differences across criteria.

Table 6. Normalized matrix

Green Financing Strategies/Criteria	Environmental impact	Mobilisation of private capital	Economic efficiency/financial sustainability	Institutional feasibility	Social Impact and Equity
Green bonds	0.4228	0.3154	0.4015	0.3944	0.5162
Subsidies for renewable energy	0.4757	0.4205	0.2868	0.3381	0.4588
Carbon market mechanisms (ETS and carbon taxes)	0.4228	0.4730	0.5162	0.3944	0.2868
Green investment funds	0.4228	0.4205	0.4015	0.4507	0.4015
Guarantees and risk mitigation tools	0.3700	0.4730	0.4588	0.3381	0.3441
Green financial regulations	0.3171	0.3154	0.3441	0.5071	0.4015

Source: Compiled by the author

- Weighting of criteria (equation 2). We assigned a weight to each criterion that reflects its relative importance, based on the literature and climate policy objectives.

$$v_{ij} = w_j \, x \, r_{ij} \quad (2)$$

Where: w_j = the weight of criterion j; v_{ij}= weighted average.

We assigned the following weights (w_j): environmental impact at 30%, making it the top priority in light of the climate emergency; capital mobilisation at 25%; economic efficiency at 20%; institutional feasibility at 15%; and social impact at 10%. Together, these categories add up to 100%, and they show a deliberate emphasis on environmental outcomes and financial capacity while still accounting for practicality and fairness. Mathematically, we multiplied each normalised column by its associated weight to obtain the weighted matrix. Table 7 shows the weighted matrix obtained by multiplying the normalised values by the weights assigned to each criterion.

Table 7. Weighted Matrix

Green Financing Strategies/Criteria	Environmental impact (30%)	Mobilisation of private capital (25%)	Cost-effectiveness/ financial sustainability (20%)	Institutional feasibility (15%)	Social impact and equity (10%)
Green bonds	0.1268	0.0788	0.0803	0.0592	0.0516
Subsidies for renewable energy	0.1427	0.1051	0.0574	0.0507	0.0459
Carbon market mechanisms (ETS and carbon taxes)	0.1268	0.1183	0.1032	0.0592	0.0287
Green investment funds	0.1268	0.1051	0.0803	0.0676	0.0401
Guarantees and risk mitigation tools	0.1110	0.1183	0.0918	0.0507	0.0344
Green financial regulations	0.0951	0.0788	0.0688	0.0761	0.0401

Source: Own calculations based on collected data

- Determining the ideal and anti-ideal solutions (equation 3 and 4 for benefit-based criteria). The composite ideal solution was constructed by selecting, for each criterion, the maximum value from the weighted matrix (since all our criteria are benefit-based higher score = better).

$$A^+ = \{\max(v_{ij})\} \quad (3)$$

$$A^- = \{\min(v_{ij})\} \quad (4)$$

Where: A^+ is the ideal positive solution; A^- is the ideal negative solution.

The result is a vector representing the "perfect strategy" with the best environmental impact, the highest capital mobilisation, and so on. Similarly, the anti-ideal solution contains the minimum values for each criterion (the lowest scores), representing a hypothetical strategy with the worst performance across all dimensions. Table 8 summarises the ideal and anti-ideal solution vectors, obtained from the maximum and minimum values, respectively, for each criterion in the weighted matrix.

Table 8. The ideal and anti-ideal solutions

Ideal solution	Environmental impact	Mobilisation of private capital	Economic efficiency/financial sustainability	Institutional feasibility	Social Impact and Equity
Positive	0.1427	0.1183	0.1032	0.0761	0.0516
Negative	0.0951	0.0788	0.0574	0.0507	0.0287

Source: Own calculations based on collected data

- Calculation of distances from the ideal and anti-ideal solutions (equation 5 and 6). For each (alternative) strategy, we calculated the Euclidean distance.

$$S_i^+ = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^+\right)^2} \quad (5)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2} \quad (6)$$

Where: S_i^+ is the Euclidean distance from the positive ideal solution; S_i^- is the Euclidean distance from the negative ideal solution.

Table 9 summarises the distances calculated for each alternative relative to the ideal and anti-ideal solutions. These values form the basis for the final calculation of the relative proximity scores.

