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Financing building energy renovation through public, private, and crowdfunding schemes: evidence from Greece, Cyprus, and Croatia

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PEER-REVIEWED PAPER

PETRA POMPER
STAVROS SPYRIDAKOS
SOFIA-NATALIA BOEMI
IVANA ROGULJ
DIMITRIOS ATHANASIOU

*Author affiliations can be found in the back matter of this article

ABSTRACT

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Investment in energy efficiency and deep renovation of buildings in the European Union continues to be constrained by limited access to financing. Although Member States have introduced a range of support schemes and financial institutions have expanded offer of renovation-related products, financing arrangements remain fragmented and insufficient. This paper presents a comparative analysis of financing instruments for building energy efficiency and deep renovation in Greece, Cyprus, and Croatia, using a common methodological framework.

The analysis covers public financing schemes, including grants, subsidies, and tax incentives, alongside private and market-based instruments such as loans, green mortgages, energy performance contracting, and equity-related mechanisms. Particular attention is given to their structure, targeting, and combination in practice, including the use of hybrid public–private financing schemes. The findings indicate that financing instruments are largely implemented in isolation, with limited coordination between public support and private finance.

Based on the mapping results, the paper examines crowdfunding as a complementary financing option within renovation financing frameworks. Different crowdfunding business models are analysed, including donation-based, reward-based, lending-based, and equity-based approaches, with respect to their potential application to building renovation. The analysis assesses how these models differ in terms of capital mobilisation, risk allocation, investor involvement, and compatibility with public support schemes and conventional bank finance. The paper concludes by discussing the conditions under which crowdfunding models may be integrated into hybrid financing schemes for building energy renovation and the limitations and regulatory considerations associated with their use.

CORRESPONDING AUTHOR:
Stavros Spyridakos
Institute for European Energy and Climate Policy (IEECP), NL
stavros@ieecp.org

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INTRODUCTION

According to the European Commission, the building sector accounts for about 40% of final energy consumption; 85% of the building stock was built before 2000, and 75% have poor energy performance. Despite significant renovation potential, only around 1% of buildings are renovated (European Commission, 2023; Wilson et al., 2018). Thus, within the recast of the Energy Performance of Buildings Directive (EPBD), the EU aims to double the annual energy renovation rate of buildings by 2030 and promote deep renovations (European Commission, n.d.).

Nevertheless, numerous barriers hinder the large-scale uptake of comprehensive energy renovations. Structural limitations in data availability and the quality of Energy Performance Certificates (EPCs) reduce transparency and undermine confidence in projected savings. Issues such as limited data and EPC quality (Heidenthaler et al., 2026; Iribar et al., 2021), trust in suppliers (Mogensen and Thøgersen, 2024), homeowner behaviour (Cattaneo, 2019), lack of information about available technologies and actual savings, technology uncertainty (Cattaneo, 2019; Schleich et al., 2016), hidden costs, and others prevent a larger share of renovations. The biggest barrier is the inability or inertia to finance upfront costs of energy renovations (Bertoldi et al., 2020; Cattaneo, 2019; Stieß and Dunkelberg, 2013).

In response to persistent investment barriers, Member States (MSs) have introduced a wide range of policy instruments to stimulate building renovation, including grants, subsidies, tax incentives, revolving funds, and preferential loans, often supported by EU and national funding (Bertoldi et al., 2020). In parallel, private financial institutions have expanded offerings such as green loans, green mortgages, and energy efficiency credit lines, while EPC models and service-based models aim to reduce upfront costs and shift performance risk.

Despite this, investment levels remain insufficient to meet EU decarbonisation targets. This is largely due to fragmented implementation and limited coordination between public and private instruments. Subsidy-based schemes continue to dominate, while market-based mechanisms remain underdeveloped, constraining private capital mobilisation and reinforcing reliance on public funding.

As a result, stronger integration of public and private finance has become central in policy discussions. Hybrid financing schemes combining grants, loans, and private investment are seen as a way to address liquidity and risk constraints. However, empirical evidence on their effectiveness remains limited, particularly in Member States with fragmented property structures and less developed capital markets.

Against this background, this paper makes two contributions. First, it provides a structured comparative mapping of renovation financing instruments across Greece, Cyprus, and Croatia – three EU Member States that share high renovation needs, elevated owner-occupation rates, and relatively shallow private capital markets, making them analytically comparable while representing distinct financing ecosystem configurations. Second, it assesses the structural compatibility of crowdfunding models with the financing gaps identified in each national ecosystem, addressing a gap in the literature on how such mechanisms may complement, rather than replace, existing public and private instruments (Bergmann et al., 2021).

LITERATURE REVIEW

PUBLIC FINANCING INSTRUMENTS FOR BUILDING ENERGY RENOVATION

Public intervention has long been central to promoting energy renovation in the building sector. Due to market failures, such as information asymmetries, split incentives, liquidity constraints, and behavioural biases, public financing instruments are often justified as corrective policy tools (Cattaneo, 2019). Grants and capital subsidies remain the most widely implemented mechanisms across Member States, particularly in residential renovation programmes (Bertoldi et al., 2020). These instruments directly reduce upfront investment costs and can significantly boost participation, especially among low- and middle-income households.

However, the effectiveness of grant-based schemes is debated. While these schemes can accelerate the uptake of renovations in the short term, concerns persist about free-rider

effects, administrative complexity, and limited leverage of private capital (Bertoldi et al., 2020). Empirical evidence indicates that high subsidy intensities may crowd out private investment or reduce incentives for cost optimisation (Stieß and Dunkelberg, 2013). Furthermore, public schemes often operate within limited budget cycles, leading stop-and-go dynamics that undermine market stability and long-term supply chain development.

