Kyiv School of Economics

Faculty of Social Sciences

Master's Program in Urban Studies and Post-War Reconstruction

Master's Thesis

Comprehensive Modernization of the Housing Stock in Sotsmisto, Kyiv: Organizational and Economic Framework

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Kyiv 2026

Abstract

The Soviet housing stock in Ukraine has already exceeded its design service life, and the expected response from municipal authorities: demolition and construction of new buildings, is financially unfeasible and socially unacceptable in the post-war context. This study develops a self-financing strategy for the renovation of the "Sotsmisto" neighborhood in the Dnipro district of Kyiv, where, according to 2021 data, there are 1.966 million m² of dilapidated housing stock and over 107,000 residents. The main research question is: how can the renovation model developed in this study, which utilizes a municipal revolving fund, modernize this housing without significant reliance on transfers from the municipal budget?

The study is based on three hypotheses regarding cross-subsidization through the extraction of surplus value, differentiated relocation logistics, and the ongoing conversion of a pilot rapid-construction building into social housing. The methodology combines desk research on the regulatory framework, a comparative analysis of three case studies (Drewitz, Germany; KredEx, Estonia; Mykolaychuk Street, Lviv), and two quantitative optimization frameworks: the MRUB intervention priority matrix and the marginal cost of energy saved model. A pilot financial model shows that, under a single "maximum" scenario, the building generates a net surplus of 23,070,000 UAH-sufficient to cross-subsidize the renovation of 4.4 buildings within the same neighborhood (whose added value cannot be increased through the commercialization of ground floors). The analysis confirmed the first hypothesis through financial modeling, while the second and third hypotheses

received theoretical and comparative confirmation-though hypothesis 2 requires quantitative validation during the implementation monitoring phase. The study developed an adaptive model suitable for the post-war reconstruction of dilapidated housing in Ukrainian cities.
Keywords: deteriorated housing renovation, value capture, municipal revolving fund, post-war reconstruction, MRUB prioritisation, cross-subsidisation, investment delegation

Word Count: 20288.

TABLE OF CONTENTS

INTRODUCTION

1. Relevance of the Study

Kyiv has a well-known informal tradition among property developers: wait. Wait until a dilapidated building becomes dangerous enough to justify demolition, then clear the site and build a tower. No renovation costs, no negotiation with residents, no heritage complications - just a clean slab and thirty storeys of concrete. This is simply the path of least resistance in a city where the institutional framework for housing renovation barely functions and where the political will to enforce alternatives is measured in election cycles.

The Dniprovskyi District has 1.966 million square meters of dilapidated housing stock; in particular, it has the city's largest concentration of prefabricated panel buildings of the 1-464 series. Buildings from the 1960s and 1970s account for 43% of the district's 1,274 residential buildings (Kyiv City State Administration, 2011). Built with a design life of fifty to sixty years, these standardized five-story structures have long since exceeded the limits of their structural durability. Their building envelopes lose heat in the winter. Utility networks are in a state of cumulative wear and tear: 37% of water pipes and 29% of sewer lines in the district require immediate replacement. Building entrances are inaccessible, and their design does not accommodate elevators.

The war has once again altered the economic landscape, and municipal budgets cannot keep pace with these changes. Every residential building in Ukraine now requires a shelter for civilians-in the basement, structurally reinforced, equipped with ventilation, and an autonomous power supply. Every building requires modernized barrier-free access, as wounded veterans return to daily life in cities that were not designed for them. None of this is mandated, and none of it is cheap, and the district budget cannot fully address any of these issues.

So the traditional approach, as demolition and reconstruction, seems at first glance to be the only realistic one, yet demolition on the scale required by a post-war budget is simply unaffordable. Moreover, it destroys what already exists: the neighborhood's landscape, social infrastructure, and the community's daily life. Disputes over ownership and legal challenges under Ukrainian law regularly delay forced relocation for years, so demolition is not a solution; it is an expensive shifting of the problem in time and space.

The alternative, which relies on piecemeal modernization of individual elements, where the municipality insulates the facade without replacing the ventilation system or repairing the foundation - is questionable, as it depletes state subsidies and causes the "thermos effect" (an extreme increase in relative humidity, leading to moisture condensation on interior surfaces and the risk of bio-corrosion (mold)) inside buildings, disrupting the standard air exchange and the hydrothermal balance of the building envelope, and leaves structural problems unresolved, so neither approach works effectively.

This is not a diagnostic error: the Dniprovskyi District development strategy, adopted in 2011, clearly identified the reconstruction of Soviet-era residential neighborhoods as a district priority and named "Sotsmisto" - a microdistrict bounded by Myru Avenue, Tampere Street, Sobornosti Avenue, and Verkhovna

Rada Boulevard - among the sites planned for comprehensive reconstruction (Kyiv City State Administration, 2011). In the district's own planning documents, 222 residential buildings in "Sotsmisto" were registered as sites requiring intervention more than a decade ago. The strategy outlined the reconstruction as a program for the period 2012–2025; instead, it created a registry of deferred obligations, and each year of inaction exacerbated the physical deterioration of structures that had already exceeded their design lifespans at the time the document was signed.

"Sotsmisto" differs from neighborhoods with high-rise buildings, which are typically developed according to a logic of demolition and reconstruction. This neighborhood has a spatial structure that predates the era of high-rise buildings: low building density, spacious green areas between blocks, streets adapted to a human scale, and landscaping that has evolved over 60 years. Demolishing the buildings and replacing them with high-rises means destroying the spatial fabric that took decades to form and that no developer's budget will ever be able to recreate.