Table 9. Distances from the ideal and anti-ideal

Green financing strategies/Ideal distance	Positive	Negative
Green bonds	0.051159	0.046148
Subsidies for renewable energy	0.054348	0.057002
Carbon market mechanisms (ETS and carbon taxes)	0.032610	0.068820
Green investment funds	0.033961	0.051379
Guarantees and risk mitigation tools	0.045564	0.054976
Green financial regulations	0.071640	0.030100

Source: Own calculations based on collected data

- Calculation of the closeness score (equation 7). For each alternative, we determined an index of relative closeness to the ideal solution.

$$C_i^* = \frac{S_i^-}{S_i^+ + S_i^-} \quad (7)$$

where: C_i^* represents the relative closeness coefficient of alternative i to the ideal solution.

This coefficient takes values between 0 and 1; the closer it is to 1, the closer the alternative is to the theoretical multi-criteria ideal (and thus the more preferable). Based on these scores, the strategies are ranked in descending order by the closeness index.

One important aspect is that the analysis relies on qualitative scoring and a static framework, which may introduce a degree of subjectivity and limit the ability to capture dynamic changes over time. Although the scoring process is grounded in academic literature and policy evidence, some evaluation criteria require expert judgement, which may influence the final ranking. Furthermore, the model does not reflect temporal variations in policy effectiveness or market conditions, meaning that future changes in regulatory frameworks or investment trends may alter the relative performance of the analysed instruments.

By applying the described methodology, we obtained scores indicating how close each evaluated green financing strategy is to the ideal, along with their rankings. Table 10 summarises the results:

Table 10. TOPSIS scores and the ranking of green financing strategies (a score of 1 indicates the alternative closest to the ideal solution).

Green financing strategies	Close score
Green bonds	0.4742
Subsidies for renewable energy	0.5119
Carbon market mechanisms (ETS and carbon taxes)	0.6785
Green investment funds	0.6020
Guarantees and risk mitigation tools	0.5468
Green financial regulations	0.2959

Source: Own calculations based on collected data

The TOPSIS analysis clearly shows that carbon market mechanisms, such as emissions trading schemes and carbon taxes, emerge as the most effective overall strategy, with the highest score of about 0.68. This suggests that, based on the criteria assessed, carbon pricing tools offer the most balanced profile and come closest to the "ideal". They perform especially well in mobilising private capital, by creating markets and incentives for green investment, and in improving economic efficiency through clearer price signals, while still delivering a substantial climate benefit. The more delicate social impact slightly held back their score, since carbon taxes can have regressive effects if compensation measures are not introduced alongside them. Still, because the social criterion carried only 10% of the total weight compared with the environmental and financial criteria, this concern was not enough to change the overall ranking: even with the social penalty, carbon mechanisms remained at the top. This aligns with the broad consensus among economic experts, who see carbon pricing as the most effective tool for decarbonization and for spurring green innovation, for example, by pushing firms to invest in cleaner production methods and low-carbon technologies (Ahlvik and Van Den Bijgaart, 2024; Khurshid et al., 2022).

Green investment funds come in second, with a score of 0.60. They show a well-balanced profile: they are highly capable of mobilising capital through public-private co-investment mechanisms and professional management of green portfolios, and they are also institutionally feasible. These funds are flexible tools that have already been adopted in many countries in different forms, from the Green Climate Fund to green sovereign wealth funds. Their environmental performance is also strong, because they can direct investment toward a broad range of high-impact projects, including energy and green infrastructure. Compared with market-based mechanisms, green funds are at a slight disadvantage in terms of economic efficiency: the subsidised cost of capital can create inefficiencies, and the size of the fund itself constrains its overall mobilisation capacity. Even so, their second-place position suggests that they are a core pillar of the green finance architecture, helping ensure professional fund management and reducing the risks investors believe they face.

In third place are guarantees and other risk-mitigation instruments, with a score of 0.55. These tools are especially effective at mobilising private capital, as international research has also shown. For instance, guarantees can attract significantly more private capital than direct loans (Lai and Soumaré, 2011). Their strong performance on this criterion, combined with solid feasibility, given that governments and development banks already use guarantees, has brought them close to green funds in overall performance. What held them back somewhat was their environmental impact, which is, indirectly, a guarantee in itself that does not reduce emissions on its own. Still, it helps enable projects that do so, as well as raise some concerns about economic efficiency. If they are not designed carefully, guarantees can create moral hazard or increase fiscal exposure. Without risk-sharing mechanisms, private capital often avoids climate projects perceived as too risky. Our findings echo recent calls from the G20 and the OECD to expand the use of green guarantees to scale up sustainable financial flows.

