MUNICIPAL GREEN BONDS AND ENERGY PERFORMANCE CONTRACTS AS DRIVERS OF PUBLIC-PRIVATE PARTNERSHIP IN THE RENOVATION OF PUBLIC BUILDINGS IN THE REPUBLIC OF MOLDOVA

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Abstract: *This study examines the integration of two innovative financial instruments — Municipal Green Bonds (MGB) and Energy Performance Contracts (EPC) implemented through Energy Service Companies (ESCO) — as drivers of sustainable Public-Private Partnership (PPP) in the renovation of public buildings in the Republic of Moldova. The aim of the research is to substantiate an integrated MGB-ESCO model capable of mobilizing private institutional capital for an estimated investment gap of 9.1 billion euros. The study adopts a qualitative methodology combining literature review (2018-2025), document analysis of EU and national legal frameworks, and case-study analysis of recent Moldovan projects — the Moldova Energy Efficiency Project, the Energy Vulnerability Reduction Fund, the Chișinău kindergarten modernization project, and the pioneering municipal bond issuances of Sîngera, Ceadâr-Lunga and Chișinău. Data sources include the National Bureau of Statistics, the World Bank, the European Commission and the Energy Community Secretariat. The findings demonstrate that, individually, ESCO contracts and Green Bonds face structural barriers — high cost of commercial capital and the shortage of bankable green projects with verifiable savings. Their integration within a blended finance architecture, however, generates a self-reinforcing renovation cycle in which municipalities act as financial aggregators, ESCOs absorb the technical risk, and institutional investors gain access to verified green assets. On this basis, four strategic recommendations are formulated for Moldovan public authorities.*

Keywords: *municipal green bonds, energy performance contracts, public-private partnership, blended finance, Republic of Moldova.*

JEL: G18, H54, Q56, R51.

Introduction

Ensuring a high level of energy efficiency of the national economy constitutes a fundamental precondition for achieving the goals of full and cost-effective decarbonization, enhancing global competitiveness and guaranteeing long-term energy security. Empirical data of the European Union indicate that buildings account for approximately 36% of total final energy consumption and around 40% of all anthropogenic greenhouse gas emissions directly related to energy processes. Moreover, statistics for 2023 confirm that 52% of all natural gas consumed in the European Union was, directly or indirectly, used for air conditioning, heating and electricity supply of buildings (European Commission, 2025a). In response to these challenges, the revised EU Energy Efficiency Directive sets stringent targets: reducing final energy consumption to no more than 763 million tonnes of oil equivalent by 2030, which requires at least doubling the current building renovation rate (currently at a critically low level of about 1% per year), and transforming the existing stock into zero-emission buildings by 2050 (European Commission, 2025a).

For the Republic of Moldova, the global energy crisis of 2022–2025 — triggered by the geopolitical instability in the East European region and systemic disruptions in the supply of conventional hydrocarbons — has exposed the critical vulnerability of the Moldovan economy, historically dependent on imported energy resources (Kontogouri, 2025). Given that 60% of national energy

consumption is attributed to the construction sector, the large-scale thermal modernization of both the residential and the public building stock is transformed from a narrow sectoral environmental initiative into a first-order macroeconomic security priority (World Bank, 2025).

Current estimates of investment needs reveal a vast gap between required and available financial resources. According to preliminary calculations of the World Bank and the relevant ministries, presented in the draft Energy Strategy of the Republic of Moldova until 2050, the comprehensive renovation and rehabilitation of the national building stock alone require no less than 9.1 billion euros (World Bank, 2025). It is evident that covering such considerable investment needs exclusively from the state budget, municipal appropriations or direct donor grants is mathematically and economically impossible, especially against the background of the budget deficit and the need to preserve fiscal stability. As a result, there is a clear need to design and adapt innovative financial mechanisms able to mobilize private institutional capital for the implementation of infrastructure projects.