This work argues that "Sotsmisto" does not need to be demolished. It needs a neighborhood-level renovation model capable of self-financing through the value it creates-one that preserves what already works spatially while modernizing what has suffered structural failure. The district contains two distinct types of buildings requiring intervention: the brick series 1-438 and the large-panel series 1-464, which require different approaches to renovation and different resettlement strategies. "Sotsmisto" is also small enough to serve as a pilot project and complex enough to allow for generalizations based on it. This study treats it as an empirical case and interprets its findings as a model applicable to the postwar reconstruction of Ukrainian cities of comparable scale.

2. Research Question

This study developed a three-tier model for the redevelopment of the “Sotsmisto” neighborhood, based on a municipal revolving fund and an investment delegation mechanism. The main research question is: under what institutional and financial conditions can the three-level reconstruction model become self-financing and ensure the comprehensive modernization of the housing stock in the “Sotsmisto” neighborhood given significant constraints on municipal funding?

The study is based on three hypotheses: it examines whether the revenue from increased property values-generated by the construction of attic floors and the commercialization of ground floors-covers the costs of renovation components that no private investor would voluntarily finance; whether differentiating relocation logistics by building type reduces social conflicts and operational costs compared to standard relocation procedures; and whether the construction of a pilot “rapid-build” house mitigates resident resistance. These hypotheses are fully formulated and methodologically justified in the “Analytical Framework” section.

3. Object and Subject of the Study

The objective is the comprehensive architectural and structural renovation of the deteriorated housing stock in the Sotsmisto microdistrict, Dniprovskyi district, Kyiv.

The subject comprises the management models and financial instruments through which that renovation proceeds - specifically, the municipal revolving fund mechanism, the investment delegation instrument established under the 2026 Housing Policy Act, and the differentiated socio-technical intervention scenarios applicable to the 1-438 brick series and the 1-464 large-panel series.

4. Research Methodology

The study is conducted within a pragmatic research paradigm. It employs a sequential research design using mixed methods, in which a qualitative analysis of institutional and spatial contexts defines the framework within which quantitative scenario modeling takes place.

The methodology consists of three analytical components.

The first is a systematic desk analysis covering the Ukrainian regulatory framework: Law of Ukraine No. 525-V (2006) on the Reconstruction of Dilapidated Housing, the 2026 Housing Policy Law, which establishes an investment delegation mechanism and the operating conditions for municipal revolving funds, accessibility standards (DBN V.2.2-40:2018), as well as archival primary engineering documentation from series 1-438 and 1-464. This documentary layer includes the Dnipro District Development Strategy (Kyiv City State Administration, 2011), which provides baseline data on the composition of the district's housing stock and planning commitments that define the framework of this study's model. Together, these sources establish the baseline indicators of structural deterioration and the legal parameters within which any implementation model must operate.

The second layer is a comparative case study based on three precedents: the regeneration of the Drevitz district in Potsdam (a case of successful renovation without eviction), the KredEx revolving fund program in Estonia (state-supported energy efficiency financing), and the rapid construction project on Mykolaychuk Street in Lviv (a resettlement tool within the Ukrainian institutional context). In the study, these examples are considered not as templates for replication, but as analytical comparisons that highlight the conditions under which each mechanism is successful and the adaptations required by the Ukrainian context.

The third study applies two quantitative optimization models. The "Renovation Management in Unrenovated Buildings" (MRUB) (Nowogońska & Mielczarek, 2021) ranks the urgency of intervention based on the systemic consequences of deferred maintenance-measured using $M_i = E_i \times Sz_i$ - and provides a mathematical foundation for determining the sequence of priorities. The Marginal Cost of Energy Saved (CCE) method (Petersen & Svendsen, 2012) establishes an economic equilibrium between capital costs for retrofitting and projected energy purchase costs, providing a mathematical basis for the cross-subsidy logic of the Municipal Revolving Fund.

5. Structure of the Thesis

The thesis consists of an introduction, a literature review with an analysis of gaps in scientific research, an analytical conceptual framework, four main chapters, and conclusions with a list of references.

The literature review analyzes scientific works on urban regeneration, the economics of renovating dilapidated housing stock, self-financing mechanisms, and the management of social sustainability. Section 8 of the literature review identifies a specific gap in scientific research that this work fills: the absence of an integrated conceptual framework that combines the assessment of structural capabilities, the logic of territorial capitalization, the design of social resettlement, and institutional implementation for residential properties in Ukraine.

The analytical framework defines the three main concepts of the study, presents a theoretical model that integrates urban life cycle theory, component-based economic optimization, and neighborhood management theory, and formalizes three working hypotheses.

Chapter 1: Theoretical and methodological foundations specific to Sotsmisto-the neighborhood's position in the city life cycle, the principles of sustainable renewal applied to this site, and operational guidelines drawn from three international and domestic precedents that establish the conceptual framework upon which the empirical analysis is based.

Chapter 2: Analysis of the structural morphology and typology of Sotsmisto's buildings. Based on historical engineering records and technical inspection data, the primary destructive processes occurring in each series of buildings are diagnosed. An assessment is conducted of the street facades with the greatest potential for capitalization through commercialization, providing the spatial basis for the logic of scenario assignment applied in Chapter 3. Chapter 3 designs three renovation scenarios for simultaneous district-wide application. Minimal (thermal modernization and service life extension), Optimal (civil defense infrastructure and complete engineering network replacement), and Maximum (full Value Capture mechanism) and prices each through the MRUB prioritization sequence and CCE optimization framework, including a pilot financial model for a representative 1-438 building on a primary commercial axis.

Chapter 4 specifies the organizational and financial mechanisms for program execution: differentiated resettlement logistics by building typology, the capital allocation model for the Municipal Revolving Fund, the public-private interaction framework under the 2026 Housing Policy Act, and a risk matrix with contingency provisions for six primary failure scenarios. The chapter translates the financial model of Chapter 3 into an institutional system that a municipal project management unit can actually deploy.