Subsidies for renewable energy come fourth, with a score of 0.51. They received the highest score for environmental impact because they directly support the expansion of green energy capacity and help

cut emissions. They also performed well in terms of social impact, as they can lower the cost of clean technologies and create green jobs. At the same time, subsidies are relatively easy to implement politically in the short term, since they tend to be popular locally and offer visible, tangible benefits, such as installed solar panels or wind turbines. However, subsidies scored poorly on the economic and financial efficiency criterion, because they place a burden on public budgets and, if they are not carefully designed, for example, phased out as the technology becomes competitive, they can produce diminishing returns and distort the market. Subsidies also received only a moderate rating for their ability to mobilise private capital. Although they do encourage private investment in the sectors that benefit from them, that investment often depends on continued public support. The resulting composite score, at roughly 0.51, captures this trade-off: subsidies remain an essential tool in the early phases of the energy transition, regulated tariffs and tax credits, for instance, helped drive the growth of solar and wind power in many countries, but over the longer term, their benefits have to be weighed against their costs, and they need to be complemented by market-based instruments. The literature confirms that subsidies are useful for innovation and the early diffusion of green technologies, but for large-scale decarbonization, mechanisms such as a carbon price that permanently internalises the cost of pollution are needed (Meckling et al., 2017; Tvinnereim and Mehling, 2018; Rosenbloom et al., 2020).

Green bonds, although highly visible in the media and serving as an important signal to the markets, rank fifth in our ranking (0.47). This result is explained by their moderate-to-good performance across most criteria, without excelling in any one area in particular (except for social impact, where they received a very high score, for example, green bond issuances have often financed projects with local social benefits). Green bonds score positively on institutional feasibility (the bond market is already global and liquid, and standards such as the Green Bond Principles have existed since 2014) and on economic efficiency (the cost of capital raised through green bonds is usually similar to that of conventional bonds, sometimes even lower, the "greenium" phenomenon). However, the factor that dragged down their aggregate score is the relatively limited mobilisation of new capital: often, green bonds refinance projects that could have been financed through conventional bonds as well, raising the issue of additionality (Dong et al., 2024). In the global debt market, green bonds still account for only a small share, so their systemic impact, while increasing, remains modest relative to the scale of capital needed to achieve the SDGs. This paradox surrounding green bonds, strong public attention paired with a still-limited contribution in quantitative terms, also appears in recent literature. Some authors argue that their main effect lies in signalling and raising awareness, rather than in driving structural shifts in how capital is allocated (Petreski et al., 2024).

Green financial regulations rank last in this comparative analysis (0.30). That does not mean regulatory policies are unimportant; if anything, they establish the broader framework within which green finance can develop and expand. The low score primarily reflects how our criteria assess the instruments' direct, quantitative impact. Regulations such as ESG disclosure requirements and climate-risk guidelines for banks received relatively low scores for mobilising private capital and generating immediate environmental effects, because their influence is indirect and tends to emerge over the medium term. For example, mandatory climate-risk reporting does not automatically bring in new capital, but it does improve transparency and can gradually reshape investment portfolios over time. Their economic efficiency is also hard to measure. On the one hand, they can correct market failures, such as information asymmetry related to climate risks; on the other hand, they may impose compliance costs on firms and institutions. At the same time, green regulations scored very highly on institutional feasibility, since many jurisdictions are already putting them in place, for example, the EU through the 2019–2020 legislative package on disclosure and taxonomy, and they also received a solid score for social impact. By helping to prevent greenwashing, they protect investors and help ensure that funding reaches projects with genuine impact. Their last-place ranking suggests that, when considered on their own as a green-finance "strategy", regulations do not have the same

driving power as active financial instruments. Still, they serve as catalysts and complementary tools, strengthening the effectiveness of other strategies rather than replacing them. A supportive regulatory framework is therefore necessary but not sufficient on its own for effective green financing. It needs to be paired with concrete instruments that can actually direct capital toward sustainable projects.