Within this framework, two of the most promising and scientifically substantiated instruments capable of acting as drivers of a sustainable Public-Private Partnership (PPP) in the field of building renovation can be identified: Energy Performance Contracts (EPC) implemented through Energy Service Companies (ESCO), and Municipal Green Bonds (MGB) (C40 Knowledge Hub, 2022). Energy Performance Contracts are examined as an instrument for overcoming technical barriers and for the distribution of project risk, whereas Green Bonds are analyzed in the context of capital markets transformation and the development of ESG investing (Environmental, Social and Governance). However, the practical experience of transition economies demonstrates that, taken separately, these mechanisms face fundamental obstacles: the ESCO market stagnates due to the high cost of commercial lending and the distrust of the public sector, while the issuance of Municipal Green Bonds is constrained by the shortage of bankable projects capable of generating verified savings and transparent reporting.

The aim of this paper is therefore to substantiate, on the basis of a qualitative analysis of academic literature, the EU and national regulatory frameworks, and the most recent Moldovan case studies (2021–2025), an integrated financial-engineering model in which Municipal Green Bonds and ESCO mechanisms operate in inseparable symbiosis, supported by a blended finance architecture.

Literature review

Energy Service Companies (ESCO) are highly specialized economic operators offering project-based financing whose key feature is the provision of comprehensive energy services, including energy audits, design, financing, construction and installation works, as well as subsequent operation and monitoring of the modernized facilities. The interaction between an ESCO and a beneficiary (in the present study — local public administrations owning public buildings) is governed by an Energy Performance Contract (EPC). The principal difference between an EPC and a traditional construction works contract lies in the fact that the ESCO assumes both the technical and the financial risks, guarantees a certain level of energy savings, and is remunerated exclusively on the basis of the verified savings on energy expenditure actually achieved (Zheng et al., 2025).

Recent academic studies demonstrate that the formation of equilibrium strategies in the EPC model depends on several factors:

- the overestimation of potential losses by the beneficiary acts as the main systemic obstacle to the diffusion of innovation;
- in the conditions of insufficient qualification, municipal officials tend to perceive long-term obligations to pay a share of saved costs as a form of disguised lending bearing high risks;
- a conflict of interest arises, since municipalities seek to minimize their financial burden by requiring maximum levels of energy savings under zero up-front investment, whereas ESCO companies are forced to incorporate a high risk margin given the instability of the regulatory framework and the cost of capital.

The analysis of these models also demonstrates that at the early stages of market formation the development of the ESCO industry depends almost entirely on state subsidies and financial support, since both parties to the transaction (the ESCO and the municipality) exhibit a low initial readiness for cooperation. Mechanisms of state coercion (fines for inefficient energy use or for exceeding carbon quotas) exert a pronounced influence on the adaptation of economic agents to the new regulatory environment in the phase of low market maturity, yet, as the market reaches a phase of relative maturity, the effectiveness of punitive sanctions decreases, giving way to purely economic motives. Consequently, in order to launch the energy service market, a powerful external financial catalyst is required, capable of minimizing start-up risks and of providing access to inexpensive long-term financing.

A fundamental obstacle for the operability of the EPC model is the cost and availability of capital. The energy performance contract presupposes that the ESCO finances the initial capital expenditure (window replacement, facade insulation, heat pump installation) using its own or borrowed funds, while the return on the investment is realized over a period of 7–15 years. In Moldova and the neighbouring countries (such as Ukraine), macroeconomic instability dictates prohibitive commercial lending rates. As studies of Eastern European markets demonstrate, the rates on short-term corporate credit have historically ranged between 20% and 30% (Panev et al., 2018). In addition, the high level of inflation (which peaked at over 30% in Moldova in 2022) and exchange rate risks (tariffs are approved in the national currency, whereas equipment is imported in euros) render long-term cash flow forecasting impossible for commercial banks. Under such discount rates, the Net Present Value (NPV) of any energy service project becomes negative.

A second barrier consists in the public procurement procedure. Municipalities are obliged to conduct tenders within a strictly regulated public procurement law, which has traditionally been oriented towards the "lowest price" criterion when purchasing specific goods or construction works. Furthermore, the conclusion of EPC contracts is impossible without a reliable baseline database of historical energy consumption. Until recently, Moldova lacked both a systemic database on the energy consumption of buildings and a measurement and verification system of savings, which created the ground for legal disputes between ESCOs and municipalities concerning the methodology for calculating saved resources.