LITERATURE REVIEW

1. From Demolition Logic to Renovation Imperative

There is a particular absurdity in how Ukrainian cities have managed their housing inheritance. The Soviet mass-construction campaigns of the 1950s-1970s solved an urgent post-war shortage at breathtaking speed - and left behind roughly 23% of the country's current residential stock with design lifespans that expired years ago (Pleshkanovska & Biriuk, 2022). The standard response from municipal authorities, when the condition of buildings deteriorates to the point where cosmetic repairs are no longer sufficient, is demolition: clear the site, sell the land rights, and build a high-rise.

This is not a market-driven approach, but rather the prevailing culture of urban planning, and official documents have already acknowledged this without making any corrections. In the Dniprovskyi District’s own development strategy, 43% of the 1,274 residential buildings were classified as first-generation Soviet-era housing requiring replacement or reconstruction, and “Sotsmisto” was explicitly listed among the neighborhoods scheduled for comprehensive reconstruction during the 2012–2025 program period (Kyiv City State Administration, 2011). This program did not result in any renovation measures. Instead, the buildings accumulated another fourteen years of deferred maintenance. What the district administration officially designated as a priority and then neglected, proponents of demolition will ultimately present as proof that there is no alternative left-an institutional failure that creates its own justification. Another critical factor in the postponement of planned renovation measures is the lack of phased, step-by-step strategies and the tendency of municipalities toward monolithic "all-or-nothing" projects, rather than flexible, phased implementation. Since the technical condition of each building is entirely unique, the modernization framework must be adaptive. The financing mechanisms must function as a flexible modular construction kit that adapts to the specific condition of each building. Thanks to this systematic approach, it becomes possible to avoid dragging out capital works over decades and instead promptly implement the basic engineering minimum required to stabilize and maintain the housing stock within significantly shorter and optimized timeframes. Scientific literature on urban regeneration has accumulated substantial arguments against demolition as a default strategy.

The mass demolition of residential neighborhoods destroys the social and spatial systems that communities have built over decades-not just the buildings themselves, but also neighborhood relationships, local traditions, and a sense of place, which give urban life its texture (Aheieva et al., 2021). Renovation, when planned at the neighborhood level rather than for individual buildings, outperforms demolition on virtually every measure of sustainable development: lower carbon emissions, preservation of embodied energy, preservation of social capital, and, most importantly, the existing infrastructure of streets, schools, clinics, and green spaces, which new construction would have to recreate from scratch at enormous cost.

Power (2008) refutes one of the central arguments in favor of demolition: that removing "leaky" old housing accelerates the reduction of carbon emissions. Her analysis shows that demolition advocates typically exclude from their calculations the embodied carbon in new concrete and steel, emissions from waste disposal, and significant transportation costs for both demolition and reconstruction. Retrofitting existing brick housing stock to meet modern thermal standards achieves equivalent carbon emission reductions faster and with lower overall emissions. The German Zukunft Haus program documented an 80% reduction in specific heat energy consumption through retrofitting buildings constructed before 1984, matching the performance of new buildings without the carbon embodied in the replacement. This conclusion directly applies to "Sotsmisto": demolishing a mature neighborhood with green infrastructure and replacing it with a complex of high-rise buildings does not accelerate decarbonization, but creates a carbon debt for the future, while simultaneously destroying the spatial fabric-courtyards suitable for walking, sixty-year-old tree canopies, streets whose proportions correspond to the human scale-which no development budget will be able to recreate once it has disappeared.

2. The Legacy Stock: What It Is and Why It Fails

The first series of standard housing units-primarily Type 1-438 brick buildings and Type 1-464 large-panel buildings-were designed with mass production and rapid construction in mind, addressing the challenges of the time: the postwar housing crisis. Designers made systematic compromises regarding comfort, functionality, and durability, the consequences of which Ukrainian cities are still feeling today (Inozemtseva et al., 1988). Contemporary scholars are not inclined to view this housing stock as a single, undifferentiated problem. Pleshkanovska and Biryuk (2022) divide it into typological groups: historic buildings, barrack-style structures, and structures from the Stalin and Khrushchev eras, each with its own reconstruction possibilities, costs, and risks. What a solidly built structure from the Stalinist era can withstand is fundamentally different from what a 0.35-meter-thick prefabricated panel can withstand.

Buildings from the Khrushchev era deserve special attention because, despite visible wear and tear, their load-bearing structures often retain their service life for another forty to fifty years - provided that the specific weak points of each series receive targeted attention (Akheeva et al., 2021). The structure lasts longer than the utility networks, the heating system, and the spatial layout. Technical assessments throughout the Dnipro district confirm this pattern in practice: 37% of water supply pipelines and 29% of sewer networks already required immediate replacement in 2011, while the load-bearing brick and panel frames in buildings of comparable age remained within acceptable wear limits (Kyiv City State Administration, 2011). Infrastructure fails first, and its failure is not passive-leaking pipes create chronic moisture on foundations, accelerating structural degradation that targeted restoration could have delayed for decades. This presents an opportunity for renovation, but it narrows with every year of inaction: what is considered targeted restoration at 45% structural wear becomes a complete replacement at 65%.

3. Renovation Strategy: Scale, Sequence, and the MRUB Logic

Renovation at the level of individual buildings, without coordination with the surrounding infrastructure, invariably yields unsatisfactory results. Gabrel (2016) argues that isolated building renovation efforts can actually worsen a neighborhood's functional efficiency-renovated apartments end up in neglected public spaces, with weakened public services and disrupted transportation links. A neighborhood is the smallest viable unit; at the district level, the modernization of utility networks, site improvement, and measures related to shared infrastructure are significantly cheaper per unit and provide a much greater systemic effect.