Conclusions

This study adds to the literature by offering a structured, multi-criteria comparative framework for green finance instruments using TOPSIS, offering an integrated ranking across environmental, economic, and institutional dimensions. It becomes evident that there is no one-size-fits-all approach to financing climate action and the Sustainable Development Goals. However, some strategies are clearly more comprehensive and effective than others. Consistent with earlier academic research, the priorities identified here, carbon pricing, funds, and de-risking mechanisms, also appear throughout the expanding empirical literature. For instance, Meng et al. (2024) find that countries with emissions trading schemes attract greater investment in clean energy; Kerr and Hu (2025) report that banks following the Principles for Responsible Banking (a voluntary initiative that anticipates future regulation) are reducing their exposure to brown assets more quickly than their peers; and Salsabila et al. (2022) emphasize the importance of private sector participation through innovative financial mechanisms to help close the SDG financing gap.

Designing effective green finance policy requires a tailored strategy built from multiple, complementary components rather than dependence on any single instrument. The results offer quantitative support for this integrated view: market-based instruments deliver efficiency and scale; funds and guarantees provide direction and help attract resources; grants and green policies create early momentum and strengthen public legitimacy; and regulation provides structure and credibility. When properly calibrated and adapted to local conditions, this combination can generate substantial green financing enough to support climate and sustainable development goals while "leaving no one behind," as set out in the 2030 Agenda.

The study's findings also provide clear answers to the research questions. For RQ1, the results highlight that carbon market mechanisms, especially emissions trading schemes and carbon taxes, are the most effective green finance instruments for advancing the Sustainable Development Goals when assessed across multiple criteria. These instruments received the highest TOPSIS scores because they performed strongly in environmental impact, private capital mobilisation, and economic efficiency. Green investment funds and guarantee instruments also ranked highly, confirming their important complementary role within the broader green finance architecture.

For RQ2, the comparative analysis reveals substantial differences among green finance instruments across the five evaluation dimensions. Carbon pricing mechanisms perform best in terms of economic efficiency and capital mobilisation, while renewable energy subsidies show stronger results in direct environmental impact and social benefits. Green investment funds exhibit balanced performance across most criteria, whereas green financial regulations, though essential for institutional support and transparency, tend to have more indirect, long-term effects than immediate financial mobilisation. Taken together, these findings confirm that no single instrument is sufficient on its own and that an effective, sustainable finance strategy depends on a complementary mix of instruments tailored to specific policy and market conditions.

From a policy perspective, governments should prioritise the gradual expansion of carbon pricing mechanisms alongside targeted compensation schemes for vulnerable households to protect social equity while maintaining economic efficiency. At the same time, expanding public guarantee schemes and blended finance instruments can significantly boost private sector participation, particularly in emerging markets, where perceived risks remain high.

Policy frameworks should also encourage the creation of green investment funds, backed by clear governance standards that promote transparency, accountability, and measurable environmental and

social impact. Regulators should also tighten ESG disclosure requirements and push for greater standardisation to reduce information gaps and prevent greenwashing, thereby strengthening investor confidence. Finally, public support tools, such as subsidies, should be designed with clear exit strategies in place so that markets can gradually take the lead as technologies become cost-competitive over time.

The tailored green financing strategies examined here provide the foundations needed for this paradigm shift, bringing together market efficiency and public policy direction. They also show that, while the challenge of sustainable finance is immense, the tools to address it already exist and can deliver meaningful results when used in a complementary and strategic way.

The study has several limitations. First, the scoring of alternatives relies on qualitative assessments that are converted into numerical values, which may introduce some subjectivity into the final ranking. Second, the analysis is static and does not account for changes over time, particularly shifts in market conditions, regulatory frameworks, or policy priorities. Third, the results depend on the weights assigned to each criterion, which may vary with national priorities, institutional settings, or stakeholder perspectives.

Future research could build on this analysis by applying dynamic TOPSIS models that can capture changes over time in the effectiveness of green finance instruments. Further studies could also include sensitivity analyses of the weights to test the robustness of the rankings and reduce potential subjectivity. In addition, integrating real-time financial data and conducting cross-country comparative analyses would provide stronger empirical validation and improve the generalisability of the findings across diverse economic and institutional environments.