In order to overcome the barriers described above, state institutions have launched a series of reforms. A fundamental shift was the adoption by the Parliament of the Republic of Moldova of Law No. 282 of 5 October 2023 "On the Energy Performance of Buildings", which entered into full legal force in the spring of 2024 (Law No. 282/2023). This legal act lays a European foundation: Article 12 obliges the State to develop a long-term strategy for the renovation of the national real estate stock, while Article 13 regulates in detail the mechanisms of financial incentives and the overcoming of market barriers in order to attract private investment (Law No. 282/2023). A significant step has also been taken in the digitalization of the sector: with the financial support of the World Bank, within the M-GROW programme, the design and implementation of the National Information System for the Energy Performance of Buildings (NISEEB) has been initiated. This system, the tender for which was launched at the end of 2025, is to become the central analytical core, providing investors and ESCO companies with reliable data. In parallel, in order to address the problem of human resources shortage at the municipal level, in September 2024 the Energy Efficiency Training Network was officially launched in Chișinău with GIZ support, providing instruments of energy planning and access to professional networks (Stockholm Environment Institute, 2025).

The second component of the model investigated is constituted by Green Bonds. As fixed-income instruments, Green Bonds differ from classical debt securities exclusively through the targeted nature of the use of the funds raised — these must be channelled strictly towards the financing or refinancing of projects generating measurable environmental or climate benefits (C40 Knowledge Hub, 2022).

For a long period, subnational debt instruments were not used in Moldova. A breakthrough occurred in the period 2022–2024, owing to the technical assistance of donors and to the projects of Expert-Grup. The debut issuances of municipal bonds by the town halls of small cities — Sîngera and Ceadâr-Lunga — demonstrated an unexpectedly high appetite from local investors, both issuances being closed in advance due to oversubscription (Expert-Grup, n.d.). Shortly thereafter, the largest commercial bank of the country, MAIB, acted as arranger and underwriter for the primary issuance of municipal bonds of the capital city of Chișinău. In April 2024, with the support of the Embassy of the Netherlands, a long-term programme was launched to support four additional Municipal Public Administrations (MPAs) in the issuance of their own debt securities (Expert-Grup, n.d.). Although these first issuances did not undergo the complex certification procedure under the standards of the International Capital Market Association (ICMA) as strictly "green" (Green Bonds), they shaped the legal, procedural and cultural infrastructure for future targeted climate issuances.

For municipalities, the issuance of Municipal Green Bonds provides a number of strategic advantages over traditional bank borrowing. First, bonds generate economies through the aggregation of a portfolio of multiple local projects (for example, the renovation of dozens of kindergartens, hospitals and administrative buildings) into a single investment proposition attractive to large institutional investors (pension funds, insurance corporations). Second, the unmet demand from the private sector for sustainable investments often allows issuers to place bonds with the so-called "greenium" — a negative yield spread compared to conventional bonds of the same credit quality, which directly reduces the cost of capital for the municipality. Third, the access to public capital markets entails internal institutional changes within municipalities: transparency is enhanced, risk management procedures are improved and interdepartmental coordination between financial and environmental departments is strengthened.

Particular relevance, within the financing of public buildings, is acquired by the integration of Green Bonds with the Sustainable Development Goals (SDGs). The issuance of debt obligations directed at the modernization of social infrastructure (educational institutions, hospitals) allows combining environmental metrics (the reduction of CO_2 emissions) with socioeconomic indicators (improvement of the quality of the educational environment, reduction of respiratory diseases owing to proper ventilation, accessibility of services). Hence, the convergence of the ESCO model and the Green Bond model represents a synthesis between technical guarantee of result and long-term optimized financing.