Tax incentives represent an alternative policy instrument, frequently used to stimulate renovation investments through deductions or credits. Their impact depends heavily on household income levels and tax liability, potentially limiting accessibility for vulnerable groups (Belleflamme et al., 2014). Revolving funds and publicly backed loan guarantees have also been implemented to improve capital recycling and reduce credit risk exposure for financial institutions (Boza-Kiss et al., 2017). Nevertheless, their effectiveness depends on institutional capacity, project aggregation mechanisms, and standardisation of technical assessment procedures (Bertoldi et al., 2020).

Despite the diversity of public financing instruments, studies increasingly highlight the need to move beyond isolated subsidy schemes towards more integrated financing frameworks capable of mobilising private capital at scale (Bertoldi et al., 2020; Heidenthaler et al., 2026).

PRIVATE AND MARKET-BASED FINANCING MECHANISMS

Private finance is essential for bridging the renovation investment gap. Traditional bank loans remain the primary financing channel for energy renovation, particularly when grant schemes require beneficiary co-financing (Bertoldi et al., 2020). Recently, green loans and green mortgages have emerged, offering preferential interest rates to improved building energy performance (Di Tommaso et al., 2025). These instruments incorporate expected energy-saving credit risk assessments, which help reduce borrowing costs.

Energy Performance Contracting (EPC), implemented through Energy Service Companies (ESCOs), represents another market-based mechanism addressing upfront capital barriers (Boza-Kiss et al., 2017). Under EPC arrangements, the ESCO assumes performance risk and is remunerated through realised energy savings. Although EPC models have gained traction in public buildings and commercial sectors, their penetration in residential markets remains limited due to transaction costs, contract complexity, and small project sizes (Boza-Kiss et al., 2017).

Blended finance, which combines public funds with private capital, is increasingly considered as a de-risk strategy to enhance leverage ratios. Such structures may include subordinated public loans, first-loss guarantees, or co-investment facilities. However, the operationalisation of blended finance requires institutional coordination, robust monitoring frameworks, and stable regulatory environments. In many Member States, financial instruments continue to operate in parallel rather than as an integrated comprehensive renovation ecosystem (Bertoldi et al., 2020).

FINANCING ECOSYSTEMS AND INSTRUMENT COORDINATION

Recent publications highlight the need to analyse renovation finance as a system, rather than focusing on single instruments (Bertoldi et al., 2020; Di Tommaso et al., 2025). A financing ecosystem perspective considers the interactions between public policies, financial actors, regulatory frameworks, and end users, highlighting how fragmentation can reduce overall effectiveness even when instruments are well designed (Mochkabadi and Volkmann, 2018).

Key challenges include limited project standardisation, low data transparency, underdeveloped secondary markets, and the lack of aggregation mechanisms for small-scale investments. These factors increase transaction costs and perceived risk, limiting institutional investor participation (Bergmann et al., 2021).

In cohesion-oriented Member States, high owner-occupation rates, fragmented ownership structures, and shallow capital markets further constrain market-based financing, reinforcing reliance on subsidy-driven models (López-Mesa et al., 2024). Consequently, subsidy-heavy models often dominate, while private capital mobilisation remains comparatively weak.

CROWDFUNDING AND ALTERNATIVE FINANCING MODELS

Crowdfunding has emerged over the past decade as an alternative mechanism for mobilising capital through digital platforms (Belleflamme et al., 2014). Donation-based crowdfunding

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model (Figure 1) involves contributions without financial return, typically driven by social or charitable motives (Mollick, 2014). Reward-based models (Figure 2) provide non-financial benefits, often resembling pre-order mechanisms. Lending-based crowdfunding (Figure 3) involves repayable loans, sometimes combining financial and social motivations. Equity-based crowdfunding grants investors ownership stakes, with higher risk and return expectations (Mochkabadi and Volkmann, 2018; Mollick, 2014). Contributor motivations (Figure 4) vary accordingly, ranging from social impact to financial returns (Kgoroeadira et al., 2018).

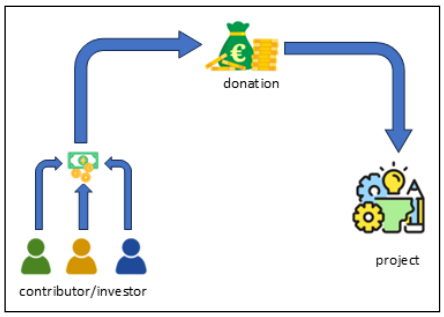

Figure 1 Donation-based crowdfunding model.

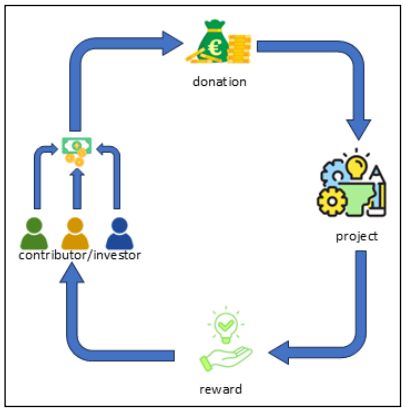

Figure 2 Reward-based crowdfunding model.

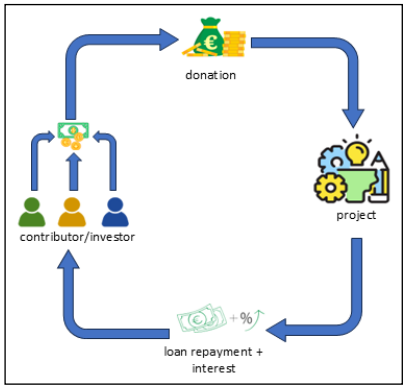

Figure 3 Lending-based crowdfunding model.