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References

1. Ahlvik, L. and Van Den Bijgaart, I., 2024. Screening green innovation through carbon pricing. *Journal of Environmental Economics and Management,* 124, 102932. https://doi.org/10.1016/j.jeem.2024.102932
2. Ali, E., Anshari, M., Hamdan, M., Ahmad, N. and Surieshtino, Y., 2023. Green Finance for Sustainable Development: A Bibliographic Analysis. *International Conference on Sustainable Islamic Business and Finance (SIBF), Bahrain*, pp. 46-49. https://doi.org/10.1109/SIBF60067.2023.10379915
3. Bhandary, R. R., Gallagher, K. S., Zhang, F., 2021. Climate finance policy in practice: A review of the evidence. *Climate Policy,* 21(4), pp. 529–545. https://doi.org/10.1080/14693062.2020.1871313
4. Boyce, J.K., 2018. Carbon Pricing: Effectiveness and Equity. *Ecological Economics,* 150, pp. 52-61. https://doi.org/10.1016/j.ecolecon.2018.03.030
5. Brühl, V., 2021. Green Finance in Europe – Strategy, Regulation and Instruments. *Center for Financial Studies* Working Paper No. 657. Available at: http://dx.doi.org/10.2139/ssrn.3934042
6. Cantale, S. and Gavin, B., 2024. Time to go green? What bonds are best for you? *Sustainability*, [online] Available at: <https://www.imd.org/ibyimd/finance/time-to-go-green-process-vs-outcome-and-what-bonds-are-best-for-you/#:~:text=further%20information%20from%20additional%20issuance,in%20the%20longer%20run> [Accessed 18 June 2025].
7. Climate Bonds Initiative, 2019. Climate Bonds launches Green Bonds: The State of the Market 2018 report at the London Annual Conference. *Climate Bonds Initiative*, [online] Available at: <https://www.climatebonds.net/news-events/blog/climate-bonds-launches-green-bonds-state-market-2018-report-london-annual-conference#:~:text=Global%20green%20bond%20market%3A> [Accessed 20 June 2025].
8. Climate Policy Initiative, 2025. Energizing Private Capital: Innovations in Guarantee Offerings for Climate Finance. *Climate Policy Initiative*, [online] Available at: <https://www.climatepolicyinitiative.org/wp-content/uploads/2025/01/Energizing-Private-Capital-Innovations-in-Guarantee-Offerings-for-Climate-