Methodology and conceptual framework

The present study adopts a qualitative methodological approach combining several research techniques. First, a critical analysis was carried out of the recent academic literature (2018–2025) on ESCO and EPC mechanisms, Green Bonds, blended finance and energy efficiency policy in transition economies. Second, a document analysis was conducted of European Union directives, national legal frameworks (notably Law No. 282/2023 on the Energy Performance of Buildings) and key strategic documents, such as the draft Energy Strategy of the Republic of Moldova until 2050 and the National Energy and Climate Plan (NECP). Third, a case-study analysis was carried out of pilot and ongoing projects in Moldova: the Moldova Energy Efficiency Project (MEEP); the STEEM and M-GROW programmes; the Energy Vulnerability Reduction Fund (EVRF); the kindergarten modernization project of Chișinău, implemented under the Green City Action Plan of the European Bank for Reconstruction and Development (EBRD); and the pioneering municipal bond issuances of Sîngera, Ceadâr-Lunga and Chișinău. Finally, a comparative statistical analysis was performed using data from the National Bureau of Statistics of the Republic of Moldova, the World Bank, the European Commission and the Energy Community Secretariat.

The analytical framework of the study is built on three pillars. The first pillar refers to the macroeconomic context of the energy vulnerability of the Republic of Moldova and to the need to shift from consumption-side subsidies to capital investments in the infrastructure of the building

stock. The second pillar refers to the microeconomic logic of EPC contracts (the transfer of technical risk to the ESCO and performance-based remuneration). The third pillar refers to the financial logic of Municipal Green Bonds, viewed within a blended finance architecture (first-loss capital, credit enhancement and the mobilization of institutional investors). The integration of these three pillars makes it possible to formulate the proposed PPP model and the corresponding operational recommendations.

Results and discussions

Condition of the building stock and energy vulnerability of the Republic of Moldova

In order to objectively assess the potential for the implementation of an integrated financial model, an analysis of the current state of the national building stock and of the specific energy vulnerability of the Republic of Moldova in the period 2021–2025 is required. The statistical analysis based on the data of the National Bureau of Statistics of the Republic of Moldova shows that, as of 1 January 2024, the national housing stock comprised 1,331.3 thousand dwellings, representing a 0.5% increase compared with the previous year. The total floor area of the housing stock exceeded 91.15 million square metres (NBS Moldova, 2024). Although these figures describe the residential segment, they reflect the general degree of obsolescence and the scale of the construction infrastructure requiring intervention. This level of inefficiency generates an overload both for the national energy grid — dependent on the unstable import of natural gas and electricity (including the critical dependence on the Moldavian GRES located in the Transnistrian region and on the transit routes through Ukraine) — and for the fiscal system of the municipalities (European Commission, 2025b). With a view to radically changing the development vector, in 2023–2024 the Government of the Republic of Moldova updated the strategic national documents. The adopted National Energy and Climate Plan (NECP) provides for the achievement, by 2030, of a 27% share of renewable energy sources (RES) in final energy consumption and 30% in the structure of electricity production. Furthermore, in the framework of the national legislation, the EU directive optimizing the regulation of RES auctions and establishing sustainability criteria has been transposed (Energy Community Secretariat, 2025). Nevertheless, the achievement of these targets is impossible without a parallel reduction of baseline demand through energy efficiency programmes.

Energy poverty and the transformational effects of the EVRF and of the national renovation programmes (MEEP and STEEM)

The critically low energy efficiency of the infrastructure, combined with the inflationary shocks of 2022 (when European spot gas prices set historical records), provoked a large-scale energy poverty crisis in the Republic of Moldova. The reaction of the State took the form of the creation of the Energy Vulnerability Reduction Fund (EVRF), supported by the United Nations Development Programme, the governments of Italy, Slovakia and other partners (UNDP Moldova, 2025). This Fund implemented a complex information system (EVIS) distributing targeted financial compensations on citizens' utility bills, depending on their verified income level and energy consumption.