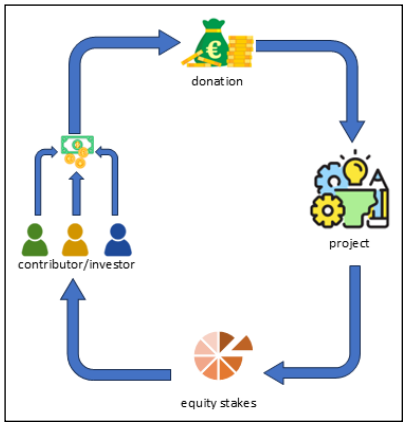

Figure 4 Equity-based crowdfunding model.

In the energy sector, crowdfunding has been mainly applied to renewable and community energy projects, offering benefits such as risk-sharing, reduced reliance on bank financing, and increased local acceptance (Bonzanini et al., 2016). Lending and equity models have shown particular potential for mobilising small-scale investments.

Community-based crowdfunding has also emerged, emphasising local participation, shared ownership, and collective benefits. While not a distinct model, it builds on lending or equity approaches and is particularly relevant for local sustainability projects (Bauwens and Devine-Wright, 2018).

In addition to these established models, crowdfunding practice has increasingly incorporated community-based financing approaches, particularly in sectors involving local infrastructure or sustainability projects. Community-based crowdfunding has emerged as an additional configuration that builds on lending- or equity-based structures by emphasising the collective participation of individuals within a specific locality. While not a fully independent model, it is characterised by shared ownership, local engagement, and the desire to support projects generating community-wide benefits. This configuration is particularly relevant for building renovation, where multi-owner properties and community infrastructure create conditions suited to collective financing approaches (Bauwens and Devine-Wright, 2018; Commission and Directorate-General for energy, European Commission, DG ENER, 2023).

However, applying crowdfunding to building energy renovation presents distinct challenges. Renovation projects are often small-scale, heterogeneous, and associated with performance uncertainty. Moreover, energy savings-based returns may be less transparent to retail investors compared to feed-in tariff-supported renewable energy projects. Regulatory frameworks governing crowdfunding, investor protection, and securities law further influence feasibility and scalability.

Despite these limitations, crowdfunding may offer complementary value within hybrid financing structures. It could potentially support beneficiary co-financing requirements, facilitate community-based renovation initiatives, or enhance social acceptance of projects. Nevertheless, systematic analysis of its compatibility with public support schemes and conventional banking products remains limited in the literature (Mollick, 2014).

METHODOLOGY

RESEARCH APPROACH

This study employs a systematic mapping methodology to document financing instruments supporting building energy renovation across Greece, Cyprus, and Croatia. The mapping serves a twofold purpose: first, to produce a structured, comparable inventory of active renovation financing schemes; and second, to diagnose the structural characteristics of each national financing ecosystem in ways directly relevant to assessing crowdfunding integration potential. This dual objective distinguishes the approach from a simple descriptive inventory and positions the mapping as an analytical instrument for identifying where alternative financing mechanisms could add value.

Scheme-level characteristics are recorded using harmonised variables across all three countries to enable systematic comparison and to identify patterns such as concentration of support in specific sectors, dependence on public subsidies, and limited coordination across financing tools.

Combinability between instruments is explicitly documented, as it determines whether crowdfunding contributions could legally and operationally complement existing public or private schemes within a layered financing structure.

Scheme characteristics are thus analysed not only descriptively but also diagnostically: indicators such as high co-financing requirements, beneficiary-level funding caps, or limited instrument combinability signal areas where crowdfunding could plausibly operate as a complementary financing layer.

IDENTIFICATION AND SELECTION OF INSTRUMENTS

Financing instruments were identified through a structured review of official national sources, including legislation, government portals, programme guidelines, managing authority

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documentation, and financial institution data. Eligible schemes explicitly support energy efficiency, renewable energy in buildings, heating and cooling upgrades, or broader renovation measures with measurable energy performance impacts. Both dedicated programmes and broader frameworks were included where relevant building-related components exist, provided they were active, recently implemented, or adopted in the latest programming period.

The three countries share structural characteristics that justify their comparative analysis. Owner-occupation rates exceed 70% in all three, renovation rates remain below the EU average, and private capital markets for green finance are comparatively underdeveloped relative to northern and western EU Member States. At the same time, they represent distinct financing configurations – subsidy-dominated (Greece), credit-dependent (Cyprus), and high-intensity co-financing (Croatia) – making cross-country comparison analytically productive.

DATA RECORDING STRUCTURE

Each financing scheme was recorded as a separate entry in a structured database using harmonised variables to ensure cross-country comparability. These include territorial level, geographical coverage, scheme name, and implementation period, as well as sectoral scope (e.g. building envelope, heating and cooling, renewable energy, district systems) and building typology. Beneficiary categories were systematically captured, including private individuals, vulnerable households, businesses, SMEs, public authorities, and other actors. This enables assessment of distributional targeting and identification of underserved segments.

Financial characteristics were recorded in detail, including scheme type (e.g. grant, subsidy, obligation scheme, investment law framework), total scheme budget, maximum funded amount per beneficiary, and incentive rate expressed as a percentage of eligible costs. Where applicable, the database also documents whether schemes are combinable with other incentives. This variable is particularly relevant for assessing whether alternative financing mechanisms could legally and operationally complement existing instruments. Qualitative descriptions of scheme objectives and eligible measures were included to assess the depth and scope of supported interventions and the potential investment size per project.