Once a decision to renovate at the neighborhood level is made, the question of sequencing becomes technical and non-trivial. Novogonska and Mielczarek (2021) developed the concept of "Renovation Management in Unrenovated Buildings" (MRUB) specifically to address this issue. Their argument: the urgency of intervention depends not so much on the purely percentage measure of physical wear and tear (Sz_i) as on the systemic consequences of refraining from such intervention (E_i). Their sequence indicator $M_i = E_i \times Sz_i$ ranks structural elements by the cascading damage that their neglect will cause-progressive building degradation, threat to life, loss of thermal comfort, and asset depreciation. By assigning weighted coefficients using an analytical hierarchy process, they demonstrate that the stabilization of foundations and load-bearing masonry must strictly precede any aesthetic renovation or secondary repair of utility systems. Insulating a facade over a saturated slag concrete foundation achieves nothing but a warm appearance, which accelerates the structure's deterioration.

4. The Economics of Self-Financing Renovation

Financial viability determines whether any redevelopment plan will move from theory to practice. Traditional cost-benefit analyses (Schreiber, 1993) provide an initial framework but do not account for the mechanisms that modern projects can employ. A more effective model transforms the area itself into a source of revenue: additional space for sale, commercial functions that generate steady rental income, and increased property values throughout the renovated district.

Petersen and Svendsen (2012) elaborate on this using component-based economic optimization: in established urban areas, annual property replacement rates remain below 1%, meaning that the primary potential for capital savings and carbon emission reductions lies within the existing building stock. Their model identifies initial investment costs and projected market value after renovation as the dominant factors in deciding between "renovation or demolition." Demolition creates immediate negative externalities: pre-demolition costs, construction waste disposal, and lost revenue from land transfer in the absence of eviction. The Marginal Cost of Energy Saved (CCE) model allows the municipality to evaluate the project's economics simultaneously from both macroeconomic and private financial perspectives; while retrofitting with targeted vertical expansion preserves structural assets and generates a commercial surplus precisely through a mechanism that enables cross-subsidization: buildings located in commercially advantageous locations finance the renovation of buildings that cannot attract private capital.

Morelli, Harretrup, and Svendsen (2014) extend this logic using a two-step evaluation method that clearly quantifies the economic trade-offs between modernization and demolition followed by reconstruction at the neighborhood level. Their approach sets a financial equilibrium between retrofitting capital expenditure and future energy procurement costs - the CCE calculation that prevents the common trap of executing thermally aggressive insulation overhauls that never recover their investment.

In the context of Ukraine's postwar reconstruction, market mechanisms alone are unable to bridge the funding gap: the country's economic conditions and the limited purchasing power of many residents mean that purely commercial models cannot ensure regeneration at the neighborhood level. A viable model combines territorial capitalization - generating profit through vertical expansion and the commercialization of ground floors, with EU grant funding for those components (civil shelters, accessibility infrastructure) that private investors are not motivated to finance voluntarily.

5. Institutional Barriers: Law, Taxation, and the Shanghai Warning

The regulatory framework in Ukraine has not kept pace with domestic needs and global renovation practices: the primary piece of legislation - Law of Ukraine No. 525-V (2006) - theoretically establishes a framework for organized renovation, but it has been revised many times and has never been implemented due to significant shortcomings: it does not provide clear criteria for identifying buildings eligible for renovation; it considers physical deterioration as the sole justification for intervention, ignoring functional and social obsolescence; and the procedures for implementing projects are so cumbersome that they deter private actors, whose participation is necessary for renovation (Pleshkanovska & Biriuk, 2022). The law was designed to create a renovation pipeline; instead, it created a procedural obstacle course.

The fiscal aspect complicates the problem. Power (2008) notes that the historical policy framework structurally favors demolition and new construction due to distorted taxation: reinvestment in structures and repairs is subject to full VAT, while new construction projects enjoy tax-exempt status. In Ukraine, however, Article 197.15 of the Tax Code partially offsets this asymmetry: VAT exemptions formally apply to both new developments on greenfield sites and the reconstruction of buildings and major repairs. In practice, the described tax distortions persist, as major VAT exemptions have historically favored residential real estate over civil infrastructure. The investment delegation mechanism in the 2026 Housing Policy Act addresses this issue by creating a legal framework in which the municipality grants commercial rights to newly developed spaces to the developer in exchange for confirmed completion of the building's major repairs - mobilizing private capital without the need for a full PPP apparatus, which Ukrainian conditions currently cannot support.

The instructive international precedent is not a success story, but a cautionary tale: Shi and colleagues (2019), in their analysis of Shanghai's urban renewal, document what happens when a transition economy shifts from mass demolition to housing preservation without resolving deep-seated institutional contradictions. Early “semi-HCR” initiatives, such as the Xintiandi project, optimized redevelopment for commercial returns, displaced residents, and destroyed local social networks, while formally claiming preservation status. Shanghai’s experience revealed three structural bottlenecks: an acute shortage of funding, a persistent mismatch between the level of municipal subsidies and residents’ expectations, and a regulatory framework incapable of managing the gap between planned and actual property use. The “Social City” strategy directly takes this lesson into account: the investment delegation mechanism ties the developer’s commercial rights to the confirmed completion of comprehensive reconstruction, preventing the trap of partial reconstruction that commercial logic always creates.

6. Social Sustainability and Governance: Who Decides, Who Stays

Renovation projects that ignore the social aspect are doomed to fail, regardless of their technical quality. Residents resist interference in their homes; they do not trust external institutions; they fear losing the social ties that bind them to their neighborhood (Meerovich & Antonenko, 2018). These fears are rational because they reflect the real risks residents face when external actors propose to rebuild their living environment, especially in post-Soviet institutional contexts, where orders for forced relocation have been documented as being used to free up valuable urban land for developers. It was precisely this aspect that was one of the key factors hindering the implementation of the previous 2006 reconstruction plan.