The analysis of empirical data for the cold seasons of 2022–2023 and 2023–2024 demonstrates that the State interventions have protected the population from a massive transition into a state of critical energy poverty. Without these payments, the level of energy poverty would have exceeded 89.0%, however, owing to the EVRF, it was reduced to 81.3%. The absolute monetary poverty rate decreased from an estimated 44.3% to 34.9%, while food poverty fell from 25.6% to 17.8%. The assistance proved particularly critical for vulnerable demographic groups: female-headed households, the elderly and Ukrainian refugees (among the latter, the rate of monetary poverty declined by 18 percentage points) (UNDP Moldova, 2025).

Despite the social success of the programme, the academic expert community and international donors unanimously recognise that the subsidization of tariffs (the compensation of operating expenditure) is a fiscally unsustainable path. The long-term strategy of the National Center for Sustainable Energy (NCSE) and the Ministry of Energy requires a transition from the subsidization

of consumption to the subsidization of capital investment in energy efficiency. The first step in this direction was the "EcoVoucher" programme, launched at the end of 2023, in the framework of which vulnerable families received targeted funds to replace old household appliances. As a result of the use of 39,084 vouchers, an annual saving of 1.6 million kWh (approximately 7 million Moldovan lei) and a corresponding reduction in carbon dioxide emissions were achieved (Berzerdeanu et al., 2025).

At the national level, the principal project is the Moldova Energy Efficiency Project (MEEP), with a total budget exceeding 70 million euros. The financing of the project is based on parity co-financing: the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) have provided sovereign loans of 30 million euros each, which are complemented by a grant from the EU Neighbourhood Investment Platform (NIP Grant) of approximately 12–15 million euros. Phase I of the project focused on the reconstruction of republican hospitals, whereas Phase II (launched in August 2023) shifted the emphasis to institutions under local authority (schools, kindergartens, district medical units). The implementation of MEEP allows the operationalization of standardized environmental and social assessment procedures, stakeholder engagement plans and public procurement procedures aligned with EU standards (MEPIU, 2022).

In parallel, within the M-GROW mechanism and the STEEM (Sustainable Transition through Energy Efficiency in Moldova) project, detailed energy audits of 46 public schools have been financed (covering more than 46,000 pupils), which represents an absolutely necessary stage for the preparation of design and estimate documentation and for the formation of investment projects eligible for future Green Bond issuances (World Bank, 2025).

The Chișinău kindergarten modernization project as a symbiosis of municipal debt and ESCO mechanisms

The most representative project, demonstrating the evolution of financing and the elements of the future symbiosis with ESCO, is the project for enhancing the energy efficiency of kindergartens in Chișinău, initiated in 2024. This project is organically integrated into the Green City Action Plan for Chișinău, implemented under the aegis of the EBRD (Chișinău Municipality, 2019). The project covers the deep thermomodernization of up to 30 preschool institutions. The technical package includes the insulation of the building envelope, the modernization of heating and water supply systems, the replacement of joinery, the installation of air recovery systems and the deployment of distributed renewable energy sources (photovoltaic panels and solar collectors). The expected engineering outcome is energy savings of 55% (over 46,000 GJ per year) and an annual reduction of greenhouse gas emissions of 3,165 tonnes of CO_2 equivalent (EBRD, 2026). The financial structure of this project is a classic example of blended finance, combining IFI credit resources, grants and contribution from the municipality itself.

However, the most fundamental aspect of this project is its institutional dimension: the project provides not only for physical works, but also for the introduction of energy management standards, mandatory energy audits, and the introduction of Energy Performance Contracts (EBRD, 2026). This is direct evidence that international development institutions purposefully use large tranches of municipal debt for the development of the ESCO market, stimulating the engagement of private engineering firms in the implementation of municipal tasks.

The proposed integrated MGB–ESCO model

The analysis of theoretical barriers and the examination of practical projects (MEEP and the Chișinău kindergarten project) allow scientifically substantiating an innovative financial-engineering model of PPP, in which Municipal Green Bonds and ESCO mechanisms operate in inseparable symbiosis. This integration solves the main problems: it minimizes the "erroneous overestimation of potential losses" by the clients and it addresses the inaccessibility of cheap capital for the contractors. In the proposed model, the municipality does not merely act as a beneficiary but is transformed into a financial aggregator, which is fully consistent with the new public management approach.