LIMITATIONS

The study is based on documented scheme design and publicly available information. As such, it reflects formal policy architecture rather than realised investment performance or uptake levels. Private bilateral financing arrangements not embedded in formal programmes may not be fully captured. Furthermore, the crowdfunding assessment remains conceptual, given the limited empirical deployment of such models in building renovation within the examined countries. Nevertheless, the structured and harmonised mapping provides a transparent basis for comparative analysis and for evaluating integration pathways for alternative financing mechanisms.

CROWDFUNDING INTEGRATION ASSESSMENT

Building on the mapped characteristics of national financing ecosystems, crowdfunding models are analysed in relation to identified structural features. The assessment evaluates whether donation-based, reward-based, lending-based, or equity-based crowdfunding models could potentially complement existing instruments by addressing uncovered investment shares, supporting SME capital needs, or enabling community-based renovation initiatives.

The analysis focuses on structural compatibility rather than empirical case studies. It examines alignment between typical project sizes and crowdfunding ticket volumes, compatibility with incentive structures, risk allocation implications, and the regulatory feasibility of combining retail-based capital with public support schemes. The mapping therefore functions as the empirical foundation for assessing whether crowdfunding can operate as a complementary layer within national renovation financing architectures.

FINANCING INSTRUMENTS FOR BUILDING ENERGY RENOVATION

Mapping identified 39 financing instruments across the three countries, including 21 public schemes and 18 private instruments.

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FINANCING INSTRUMENTS IN GREECE

For Greece, the mapping identified a range of financing instruments supporting building energy efficiency and renovation, including public subsidies, private bank products, and hybrid schemes. These operate within a multi-level framework shaped by national policies, EU programmes, and financial sector initiatives. Table 1 presents the instruments currently available that directly or indirectly support building energy efficiency improvements and renovation activities.

The Greek financing landscape is dominated by large residential grant programmes, with six public schemes totalling over €2.9 billion. A key structural feature is the beneficiary-level funding cap: schemes such as Exoikonomo 2025 (€35,000 per dwelling) and Renovate and Rent (€8,100) cover only a share of total renovation costs, generating a recurrent residual co-financing gap. This gap is analytically significant: it is precisely the investment share left

Table 1 Financing instruments supporting building energy efficiency and renovation in Greece.

INSTRUMENT/ PROGRAMME	IMPLEMENTING BODY	TARGET SECTOR	MAIN SUPPORTED INTERVENTIONS	FINANCIAL SUPPORT
Public subsidy programmes				
HLEKTRA	Greek Government	Public buildings	Deep renovation of public buildings, including building envelope improvements, HVAC upgrades, renewable energy systems and building energy management systems	€640 million budget; up to 100% of eligible costs
Development Law 4887/2022 – Green Transition	Ministry of Development	Businesses and SMEs	Energy efficiency improvements, renewable energy integration, modernisation of production facilities and green investments	€900 million; up to €20 million per project
Recycle–Change Appliance	Greek Government	Households	Replacement of inefficient household appliances with energy-efficient units combined with recycling of old appliances	€150 million; up to €710 per beneficiary
Exoikonomo 2025	Greek Government	Residential buildings	Thermal insulation, window replacement, heating and cooling upgrades, renewable energy systems and energy management technologies	€924.3 million; up to €35,000 per dwelling
Exoikonomo – Renovate for Young People	Greek Government	Young households	Deep energy renovation and housing upgrades, including building envelope measures, HVAC upgrades and renewable energy installations	€300 million; up to €32,500
Renovate and Rent	Greek Government	Private residential property owners	Renovation of vacant dwellings to increase the supply of long-term rental housing	€120 million; up to €8,100
Private financial instruments				
ESTIA Green Mortgage Loan	National Bank of Greece	Households	Financing purchase or renovation of energy-efficient residential properties	Long-term mortgage financing (up to 40 years)
Green Fixed-Rate Mortgage Loan	Piraeus Bank	Households	Purchase, construction or renovation of energy-efficient residential buildings	€20,000–€500,000
Green Loan	National Bank of Greece	Households	Energy efficiency upgrades, including insulation, high-efficiency HVAC systems and renewable energy installations	Varies
Green Loan for the Home	Alpha Bank	Households	Solar panels, heat pumps, thermal insulation, window replacement and efficient appliances	€1,500–€30,000
Green Loan for Home Improvements	Eurobank	Households	Photovoltaics, heat pumps, efficient windows and doors, insulation and energy-efficient appliances	€1,000–€30,000
Green Home Improvement Loan (with collateral)	Piraeus Bank	Households	Energy renovation measures including insulation, heating and cooling upgrades and renewable energy integration	From €10,000
Green Loan guaranteed by EIF	National Bank of Greece/EIF	Households	Energy efficiency renovation measures and renewable energy installations	€300–€50,000
Hybrid public–private financing schemes				
My Home II	Greek Government + banks	Young households	Financing purchase of first residential property	€2 billion programme; loans up to €190,000
Upgrade My Home	Greek Government + banks	Households	Energy renovation measures including insulation, renewable energy systems and heat pumps	€400 million programme; €5,000–€25,000

uncovered by public subsidies that defines the structural space within which alternative financing mechanisms could operate.

Private instruments, while diverse (seven products from five banks), remain modest in scale and reach. Green loans typically range from €1,500 to €50,000 and are subject to standard creditworthiness conditions, limiting access for households with limited collateral. The two hybrid schemes (My Home II and Upgrade My Home) partially bridge this gap but are restricted to young households and specific renovation measures. The overall picture is one of public-sector dominance with limited private capital leverage, a pattern that reinforces the analytical case for exploring complementary mechanisms.