Practices that help overcome this resistance are well-documented in the literature: phased relocation minimizes disruption to households' daily lives. Legal certainty regarding return conditions, clearly defined prior to any relocation, eliminates the information gap that generates resistance before construction begins. Genuine community power over co-design, as opposed to consultative participation, transforms potential opponents into stakeholders in the program. Lowndes and Sullivan (2008) demonstrate that devolving decision-making authority to neighborhood-level bodies alleviates tensions in civic conflicts that are constantly generated by top-down municipal directives. Both the London Assembly Planning Committee (2020) and the Commission on the Review of Borough Council Operations (2007) empirically confirm that neighborhood-level planning committees reduce resident resistance at a rate that borough-level administration cannot match. The normative argument in favor of this approach stems from Henri Lefebvre's theory of "The Right to the City" (1968). Lefebvre views the urban environment as a space of lived experience, not as a real estate commodity, where the mass demolition of buildings followed by their replacement with high-rises deprives original residents of this right-replacing the neighborhood's identity with speculative spatial forms that serve the interests of developers rather than communities. Mayer (2012) documents how this concept has inspired contemporary social movements resisting gentrification in European cities, driven by the interests of property owners. The Sotsmisto renovation strategy draws on both theorists to justify its distributional logic: value captured through vertical additions finances civil protection shelters and barrier-free access - public goods that serve the existing community, rather than maximizing developer margins.

7. Three Tested Models as Analytical Benchmarks

The literature on urban renewal has moved beyond theoretical frameworks and includes documented practical case studies that clearly demonstrate that comprehensive neighborhood-level renewal is feasible provided that the principles of no evictions, self-sustaining financing, and structured relocation logistics are adhered to. Three programs serve as analytical benchmarks for this study, each corresponding to a specific mechanism provided for by the "Sotsmisto" model.

Drewitz, Potsdam (Germany), implemented a renovation model without eviction at the housing estate level: the modernization of a large housing complex of prefabricated buildings, carried out apartment by apartment: external thermal insulation, elevator shafts installed on the facade, and a complete reconstruction of utility networks took place without mass eviction of residents. Post-renovation monitoring recorded a 60–70% reduction in specific heating demand alongside a decrease in vacancy rates (Busa, 2024).

KredEx, Estonia demonstrated nationwide financing for the comprehensive renovation of Soviet-era buildings in a post-socialist economy through newly established housing associations. A preferential loan instrument with a 30–50% grant component, provided on the condition of comprehensive renovation - ventilation, roof, walls, windows, and heating systems as an integrated package - had financed over 1,300 buildings by 2020, achieving an average reduction in specific heat consumption of 40–50%.

The project on **Mykolaychuk Street in Lviv (2022–2023)** demonstrated a more niche but critically important solution for operational activities: rapidly assembled prefabricated panel structures using domestically produced components provide habitable housing units at the municipal level within six to eight weeks of implementation - a timeline that would require eighteen to thirty-six months in traditional construction for equivalent capacity. The project confirmed that this technology is available on the domestic market, is subject to institutional management within the framework of the Ukrainian public procurement system, and is capable of meeting housing suitability standards. It is precisely this case that is being considered for the implementation of a renovation strategy without relocation: the construction of a single such building within a neighborhood will significantly reduce residents' resistance to the implementation of this program, as they will remain in their familiar environment.

The experience of implementing the project on Mykolaychuk Street in Lviv (2022–2023) demonstrated a narrower, yet critically important option for the model's viability: the use of quick-assembly prefabricated panel structures based on domestic components allows for the deployment of municipal housing stock within six to eight weeks. By comparison, traditional methods of capital construction for facilities of equivalent capacity require 18 to 36 months. This case study demonstrated the technology's market viability, its adaptability to institutional oversight within the Ukrainian public procurement system, and full compliance with current housing standards. In the context of renovating dilapidated neighborhoods without relocating residents, this technology is viewed as a tool for creating a local maneuvering fund. The construction of a single such pilot building within a neighborhood minimizes social resistance to the program, as it allows residents to be relocated within their familiar spatial and social environment

The mechanisms of operation for each institutional transfer or replacement required by the Ukrainian context, as well as the points where the logic of each precedent breaks down - all of this is detailed in Chapter 1.

8. Research Gap

In contemporary scientific literature, the issue of renovating aging housing stock is addressed in a fragmented manner and examined through the lens of individual disciplines. Technical and engineering studies (Aheieva et al., 2021; Elizarov & Medvedeva, 1961; Nowogońska & Mielczarek, 2021) provide an in-depth analysis of the structural capabilities of buildings relevant to specific areas with the analyzed type of development, but do not consider the legal context, social consequences, or economic feasibility of the proposed solutions; furthermore, their calculations are typically highly specialized, making it impossible to scale them as a universal model. On the other hand, urban and socio-spatial studies (Gabrel, 2016; Busà, 2024), while focusing on social aspects and spatial development, pay insufficient attention to the rigid structural and design constraints inherent in Soviet-style housing.

Economic literature (Petersen & Svendsen,2012; Shi et al., 2019) develops financing mechanisms largely outside the Ukrainian institutional context. Ukrainian scholarship acknowledges the question of financial viability but rarely supports the argument with concrete models or calculations (Pleshkanovska & Biriuk, 2022).

The result: no integrated framework simultaneously addresses structural capability assessment, territorial capitalisation mechanisms, social resettlement logistics, and institutional implementation for a specific Ukrainian urban district. The link between what engineering makes structurally possible - vertical extension above existing buildings - and what economics makes financially sustainable - cross-subsidization via value capture - remains the least-examined problem in the literature.