The operational sequence is as follows. First, the municipality conducts standardized energy audits of hundreds of public buildings (schools, kindergartens, polyclinics), thus shaping a large-scale verified investment portfolio (green portfolio). Against this portfolio, the municipality issues Municipal Green Bonds on the domestic or international capital markets. Owing to the use of the municipal credit rating and the guarantees attached to the issuance, the coupon rate on these bonds is expected to remain in the single-digit range, which is significantly cheaper than commercial loans at 20–30% applicable to private contractors. The capital raised from institutional investors (including the international financial institutions themselves, local banks and pension funds) is accumulated in a dedicated Municipal Fund, the management of which involves external auditors.

Subsequently, the transfer of technical risk occurs: instead of independently procuring equipment and contracting dozens of construction crews, the municipality launches tenders for the conclusion of EPC contracts. ESCO companies win the tenders, guaranteeing a specific percentage of energy consumption reduction (for example, 55%, as in Chișinău). The financing of capital expenditure is provided to the ESCO from the Municipal Fund in the form of targeted interest-free or low-interest loans (or the municipality pays directly, but the contract obliges the ESCO to refund the investment in the event of non-achievement of the KPIs). In return, the municipality is relieved of technical risks: should the heat pumps malfunction or the insulation prove inadequate, the ESCO will not receive a performance premium and will be obliged to compensate the difference under the contract.

Once the modernization is completed, the municipal expenditure on heating and electricity bills drops sharply. The difference between the baseline (historical) energy budget and the new (low) bills constitutes a free cash flow stream. This saved amount is annually redistributed: a portion is used for the payment of coupons to the holders of the Green Bonds and for the gradual formation of a sinking fund for the principal; a portion is paid to the ESCO as a premium for guaranteed performance; and the remainder forms a net profit of the local budget, which can be channelled to social needs or reinvested in the Fund to finance new projects.

In order for the green bonds of Moldovan municipalities to inspire confidence among international and local investors, the model requires the application of the concept of blended finance. As studies of emerging market economies show, blended finance entails the strategic use of a limited amount of public or grant capital in order to mobilize large-scale private investment. Within the context of the Republic of Moldova, such concessional capital can take the form of grant funds from the European Union (e.g. NIP grants), tranches from Norway via the M-GROW Fund, or resources from the Global Environment Facility (GEF). These non-repayable resources should be used for the formation of a first-loss tranche covering potential defaults on municipal bonds. If the municipality, for force majeure reasons, fails to honour a coupon payment, investors are compensated from this grant-based guarantee fund. The presence of such a layer instantly raises the credit rating of the issuance, reduces the interest rate, and makes investments in Moldovan energy efficiency attractive to global ESG funds. The complementarity is evident: Green Bonds provide liquidity at a low cost, the blended finance arrangement reduces financial risks for investors, and EPC contracts fully insure the municipality against technical and operational failures.

Conclusions

The renovation of the outdated public building stock of the Republic of Moldova constitutes one of the most complex infrastructure challenges of the current decade. In conditions in which the average energy consumption of public buildings is nearly twice the European Union standards, and where considerable thermal losses impose a heavy inflationary burden on the budget and on society, the transition from fiscally burdensome consumption subsidies to investments in infrastructure capital represents the only sustainable macroeconomic strategy.

The conducted research demonstrates that the integration of the instruments of Municipal Green Bonds and Energy Performance Contracts (implemented through ESCOs) forms a powerful

foundation for Public-Private Partnership. Municipal Green Bonds act as the financial foundation: they consolidate fragmented projects, eliminate the problem of high banking rates, and open access to the global liquidity of ESG funds prepared to invest in climate objectives. In turn, EPC contracts, implemented by qualified energy service companies, ensure the engineering integrity of the process: they neutralize the technical and operational risks for the municipalities, guaranteeing that investments are actually converted into saved gigajoules and reduced CO_2 emissions.