FINANCING INSTRUMENTS SUPPORTING BUILDING ENERGY RENOVATION IN CYPRUS

The mapping exercise for Cyprus identified a set of financing instruments to support building energy efficiency improvements and renovation activities, combining public support schemes with private financial instruments offered by national banking institutions. Compared with the Greek financing ecosystem, the number of instruments identified is more limited, reflecting the smaller scale of the national renovation support framework. Table 2 presents the financing instruments identified for Cyprus through the structured mapping exercise.

Table 2 Financing instruments supporting building energy efficiency and renovation in Cyprus.

INSTRUMENT/PROGRAMME	IMPLEMENTING BODY	TARGET SECTOR	MAIN SUPPORTED INTERVENTIONS	FINANCIAL SUPPORT
Public subsidy programmes				
Energy Fund of Funds for Energy Efficiency	Government of Cyprus/Financial intermediaries	Households, SMEs, public sector	Energy efficiency renovations in buildings, including insulation, window replacement, heating and cooling upgrades, renewable energy systems (e.g., photovoltaic and solar thermal), energy storage, and energy management systems	Approx. €50–60 million; loans typically up to €2–3 million per project
Renovate – Rent Scheme	Government of Cyprus	Residential buildings	Renovation and refurbishment of vacant or unused residential units to enable their integration into the affordable rental market	€25 million; €15,000–€35,000 per dwelling
Scheme for the Energy Upgrade and Competitiveness of Large Businesses	Government of Cyprus	Large enterprises	Energy efficiency improvements in industrial facilities and buildings, equipment upgrades, renewable energy integration, and circular economy investments	€17 million; up to €750,000 per project
Private financial instruments				
Business Green Loan	Hellenic Bank	Businesses	Renewable energy investments, energy efficiency upgrades, sustainable construction and green building projects	Loan-based financing
Fil-eco Home Renovation for Energy Upgrade	Bank of Cyprus	Residential buildings	Energy efficiency renovation of residential properties	Loans up to €30,000
Fil-eco Photovoltaic & Other Systems	Bank of Cyprus	Residential buildings	Installation of photovoltaic systems and other household energy-saving technologies	Loans up to €15,000
Green Energy Solutions	CDB Bank	Businesses and households	Financing for renewable energy systems and energy efficiency technologies	Loan-based financing
Green Home Loan	Hellenic Bank	Residential buildings	Energy-efficient housing construction and purchase of energy-efficient homes	Preferential mortgage rates
Green Loan for Home Improvements	Hellenic Bank	Residential buildings	Photovoltaic systems, heat pumps, insulation, energy-efficient windows and doors, and energy-efficient appliances	Loans up to €30,000

The Cypriot financing ecosystem is characterised by a relatively small public support architecture (approximately €90–100 million across three programmes) and a correspondingly greater reliance on commercial bank lending. With nine private green loan products spanning €15,000–€30,000, the dominant financing model is debt-based rather than subsidy-driven. This structural feature shifts the nature of the financing barrier: unlike Greece, where the gap arises from subsidy caps, in Cyprus the principal constraint is credit access, particularly for households and SMEs unable to meet standard lending criteria. This distinction is analytically important for assessing which crowdfunding models are most structurally compatible with the Cypriot context.

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FINANCING INSTRUMENTS SUPPORTING BUILDING ENERGY RENOVATION IN CROATIA

The mapping exercise identified 10 public and 5 private financing instruments supporting building energy-efficiency improvements and renovation activities in Croatia. Compared with the other two countries, Croatia exhibits the strongest reliance on publicly funded renovation programmes, particularly through national environmental fund and European structural financing mechanisms. Table 3 presents the financing instruments currently supporting building energy efficiency improvements and renovation activities in Croatia, including both public funding programmes and private financial instruments. It is worth noting that public subsidy programmes provide direct public financial support (grants, subsidies, tax incentives), while private financial instruments include market-based instruments such as loans, bonds, and ESG-linked financing mechanisms.

Table 3 Financing instruments supporting building energy efficiency and renovation in Croatia.

INSTRUMENT/ PROGRAMME	IMPLEMENTING BODY	TARGET SECTOR	MAIN SUPPORTED INTERVENTIONS	FINANCIAL SUPPORT
Public subsidy programmes				
Croatian Modernisation Fund (First Call)	Ministry of Environmental Protection and Green Transition; Environmental Protection and Energy Efficiency Fund (FZOEU)	Industrial sector (processing and heating industries)	Renewable energy deployment and energy efficiency investments for industrial energy production and self-consumption	Grant funding through the EU Modernisation Fund (project-specific allocations); total amount available €1.3 billion until 2030, i.e. 130 million per year.
Energy Efficiency Obligation Scheme (White Certificates)	Government of Croatia/ Energy suppliers	Energy consumers across sectors	Energy-saving measures implemented by obligated energy suppliers to achieve national energy savings targets	Regulatory obligation scheme (no direct grant; suppliers finance efficiency measures)
Energy Renovation of Family Houses	Environmental Protection and Energy Efficiency Fund (FZOEU)	Residential buildings	Thermal insulation, window replacement, renewable energy sources (RES) installation, EV charging infrastructure	Up to 60% co-financing (80% for earthquake-damaged homes) with maximum grant up to €62,120 per project; programme budget approx. €120 million (2024 call) (fzoeu.hr)
Energy Renovation of Multi-Residential Buildings	Government of Croatia/ ERDF	Residential buildings (multi-apartment buildings)	Energy renovation of building envelope, heating systems, and RES installation	Typically, 60% grant funding for renovation works and up to 85% for project preparation and technical documentation
Energy Renovation of Public Sector Buildings	Ministry of Physical Planning, Construction and State Assets	Public buildings	Comprehensive renovation of schools, kindergartens, student accommodation, and other public buildings	Grants covering 60–80% of eligible renovation costs (in 2026 – from €30 k to €12 m per project)
Energy Renovation of non-residential commercial buildings	Environmental Protection and Energy Efficiency Fund (FZOEU)	Commercial and service buildings	Energy renovation of building envelope, heating systems, RES installation	Grants for energy efficiency measures
Environmental Protection and Energy Efficiency Fund programmes (FZOEU)	FZOEU	Residential and non-residential buildings, public sector, energy-poor households	Energy retrofits, renewable energy deployment, energy efficiency projects, and low-emission mobility	Co-financing through public calls (varies by the programme; national and EU funds)
Geothermal Potential Research for District Heating (C1.2 R1-12)	Ministry of Economy and Sustainable Development	District heating systems and energy infrastructure	Research and development of geothermal resources for district heating	€29.8 million grant funding for geothermal exploration projects
Public Call for Renewable Energy Systems in Family Buildings	FZOEU	Residential buildings	Installation of renewable energy systems such as heat pumps and related equipment	Subsidies typically up to €4,250 (40%), increasing up to €8,500 (80%) in less developed regions (UNILAB – Heat Transfer Software)
Scheme reducing electricity levy for energy-intensive companies	Government of Croatia	Energy-intensive industries	Support linked to energy efficiency investments, emissions reductions, or renewable electricity use	Reduction of renewable energy levy on electricity consumption