The Dniprovskyi District Development Strategy (Kyiv City State Administration, 2011) illustrates this gap from the practice side. Municipal planning documents designated Sotsmisto as a reconstruction priority and scheduled it for intervention over a 13-year program period. They produced no operative financial model, no phased resettlement architecture, and no cross-subsidization mechanism. The documents identified the buildings; they provided nothing that could move one of those buildings into a contractor's schedule. This study bridges the gap between strategic identification and financial operationalization - connecting the structural analysis of two specific building series to a self-financing model tested against the governance and legal conditions of a real Kyiv microdistrict.

ANALYTICAL FRAMEWORK

1. Conceptualization

Before proceeding to the analysis, it is necessary to clearly define three concepts.

In this study, housing renovation refers to comprehensive structural, engineering, thermal, and infrastructure measures at the neighborhood level, rather than the modernization of individual elements or cosmetic repairs. This distinction is important because the renovation of individual elements (insulating a facade without replacing the ventilation system, repairing a foundation without replacing utilities) has a documented failure rate: it exhausts government subsidies without achieving systemic improvement. Comprehensive neighborhood-level renovation is the minimum viable unit of intervention.

“Value Capture” is a mechanism through which the monetary value created by public investments in urban modernization-such as increased property values, new leasable space, and commercial rental income-is recirculated to finance these investments. In the “Sotsmisto” model, “value capture” is achieved through two tools: vertical expansion (construction of an addition that creates new residential space for sale) and the commercialization of ground floors (converting residential spaces on the ground floors into commercial spaces that generate rental income). The surplus from these tools is used to cross-subsidize renovation components that do not generate commercial profit.

Self-financing of renovation refers to a renovation program where the net revenue from value capture instruments, EU grants for civil infrastructure, and the accumulation of a revolving fund covers the total cost of renovation at the neighborhood level without structural dependence on regular transfers from the municipal budget. The model may include budget contributions in the early stages of the program, but the long-term financial architecture does not require them to ensure district coverage.

2. Theoretical Framework

The study combines three theoretical approaches into a single explanatory model.

According to the theory of the urban life cycle (Pleshkanovska, 2019), the main argument is that "Sotsmisto" currently stands at the crossroads between stagnation and renewal, that is, in a phase where routine maintenance yields no results and only systematic reconstruction can restore the neighborhood's full viability. Pleshkanovska's typological scheme, applied to the actual housing stock of the Dniprovskyi District, classifies 43% of the district's 1,274 residential buildings as being in this very phase: these are structures in which utility networks are the first to fail, creating chronic moisture damage that traps structurally sound frames in conditions of deepening degradation (Kyiv City State Administration, 2011). This positions the renovation program as a strategic territorial intervention during a transitional phase, rather than as a maintenance task that could be covered by routine municipal operations.

Based on component-based economic optimization (Petersen & Svendsen, 2012; Morelli et al., 2014), a financial logic emerges: in established urban areas where annual property replacement rates remain below 1%, the dominant potential for capital savings and carbon emission reductions is concentrated in the existing building stock. The CCE framework strikes a balance between retrofit costs and future energy costs, preventing the over-insulation trap: a common pitfall where aggressive insulation campaigns deplete capital before the investment pays off. The cross-subsidy architecture, in which commercially viable buildings finance the renovation of commercially unviable ones, relies on this framework to establish the coefficients by which the surplus is accumulated, and for regulating the sequence rule, according to which the implementation of the "Maximum" scenario on buildings along the primary axis must generate capital for the Revolving Fund before contracts under the "Minimum" scenario begin in the cross-subsidy zones.

From the theory of neighborhood governance (Lowndes & Sullivan, 2008) and the tradition of the "right to the city" (Lefebvre, 1968; Mayer, 2012) follows a normative and managerial logic: a renovation program must preserve the community's existing right to its neighborhood, rather than maximize the developer's profit. In practice, this means decentralized authority for co-design at the cluster level, legally formalized profit-sharing agreements prior to any eviction, and a distribution rule that directs revenue from value capture toward public goods, such as shelters and affordable access, rather than solely toward commercial surplus.

These three positions complement one another rather than running parallel. The life-cycle concept underscores the urgency: Sotsmisto buildings are in a phase where every year of inaction narrows the window of opportunity for renovation and transforms targeted restoration into structural replacement. The CCE framework establishes the financial conditions under which renovation is viable, while the governance framework establishes the institutional conditions under which renovation is socially acceptable. A renovation model that satisfies only two of the three requirements is flawed: technically sound but politically blocked; financially viable but structurally unproven; or socially acceptable but economically unviable.

Three hypotheses transform this three-component theoretical requirement into empirically testable statements, each of which targets a different causal relationship within the renovation system: between commercial revenues and the capacity for cross-subsidization, between building type and relocation costs, and between the logic of asset conversion and long-term financial returns.

3. Hypotheses

Hypothesis 1. The “value extraction” strategy-the construction of attic floors and the commercialization of ground floors along the main thoroughfares of the “Sotsmisto” neighborhood - generates sufficient revenue in the private market to cross-subsidize financially unprofitable but socially necessary components of the reconstruction: the installation of external elevators and the construction of underground civil shelters.

Hypothesis 2. Differentiation of relocation logistics by building type - floor-by-floor reconstruction without eviction for brick buildings Nos. 1–438 and a sequential “wave method” using a flexible pilot building for panel buildings Nos. 1–464 - reduces social tension and lowers overall operating costs compared to a mass eviction strategy.