The analysis of the practice of 2021–2025 testifies to a high degree of institutional readiness of Moldova for this transformation. The successful issuance of municipal bonds in the regions, the systemic integration of blended finance elements into projects (the modernization of dozens of kindergartens in Chișinău with the participation of the EBRD and the EIB for over 30 million euros), as well as the large-scale legal adaptation (Law No. 282 of 5 October 2023 "On the Energy Performance of Buildings") have created a robust basis for further development. The synchronization of these instruments, supported by blended finance guarantee mechanisms, is capable of launching a self-reproducing renovation spiral, strengthening the energy security of the country, stimulating the growth of the local green business and ensuring the full-scale integration of the Republic of Moldova into the European climate system.

Based on the results of the study, a set of strategic recommendations may be formulated for the state structures of the Republic of Moldova (the Ministry of Energy, the Ministry of Finance, the National Commission for Financial Markets and the National Center for Sustainable Energy):

1. Legislative legitimation and standardization of EPC contracts. It is necessary to develop and approve, at the level of a Government Decision, unified standard forms of energy performance contracts, in line with the Law on Public-Private Partnerships and the Law on Public Procurement. It is essential to legally enshrine the priority of the life-cycle cost assessment method over the lowest-price criterion in procurement for energy efficiency projects — this will ensure legal predictability for potential ESCO investors.

2. Creation of a guarantee mechanism. Drawing on the resources of the Energy Efficiency Fund and on the donor support of M-GROW, the State should establish a National Guarantee Scheme, providing bank-level sureties for small and medium-sized ESCO companies during their start-up phase.

3. Institutionalization of Municipal Green Bonds and taxonomy alignment. The National Commission for Financial Markets should develop methodological guidelines for local public authorities on the issuance of environmentally labelled securities aligned with the European green taxonomy and with the standards of the International Capital Market Association (ICMA).

4. Development of human capital and of knowledge transfer networks. The scaling-up of initiatives such as the Energy Efficiency Training Network for municipal managers and the "Women in Energy Internship" programme is essential to consolidate the institutional readiness for hybrid financial-engineering instruments.

Limitations and future research directions.

The present research has several limitations that need to be acknowledged. First, the model is substantiated on a qualitative basis, drawing on case-study evidence and document analysis; an econometric estimation of the precise coupon rate, of the optimal size of the first-loss tranche, and of the leverage ratio of grant capital to mobilized private capital is beyond the scope of this paper and constitutes a natural extension of the present work. Second, the empirical evidence available on Moldovan municipal bond issuances is still limited to a small number of pilot cases (Sîngera, Ceadâr-Lunga, Chișinău), which restricts the generalizability of the conclusions on investor appetite and on the magnitude of a potential greenium. Third, the analysis assumes a stable macroeconomic and political environment; severe shocks (geopolitical, fiscal or monetary) may significantly alter the parameters of the proposed architecture.

Future research directions could therefore proceed in three complementary directions: (i) the construction of an econometric model that quantifies the leverage effect of blended finance on the mobilization of private capital in transition economies; (ii) a comparative analysis of the applicability of the proposed MGB-ESCO architecture in countries with structural conditions similar to those of Moldova — notably Ukraine, Georgia and the Western Balkans; and (iii) the development of a dedicated measurement, reporting and verification framework for the social co-benefits of public-building renovation, allowing a more rigorous integration of environmental and socioeconomic indicators within the use-of-proceeds reporting of Municipal Green Bonds.