Finance.pdf#:~:text=Guarantees%20are%20an%20important%20yet,Recognizing%20the> [Accessed 20 June 2025].
9. Dai, Y. and Chen, X., 2023. Evaluating green financing mechanisms for natural resource management: Implications for achieving sustainable development goals. *Resources Policy,* 86(B), 104160. https://doi.org/10.1016/j.resourpol.2023.104160
10. Dong, H., Zhang, L. and Zheng, H., 2024. Green bonds: Fueling green innovation or just a fad?. *Energy Economics,* 135, 107660. https://doi.org/10.1016/j.eneco.2024.107660
11. European Commission, 2018. Action Plan: Financing Sustainable Growth. *European Commission,* COM(2018) 97 final, [online] Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0097> [Accessed 25 June 2025]
12. European Commission, 2019. The European Green Deal. *European Commission*, COM(2019) 640 final, [online] Available at: <https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF> [Accessed 25 June 2025]
13. European Commission, 2025. The EU Emissions Trading System has reduced emissions in the covered sectors by 50% since 2005, [online] Available at: <https://climate.ec.europa.eu/news-your-voice/news/eu-emissions-trading-system-has-reduced-emissions-sectors-covered-50-2005-2025-04-04_en#:~:text=The%20data%20reported%20by%20EU,62> [Accessed 25 June 2025]
14. European Environment Agency, 2024. Economic losses from weather- and climate-related extremes in Europe. *European Environment Agency* [online] Available at: <https://www.eea.europa.eu/en/analysis/indicators/economic-losses-from-climate-related> [Accessed 27 June 2025]
15. European Environment Agency, 2025a. Share of environmental taxes in total tax revenues in Europe.*European Environment Agency* [online] Available at: <https://www.eea.europa.eu/en/analysis/indicators/share-of-environmental-taxes-in?activeAccordion=ecdb3bcf-bbe9-4978-b5cf-0b136399d9f8> [Accessed 27 June 2025]
16. European Environment Agency, 2025b. Share of energy consumption from renewable sources in Europe. *European Environment Agency* [online] Available at: <https://www.eea.europa.eu/en/analysis/indicators/share-of-energy-consumption-from> [Accessed 27 June 2025]
17. European Environment Agency, 2025c. Green bonds in Europe. *European Environment Agency* [online] Available at: <https://www.eea.europa.eu/en/analysis/indicators/green-bonds-8th-eap> [Accessed 27 June 2025]
18. Flammer, C., 2020. Green Bonds: Effectiveness and Implications for Public Policy. *Environmental and Energy Policy and the Economy*, 1 (1), pp. 95–128. https://doi.org/10.1086/706794
19. Hwang, C.L. and Yoon, K., 1981. Multiple Attribute Decision Making: Methods and Applications. *Berlin, Heidelberg: Springer*. http://dx.doi.org/10.1007/978-3-642-48318-9
20. IDB/OECD, 2018. The Road to SDG Financing: Gap of $2.5 trillion annually in emerging markets. *Inter-American Development Bank* [online] Available at: <https://www.iadb.org/en/news/road-sdg-financing-new-destination-private-investment#:~:text=To%20begin%20with%2C%20the%20numbers,finance%20invested%2C%20the%20LAC%20region> [Accessed 30 June 2025]
21. IFC, 2024. Green Bonds Factsheet Investing for a Greener and More Sustainable Future. *International Finance Corporation* [online] Available at: <https://www.ifc.org/content/dam/ifc/doclink/2024/ifc-green-bonds-factsheet.pdf> [Accessed 29 June 2025]
22. IPCC, 2022. Climate Change 2022: Mitigation of Climate Change. IPCC Working Group III Report – Summary for Policymakers. Intergovernmental Panel on Climate Change. *Geneva Environment Network* [online] Available at: https://www.genevaenvironmentnetwork.org/events/briefing-on-the-ipcc-climate-change-2022-report-mitigation-of-climate-change/ [Accessed 30 June 2025]
23. Kerr, S. and Hu, X. Filling the climate finance gap: holistic approaches to mobilise private finance in developing economies. *Climate Action,* 4, 16. https://doi.org/10.1038/s44168-025-00220-x
24. Khurshid, A., Rauf, A., Qayyum, S., Călin, A. and Duan, W., 2022. Green innovation and carbon emissions: the role of carbon pricing and environmental policies in attaining sustainable development targets of carbon mitigation—evidence from Central-Eastern Europe. *Environment, Development and Sustainability,* 25, pp. 8777-8798. https://doi.org/10.1007/s10668-022-02422-3
25. Kuang, W., 2021. Which clean energy sectors are attractive? A portfolio diversification perspective. *Energy Economics*, 104, 105644. https://doi.org/10.1016/j.eneco.2021.105644
26. Lai, V. and Soumaré, I. (2011). An Analysis of Government Loan Guarantees and Direct Investment through Public-Private Partnerships. *Economic Modelling,* 59, pp. 508-519. https://doi.org/10.1016/j.econmod.2016.08.012
27. Lapinskiene, G. and Danileviciene, I., 2023. Assessment of Green Banking Performance. *Sustainability*, 15(20), 14769. https://doi.org/10.3390/su152014769
28. Mahesh, K.M., Aithal, P.S. and Sharma, K.R.S., 2022. Impact of Sustainable Finance on MSMEs and other Companies to Promote Green Growth and Sustainable Development. *International Journal of Applied Engineering and Management Letters (IJAEML),* 6(1), pp. 60-76. https://doi.org/10.5281/zenodo.6044523