Hypothesis 3. Converting a temporary pilot building into a permanent municipal social housing stock after the completion of the renovation cycle provides better long-term budgetary returns compared to commercially leasing the same property or commissioning equivalent new social housing.

CHAPTER 1. THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF URBAN RECONSTRUCTION

1.1 Sotsmisto's Position in the Urban Life Cycle

Where does Sotsmisto stand in the urban life cycle? Pleshkanovska (2019) would place it at the stagnation-to-revival threshold - the phase where routine maintenance has finally stopped working. That is the theoretical answer. The practical one is harder: Sotsmisto's housing stock has been sitting at that threshold for over a decade, and the threshold is not static.

This is what the planning failure documented in the literature review actually means in physical terms. The 2011 Dniprovskyi District strategy scheduled Sotsmisto for comprehensive reconstruction. Nothing happened. Each year of inaction is another year without utility network replacement, and that translates directly into chronic moisture stress on foundation systems. Moisture, left unaddressed, drives exactly the degradation chain the MRUB model warns about: what begins as targeted foundation repair eventually becomes complete structural replacement. Work that could have been done at moderate cost in 2012 now sits at a later, more expensive stage of that chain. The threshold does not wait for programs to catch up. It moves forward.

The regeneration phase this analysis addresses therefore demands simultaneous work on three fronts: structural reliability, reinforced to carry vertical expansion; accessibility and civil safety, upgraded to meet current and post-war standards; and spatial structure, transformed from single-use residential blocks into mixed-use environments capable of sustaining their own economic life.

These three dimensions are not sequential but interdependent: the financial model depends on spatial conversion, which depends on structural reinforcement, which, in turn, depends on the sequence of interventions provided for by the MRUB framework. Section 1.2 defines the principles governing each dimension within the material context of "Sotsmisto". Section 1.3 then turns to operational precedents - three programs tested at scale, and identifies precisely what the Ukrainian institutional context must build where each precedent falls short.

1.2 Three Principles of Sustainable Renovation - Sotsmisto-Specific

Cross-subsidization in the Sotsmisto program operates through a specific geographic logic: the commercial surplus from the "Maximum" scenario works on primary-axis buildings - superstructure construction and ground-floor commercialization along Prospekt Myru and Budivelnykiv Street - covers the renovation costs of interior-block buildings that cannot generate private returns. Without this redistribution mechanism, renovation retreats to cherry-picking. Developers invest in profitable buildings; the remaining stock continues to degrade; the district as a whole does not advance. The Municipal Revolving Fund operationalizes the principle by ring-fencing surplus from "Maximum" scenario completions and directing it exclusively toward "Minimal" and "Optimal" scenario works - enforcing the redistribution rather than leaving it to market discretion.

The Sotsmisto model differentiates resettlement by structural type rather than applying a single displacement procedure across both building series.

Prepared clean, copyable text format. The 1-438 brick series can be renovated apartment by apartment without displacing anyone. The reason is structural: the longitudinal load-bearing wall configuration keeps all significant works - insulation, lift shafts, utility risers, superstructure frame - on the building's exterior. No inhabited floor ever opens to construction access.

The 1-464 panel series is a different case entirely. Reinforcing inter-panel joints and deepening the foundation for a civil defense shelter both require access to the building's structural core. Temporary relocation is not a policy choice. It is a geometric necessity.

This distinction matters because it determines the entire logistics plan - not administrative preference, but the physical parameters of each building type. And the distinction has social consequences. Urban planning practice consistently shows that projects minimizing forced displacement achieve higher community cooperation, fewer legal disputes, and better long-term outcomes. The numbers follow the trust.

Start with the 1-438 series. Renovating brick buildings first - without relocating anyone - gives residents something concrete to see before the harder phase begins. A completed building is the most persuasive argument for what comes next: the panel series renovation, which does require people to move. It is much easier to ask that of a community that has already watched the program deliver on its promises.

In the case of “Sotsmisto,” ecological balance is not a third principle imposed independently of the first two-it is a condition that ensures the financial logic of the first principle at the market prices projected by the model. The inner courtyards of “Sotsmisto” feature a sixty-year-old canopy of trees that serves as urban infrastructure. This mature canopy regulates the microclimate and manages rainwater; it provides a spatial quality that distinguishes “Sotsmisto” from neighborhoods of high-rise buildings. The connection between Sotsmisto’s spatial structure and the financial viability of the renovation project has a clear institutional and economic logic. As early as the 2011 Development Strategy for the Dnipro District, the modernization of the green zone along Hetman Pavlo Polubotok Street (formerly Popudrenko Street) was viewed not as an isolated element of urban improvement, but as a linear urban framework and an integral part of the program to reconstruct the entire housing stock (Dnipro District State Administration, 2011). The fact that this green corridor and the environment formed around it have endured decades of stagnation in municipal programs is of key analytical significance. It is precisely this capital of the established urban space-with its pedestrian courtyards, streets scaled to human proportions, and a developed natural buffer-that creates a market surplus, which is monetized in the “Maximum” scenario through value capture tools.

The radical demolition of outdated buildings could destroy this human scale, and with it the added value of the surrounding environment upon which the arithmetic of cross-subsidization is based.

Thus, these key principles of our strategy reinforce one another in a trigger-based cause-and-effect sequence:

1) Cross-subsidization ensures the financial viability of the “wave-like” relocation logistics without evicting residents beyond the district’s boundaries: the commercial surplus from the “Maximum” scenario covers the capital costs of constructing the initial maneuvering building and upgrading the infrastructure.

2) The relocation model and the subsidy mechanism, in turn, directly depend on the preservation of the neighborhood’s spatial capital. The human scale of courtyards and park areas creates the added value of the environment that the fund accumulates through market prices for real estate and commercial street-retail spaces. The destruction of this microclimate will automatically lead to a reduction in the financial surplus of the entire program.