(Contd.)

INSTRUMENT/ PROGRAMME	IMPLEMENTING BODY	TARGET SECTOR	MAIN SUPPORTED INTERVENTIONS	FINANCIAL SUPPORT
Private financial instruments				
Green Housing Loan	Zagrebačka banka (commercial bank)	Residential buildings	Financing energy-efficient housing construction and renovation including renewable energy systems	Green mortgage financing (preferential loan)
Green Loans and Circular Economy Financing	Privredna banka Zagreb (commercial bank)	Businesses	Renewable energy investments, building efficiency upgrades and circular economy projects	Green loan financing (bank lending instrument)
Sustainability-Linked Bonds	M+ Group with EBRD and Erste&Steiermärkische bank)	Corporate sector	Financing sustainability-linked investments including energy efficiency and environmental performance improvements	300 million bond issuance (~€40 million)
Sustainable ESG Finance	Raiffeisen Bank	Businesses and real estate projects	Financing green investment projects including energy-efficient buildings and infrastructure	ESG-linked loans and green financing instruments
Croatian Bank for Reconstruction and Development (HBOR) Energy Efficiency Programme for Entrepreneurs	HBOR + commercial banks (Erste&Steiermärkische bank, Hrvatska poštanska banka, OTP banka, Privredba banka Zagreb, Raiffeisenbank Austria)	Business	Financing energy efficiency measures, renewable energy installations, energy-saving technologies	€250 m (€125 m from EFRD and €125 m from banks), preferential loans with possible capital rebate up to 50%

Croatia's financing architecture is distinct from both Greece and Cyprus in that it combines the highest public co-financing intensities (60–80% of eligible costs for residential and public buildings) with a broad sectoral scope spanning family houses, multi-apartment buildings, public infrastructure, and industrial facilities. The FZOEU plays a central coordinating role, administering the majority of public calls and channelling both national and EU structural funds.

Despite these high subsidy intensities, beneficiaries must still mobilise the remaining 20–40% of project costs privately. This residual share constitutes the primary financing gap in the Croatian context. The inclusion of public assets such as schools and municipal buildings (which carry strong community relevance but limited commercial return) further shapes the crowdfunding compatibility assessment. The Energy Efficiency Obligation Scheme adds a regulatory dimension absent from the other two countries, stimulating additional investment outside grant-based structures.

COMPARATIVE ANALYSIS OF STRUCTURAL FINANCING GAPS AND CROWDFUNDING INTEGRATION POTENTIAL

The structured mapping of financing instruments across Greece, Cyprus and Croatia reveals important differences in the scale, composition and institutional architecture of national renovation financing ecosystems. At the same time, the comparison identifies a common structural feature: despite the presence of public subsidy programmes and private financial instruments, none of the examined national systems currently includes crowdfunding as a dedicated financing mechanism for building renovation.

Across the three countries, renovation activity is supported primarily through public subsidy schemes and bank-based lending instruments. However, these instruments only partially cover the investment requirements associated with building renovation. In most programmes, financial support is either capped at the beneficiary level or expressed as a co-financing percentage, which means that project owners must mobilise additional capital to implement the full set of renovation measures.

In Greece, the renovation financing ecosystem is dominated by large public programmes such as *Exoikonomo 2025* (€924.27 million), *HLEKTRA* (€640 million), *Exoikonomo – Renovate for Young*

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People (≈€300 million), and *Renovate and Rent* (≈€120 million), representing a combined public investment envelope exceeding €1.9 billion. However, these programmes impose beneficiary-level ceilings, for example, €35,000 per dwelling under *Exoikonomo 2025* and approximately €8,100 under *Renovate and Rent*. When projects involve multiple interventions, total investment requirements may exceed these limits, creating a recurrent residual co-financing gap.

The Cypriot system is characterised by a smaller public financing architecture, with programmes such as the *Energy Fund of Funds* (€50–60 million), the *Renovate–Rent scheme* (€25 million), and the *Scheme for the Energy Upgrade and Competitiveness of Large Businesses* (€17 million), amounting to roughly €90–100 million. Consequently, the ecosystem relies more heavily on bank-based green lending instruments, typically financing projects in the €15,000–€30,000 range. In this context, the principal constraint relates to access to credit rather than subsidy ceilings.