References

1. European Commission (2025a). Report on Financing Energy Efficiency in Europe. Brussels: European Commission. Retrieved February 2026, from https://commission.europa.eu/topics/energy_en.
2. Kontogouri, E. (2025). Master Thesis on Energy: Strategy, Law and Economics. Piraeus: University of Piraeus, School of Economics, Business and International Studies. Available at https://dione.lib.unipi.gr/xmlui/bitstream/handle/unipi/18165/ELENI%20KONTOGOURI%20MASTER%20THESIS%202025.pdf.
3. World Bank (2025). M-GROW Annual Report 2024–25. Washington, DC: World Bank Group, 84 p. Available at https://thedocs.worldbank.org/en/doc/1b840ecb7645f07f28f05bc7642a13f1-0080012025/original/M-GROW-Annual-Report-2024-25.pdf.
4. C40 Knowledge Hub (2022). How to Decide if Green Bonds Are Right for Your City. London: C40 Cities Climate Leadership Group. Retrieved February 2026, from https://www.c40knowledgehub.org/s/article/How-to-decide-if-green-bonds-are-right-for-your-city.
5. Zheng, S., Zhou, Y., Yuan, J., Liu, R., Lyu, P., Han, Z. & Zhang, C. (2025). Understanding the Behavioral Strategies of Governments, Energy Service Companies and Clients in the Energy-Efficient Retrofitting of Public Buildings Based on Evolutionary Game Theory. Journal of Management in Engineering, American Society of Civil Engineers. Available at https://ascelibrary.org/doi/abs/10.1061/JMENEA.MEENG-6328.
6. Panev, S., Bertoldi, P., Boza-Kiss, B. & Palermo, V. (2018). Report for the Development of the ESCO Market in the EU Enlargement and Neighbouring Countries. Luxembourg: Publications Office of the European Union, 96 p. Available at https://www.researchgate.net/publication/332370505.
7. Law No. 282/2023. Law of the Republic of Moldova on the Energy Performance of Buildings, adopted on 5 October 2023. Official Monitor of the Republic of Moldova. Available at https://www.legis.md/cautare/getResults?doc_id=139619&lang=en.
8. Stockholm Environment Institute (2025). National Comprehensive Assessment of the Green Transition for Moldova. Stockholm: SEI. Available at https://www.sei.org/wp-content/uploads/2023/07/nationalcomprehensiveassessment-moldova.pdf.
9. Expert-Grup (n.d.). Municipal Bonds. Chișinău: Independent Analytical Center Expert-Grup. Retrieved March 2026, from https://www.expert-grup.org/en/resurse/obligatiuni-municipale.
10. NBS Moldova (2024). Housing Stock of the Republic of Moldova as of 1 January 2024. Chișinău: National Bureau of Statistics of the Republic of Moldova. Available at https://statistica.gov.md/.
11. European Commission (2025b). European Commission and Moldova Agree on a Two-Year Comprehensive Strategy for Energy Independence and Resilience. Brussels: DG NEAR. Retrieved February 2026, from https://enlargement.ec.europa.eu/news/european-commission-and-moldova-agree-2-year-comprehensive-strategy-energy-independence-and-2025-02-04_en.
12. Energy Community Secretariat (2025). Annual Implementation Report 2025. Tbilisi: Energy Community Secretariat. Available at https://www.energy-community.org/dam/jcr:ee52fae5-11ae-49f5-b731-3f82f9178e73/ECS_IR2025.pdf.
13. UNDP Moldova (2025). Report on the Welfare Impact of Energy Compensations in Moldova, 2021–2025. Chișinău: United Nations Development Programme. Available at https://www.undp.org/moldova/publications/report-welfare-impact-energy-compensations-moldova-2021-2025.
14. Berzerdeanu, A., Lupu, M., Uzun, G. & Daud, V. (2025). Prospects for Sustainable Development of the Energy Sector in the Republic of Moldova through Energy Efficiency Programs and Projects. Romanian Journal of Civil Engineering. Available at https://www.researchgate.net/publication/401671586.
15. MEPIU (2022). Moldova Energy Efficiency Project (MEEP). Chișinău: Moldova Energy Project Implementation Unit. Retrieved February 2026, from https://www.ucipe.gov.md/en/projects/moldova-energy-efficiency-project-meep.
16. Chișinău Municipality (2019). Green City Action Plan for the City of Chișinău. Chișinău: Municipality of Chișinău and EBRD, 168 p. Available at https://ebrdgreencities.com/assets/Uploads/PDF/GCAP_Chisinau-ENG.pdf.
17. EBRD (2026). EBRD Backs Chișinău's Ambition for Greener and More Energy-Efficient Kindergartens. London: European Bank for Reconstruction and Development. Available at https://www.ebrd.com/home/news-and-events/news/2026/ebrd-backs-chisinau-ambition-for-greener-kindergartens.html.