29. Meckling, J., Sterner, T. and Wagner, G., 2017. Policy sequencing toward decarbonization. *Nature Energy,* 2, pp. 918-922. https://doi.org/10.1038/S41560-017-0025-8
30. Meng, J., Ye, Z. and Wang, Y., 2024. Financing and investing in sustainable infrastructure: A review and research agenda. *Sustainable Futures,* 8, 100312. https://doi.org/10.1016/j.sftr.2024.100312
31. Network for Greening the Financial System, 2024. Synthesis report on the greening of the financial system Insights for financial actors in advanced and emerging economies. *Network for Greening the Financial System* [online] Available at: <https://www.ngfs.net/system/files/import/ngfs/medias/documents/ngfs_synthesis_report_on_the_greening_of_the_financial_system.pdf> [Accessed 13 June 2025]
32. OECD., 2023. Green Finance and Investment Scaling Up the Mobilisation of Private Finance for Climate Action in Developing Countries. *OECD Publishing* [online] Available at: <https://www.oecd.org/content/dam/oecd/en/publications/reports/2023/11/scaling-up-the-mobilisation-of-private-finance-for-climate-action-in-developing-countries_4edb9782/17a88681-en.pdf> [Accessed 20 June 2025].
33. Ozili, P. K., 2023. Sustainable Development Goals and bank profitability: International evidence. *Modern Finance,* 1(1), pp. 70–92. https://doi.org/10.61351/mf.v1i1.44
34. Petreski, A., Schäfer, D. and Stephan, A., 2024. The Reputation Effect of Repeated Green-Bond Issuance and Its Impact on the Cost of Capital. *Business Strategy and the Environment,* 34, pp. 2436-2448. https://doi.org/10.1002/bse.4111
35. Raman, R., Ray, S., Das, D. and Nedungadi, P., 2024 Innovations and barriers in sustainable and green finance for advancing sustainable development goals. *Frontiers in Environmental Science,* 12, 1513204. https://doi.org/10.3389/fenvs.2024.1513204
36. Rana, P., 2024. Determining Investment Decision By Evaluating Financial Performance Among Top ESG-Ranked Companies Using the TOPSIS Model. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4701453.
37. Reig-Mullor, J., Garcia-Bernabeu, A., Plà-Santamaria, D. and Vercher-Ferrandiz, M., 2022. Evaluating Esg Corporate Performance Using A New Neutrosophic Ahp-Topsis Based Approach. *Technological and Economic Development of Economy,* 28(5), pp. 1242-1266. https://doi.org/10.3846/tede.2022.17004.
38. Rosenbloom, D., Markard, J., Geels, F. and Fuenfschilling, L., 2020. Opinion: Why carbon pricing is not sufficient to mitigate climate change—and how "sustainability transition policy" can help. *Proceedings of the National Academy of Sciences,* 117, pp. 8664 - 8668. https://doi.org/10.1073/pnas.2004093117
39. Salsabila, A., Fasa, M. I., Suharto, S. and Fachri, A., 2022. Trends in Green Banking as Productive Financing in Realizing Sustainable Development. *Az-Zarqa': Jurnal Hukum Bisnis Islam,* 14(2), pp. 151-174. https://doi.org/10.14421/azzarqa.v14i2.2562
40. Sharma, A. and Kautish, P., 2023. Measuring green finance. In: M. Shahbaz, K. Dong, D. Balsalobre-Lorente and A. Gedikli, ed. 2023. *Recent developments in green finance, Green Growth Carbon Neutrality.* Elsevier, pp. 171–191. https://doi.org/10.1016/B978-0-443-15936-7.00008-6
41. Sharma, S., Gupta, C., Malhotra, R.K. and Upreti, H., 2024. Sustainable Banking Practices: Impact, challenges and opportunities. *International Conference on Recent Advances in Waste Minimization & Utilization-2024,* 556, 01031. https://doi.org/10.1051/e3sconf/202455601031
42. Tvinnereim, E. and Mehling, M., 2018. Carbon pricing and deep decarbonisation. *Energy Policy,* 121, pp. 185-189. https://doi.org/10.1016/J.ENPOL.2018.06.020
43. UN, 2019. Sustainable finance progress report. *UN Environment* [online] Available at: <https://gfc.aifc.kz/files/pages/455/docs/8/sustainable-finance-progress-report-2019-march-unep.pdf#:~:text=period,billion%20in%20the%20first%20half> [Accessed 23 June 2025]
44. Yılmaz, G. and İne, M.N., 2018. Assessment of Sustainability Performances of Banks by TOPSIS Method and Balanced Scorecard. *International Journal of Business and Applied Social Science (IJBASS),* 4(1), pp. 62-75. https://www.ssoar.info/ssoar/bitstream/handle/document/55665/ssoar-ijbass-2018-1-ylmaz_et_al-Assessment_of_sustainability_performances_of.pdf?sequence=1
45. Ziolo, M., Bak, I. and Cheba, K., 2021. The role of sustainable finance in achieving Sustainable Development Goals: does it work?. *Technological and Economic Development of Economy,* 27(1), pp. 45-70. https://doi.org/10.3846/tede.2020.13863