Croatia presents a financing structure characterised by relatively high subsidy intensities rather than large programme budgets. Residential renovation schemes typically cover 60–80% of eligible costs, with grants reaching approximately €62,120 per project, alongside additional support for renewable energy installations and public building renovations. Although public support is substantial, beneficiaries must still finance the remaining 20–40% share of project costs.

Overall, the comparison indicates that different financing gaps emerge across the three national ecosystems: subsidy ceilings in Greece, credit access constraints in Cyprus, and the residual investment share following high co-financing rates in Croatia.

These structural differences are important when assessing the integration potential of the four crowdfunding models discussed in the literature and methodological framework. Figure 5 links the main financing gap observed in each national renovation financing ecosystem with the crowdfunding model that appears most compatible with the structure of existing financing instruments.

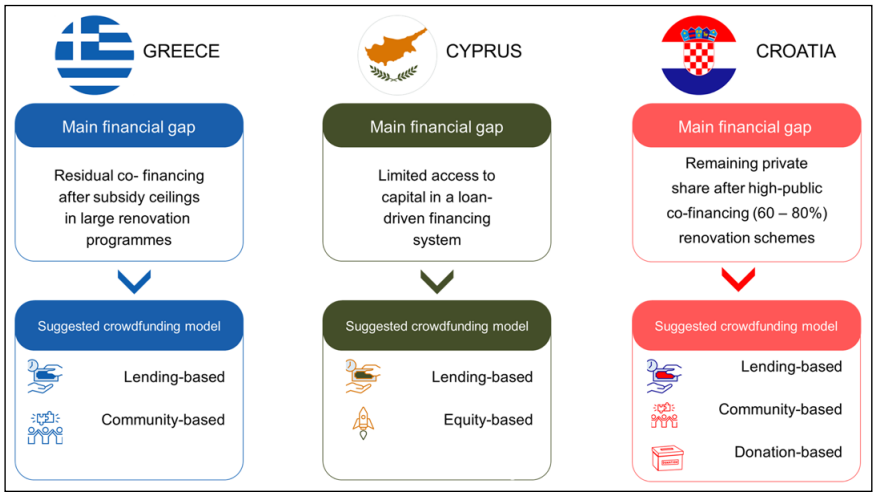

Figure 5 Main financing gaps and corresponding crowdfunding models in Greece, Cyprus and Croatia.

In the case of Greece, the most appropriate crowdfunding model appears to be lending-based crowdfunding, as the dominant financing gap arises from the uncovered share of renovation investments remaining after the application of subsidy ceilings within large public programmes. Major schemes such as *Exoikonomo* provide substantial financial support but impose beneficiary-level caps, which means that households often need to mobilise additional capital to implement the full set of planned interventions. In this context, peer-to-peer lending platforms could serve as a complementary financing channel, covering the remaining investment share for projects already approved under national subsidy programmes. In addition, community-based crowdfunding may also be particularly relevant in the Greek context, especially for renovation initiatives in multi-apartment residential buildings. In such cases, renovation investments often require the coordinated financial participation of multiple property owners, and community-based crowdfunding mechanisms could facilitate the aggregation of the necessary co-financing at the building level.

In Cyprus, the analysis indicates that lending-based crowdfunding also represents the most compatible model, although its potential role differs from that identified in Greece. Lending-

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based crowdfunding could operate as an alternative credit channel within a financing ecosystem that relies heavily on conventional bank lending. The mapping results show that typical green loan products finance renovation investments in the range of €10,000–€30,000, suggesting that crowdfunding platforms could support projects of similar scale, particularly for households and small and medium-sized enterprises that may face constraints in accessing traditional bank financing. Furthermore, Cyprus appears to offer comparatively favourable conditions for equity-based crowdfunding, particularly in projects involving renewable energy installations or energy efficiency upgrades in commercial buildings. In these cases, investment returns may be linked to electricity generation, energy cost savings, or other measurable financial benefits, which makes equity participation models more feasible than in predominantly owner-occupied residential contexts.

The Croatian case presents a different configuration. Here, the most distinctive opportunity arises for donation-based crowdfunding, primarily because a portion of the supported building stock includes assets with clear public or community relevance, such as schools, municipal buildings, and other public infrastructure. Renovation programmes in Croatia frequently provide high levels of public co-financing, typically covering 60–80% of eligible costs, yet beneficiaries must still mobilise the remaining investment share. In projects with strong local visibility and social value, donation-based crowdfunding could therefore serve as a mechanism to mobilise voluntary civic contributions that complement existing public funding. At the same time, community-based crowdfunding also appears highly relevant in the Croatian context, particularly for renovation projects involving multi-residential buildings where collective capital mobilisation among multiple owners is required. In addition, lending-based crowdfunding could provide complementary financing for the remaining private share in larger renovation projects where the uncovered investment amount exceeds the immediate liquidity of individual households.

The return on investment (ROI) here also plays an important role in shaping participation in crowdfunding markets, particularly in lending- and equity-based models where contributors expect financial compensation for the capital provided. Potential investors typically evaluate crowdfunding opportunities by assessing the balance between expected financial returns and associated risks, in a manner comparable to traditional investment decisions. In equity crowdfunding, returns are generally linked to the future growth and profitability of the funded venture, while in lending-based models they derive interest payments on the loaned capital. Empirical research shows that expectations regarding financial returns significantly influence investor behaviour and the success of crowdfunding campaigns, as investors tend to favour projects that demonstrate credible business models, transparent information disclosure, and clear value creation potential (Ahlers et al., 2015; Block et al., 2017; Mochkabadi and Volkmann, 2018; Mollick, 2014). In the context of building renovations and energy-efficiency investments, clearly identifiable financial benefits (such as energy cost savings or revenues from renewable energy generation) may further increase the attractiveness of crowdfunding mechanisms that offer financial returns to investors.

Taken together, the comparative analysis indicates that crowdfunding should not be viewed as a uniform financing instrument applicable in the same way across all national contexts. Instead, its relevance depends on the specific financing gap observed within each renovation financing ecosystem. When appropriately matched to these structural gaps, crowdfunding may function as a context-dependent complementary mechanism, expanding the range of available financing instruments while preserving the central role of public subsidy programmes and conventional financial institutions in supporting building renovation investments.

CONCLUSIONS AND POLICY IMPLICATIONS

This paper has two interrelated contributions. First, it maps the structure of renovation financing ecosystems in Greece, Cyprus, and Croatia, documenting 39 instruments across three structurally distinct but analytically comparable national contexts. Second, drawing on this diagnostic mapping, it assesses whether and how crowdfunding models can function as complementary financing mechanisms within these ecosystems. The selection of these three countries is analytically motivated: all three are cohesion-oriented Member States with high owner-occupation rates, significant renovation needs, and limited private capital market depth – conditions that constrain conventional market-based financing and make the question of alternative mechanisms particularly relevant.

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The mapping results show that renovation financing in all three countries relies primarily on public subsidy programmes and conventional bank-based lending instruments. Although these mechanisms play a central role in supporting renovation activity, they do not fully eliminate financing barriers. Public programmes frequently apply beneficiary-level funding caps or co-financing requirements, while private financing instruments remain dependent on traditional credit risk assessments. As a result, many renovation projects continue to face uncovered investment shares or access-to-capital constraints, particularly for deep renovation measures that require higher upfront capital.

The analysis presented in this study, therefore, examined whether crowdfunding models could complement existing financing instruments within national renovation ecosystems. The results indicate that crowdfunding should not be interpreted as a universal solution applicable in identical form across different national contexts. Instead, its relevance depends on the specific financing gap generated by the design of existing instruments.

Across the three countries, the analysis shows that the most compatible crowdfunding model is determined by the dominant financing gap rather than by national preference. Where subsidy ceilings create a residual investment share (Greece), lending-based and community-based models are most relevant. Where credit access is the binding constraint (Cyprus), lending-based and equity-based models offer the strongest complementarity. Where high co-financing rates leave a defined private residual (Croatia), donation-based and community-based models aligned to publicly relevant assets are most appropriate. This context-dependency is the central analytical finding of the study.

The integration of crowdfunding into renovation financing architectures, however, requires several enabling conditions. First, crowdfunding mechanisms must be compatible with existing public subsidy frameworks, particularly regarding the combinability of financing instruments and the treatment of crowdfunding contributions as eligible co-financing. Clear regulatory guidance is therefore necessary to ensure that the use of crowdfunding does not jeopardise access to public support schemes.

Second, successful implementation requires project aggregation mechanisms that bundle multiple renovation projects into investment portfolios sufficiently attractive to platform-based investors. Because many renovation investments are relatively small and dispersed across individual properties, aggregation may play a critical role in reducing transaction costs and improving investment viability.

Third, regulatory frameworks governing crowdfunding markets influence the feasibility of such models. Within the European Union, the European Crowdfunding Service Providers Regulation (ECSPR) establishes a harmonised framework for investment-based and lending-based crowdfunding platforms (European Commission, 2020). Nevertheless, the practical integration of renovation investments into crowdfunding platforms will depend on national regulatory practices, investor protection requirements, and platforms' ability to structure renovation-related investment products in compliance with financial regulations.

Finally, the development of crowdfunding-based financing mechanisms requires transparent project information and reliable performance monitoring. Investors must have access to clear data on project characteristics, expected energy savings, financial returns, and associated risks. Standardised documentation, energy performance assessments, and credible monitoring frameworks may therefore play an important role in strengthening investor confidence.

Overall, the findings suggest that crowdfunding can function as a complementary financing layer within hybrid renovation financing architectures alongside public subsidy programmes and conventional financial institutions. By aligning specific crowdfunding models with the structural financing gaps observed in national renovation ecosystems, policymakers may expand the range of available financing instruments and mobilise additional private capital for building energy renovation.

DATA ACCESSIBILITY STATEMENT

Data used from public databases is referenced.

ADDITIONAL FILE

The additional file for this article can be found as follows:

- **PowerPoint Slides.** PowerPoint slides relating to this article. DOI: https://doi.org/10.66506/essp.3-102-26.s1

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Conceptualization, S.S., P.P.; methodology, S.S., P.P.; validation S.N.B., I.R., D.A.; formal analysis, S.S., P.P., S.N.B., I.R., D.A.; resources, S.S., P.P.; data curation, S.S.; writing – original draft preparation, S.S., P.P., S.N.B., I.R., D.A.; writing-review and editing, S.N.B., I.R., D.A.; supervision, S.N.B., I.R., D.A.; project administration, S.N.B., D.A. All authors have read and agreed to the published version of the manuscript.

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AUTHOR AFFILIATIONS

Petra Pomper orcid.org/0009-0009-8392-2740
Institute for European Energy and Climate Policy (IEECP), NL
Stavros Spyridakos orcid.org/0009-0007-4340-2826
Institute for European Energy and Climate Policy (IEECP), NL
Sofia-Natalia Boemi orcid.org/0000-0003-3163-3495
Institute for European Energy and Climate Policy (IEECP), NL
Ivana Rogulj orcid.org/0000-0001-6557-9955
Institute for European Energy and Climate Policy (IEECP), NL
Dimitrios Athanasiou orcid.org/0009-0007-6469-539X
Institute for European Energy and Climate Policy (IEECP), NL

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