Section 1.3 presents international and domestic precedents that demonstrate the practical application of each of these principles, and identifies specific parameters that the Ukrainian institutional environment must adapt regarding the financing system and preferential lending to successfully implement this model.

1.3 International Precedents: Institutional Translation, Not Template Transfer

The Literature Review established what Drewitz, KredEx, and Mykolaichuka Street each documented in their own operational contexts - the outcomes each program produced, the technical lessons each generated, the conditions each revealed as necessary for success. This section addresses a different analytical task: not what each precedent proved in its original setting, but what the Sotsmisto model specifically takes from it, what it cannot take, and what institutional architecture the Ukrainian context must construct to substitute for what does not transfer. Establishing relevance identifies a precedent worth analysing; establishing mechanism determines how to use it.

Drewitz: The Structural Geometry That Makes Non-Eviction Possible

The Drewitz non-eviction model succeeded because of a structural fact about the buildings it renovated, not primarily because the governance framework was ingeniously designed. Longitudinal load-bearing wall systems - which the 1-438 brick series shares with Drewitz's panel estate in the critical respect that all structurally significant elements run along the building's external perimeter and internal longitudinal axes - leave the building's cross-section free of constraints on movement through individual floors. Insulation installation, lift shaft erection, utility riser replacement, and superstructure frame construction proceed entirely from the building's exterior without opening any inhabited floor to construction access. Residents do not vacate because the structural geometry does not require it.

This is why the non-eviction model applies to Sotsmisto's 1-438 brick series, but not to the 1-464 large-panel series. The 1-464 transverse load-bearing wall scheme places panel joint connections in positions that demand structural-core access for reinforcement - work that cannot be executed around an occupied building. Basement deepening for civil shelter construction adds a second unavoidable requirement: permeation grouting and floor-lowering operations generate differential settlement risk incompatible with continued habitation.

The Drewitz non-eviction model transfers directly to Sotsmisto's 1-438 series. The structural logic is the same in both cases: longitudinal load-bearing walls keep all significant works on the exterior, so residents never need to vacate. Where the model does not transfer is equally clear - the 1-464 panel series requires core access, and no scheduling adjustment changes that.

The financial architecture is a different story. Drewitz ran on KfW grants: multi-year cycles, predictable timelines, contracts signed years before completion. Kyiv has none of that. The EU Ukraine Facility carries real eligibility uncertainty - the Sotsmisto model treats it as a risk to manage, not a funding line to plan around.

Brandenburg's land grant commitments gave Drewitz capital certainty at every stage. The investment delegation mechanism replaces this with a different instrument: mandatory pre-sale commitments for at least 60% of superstructure apartments before construction begins. This eliminates the market exposure that, in the German context, state-level grants simply absorbed.

One gap has no direct substitute. The municipal housing company that deployed Drewitz's construction capital has no Ukrainian equivalent. Instead, the investment delegation mechanism and the Municipal Revolving Fund split its functions: the municipality acts as guarantor of commercial rights, the private developer provides the construction capital. It is a shared architecture rather than a single institution - less elegant, but workable within Ukrainian conditions.

The non-eviction model carries over unchanged. Everything around it has to be rebuilt.

The selection of insulation materials for brick buildings of the 1-438 series in the “Sotsmisto” neighborhood is carried out in accordance with the requirements of building physics: the porous brickwork of this series has a high water absorption coefficient, so the use of cheaper expanded polystyrene (foam) is technically unacceptable. Expanded polystyrene blocks vapor diffusion to the outside, causing moisture to accumulate directly at the interface between the brick and the insulation. Seasonal freeze-thaw cycles lead to rapid physical deterioration of load-bearing walls. In contrast, the “wet” facade technology using vapor-permeable mineral wool completely solves this problem. Mineral wool preserves the brick wall’s natural ability to “breathe” (release moisture outward), while simultaneously preventing the deterioration of the masonry from external atmospheric factors and improving the building’s thermal insulation to meet modern energy efficiency standards. The effectiveness of this material specification, as demonstrated by the large-scale renovation of residential complexes, is confirmed by Drewitz’s research, which makes the use of mineral wool a mandatory engineering standard for the entire “Sotsmisto” project.

1.4 Conditionality as the Core Transferable Mechanism

The KredEx program achieved results in the area of comprehensive renovation by ensuring a comprehensive approach not through technical recommendations, but through financing conditions. Loan disbursement depended on verified completion of a defined, indivisible package of work: ventilation, roof, walls, windows, and heating systems together, as part of a single construction project. Buildings that participated in the program underwent comprehensive renovation; buildings that sought financing for partial work did not receive it. It was precisely these conditions that ensured the desired result.

The investment delegation mechanism provided for by the 2026 Housing Policy Act replicates this structure of conditions using a different legal instrument. The developer acquires commercial rights to the newly created spaces-apartments in the superstructure and commercial premises on the ground floor-only after the confirmed completion of comprehensive capital repairs throughout the entire building in accordance with agreed-upon technical requirements. The right to commercial use depends on the completeness of the renovation, not on its commencement. While KredEx ensured the completeness of the work through a sequence of payments tied to the volume of work completed, the investment delegation mechanism ensures this through the structure of ownership: the developer does not own the commercial asset until the reconstruction obligation, which unlocks this right, is fully fulfilled. Partial reconstruction does not yield commercial assets - which, given the costs of constructing the superstructure and the developer's margin noted in Section 3, directly translates into financial losses. The incentive structure eliminates the partial renovation trap created by commercial logic in the absence of conditions. This is the mechanism that was missing from early "semi-HCR" initiatives in Shanghai and is evident in the results of Xintiandi, as described in the literature review.

The limitation of the "thermal effect" is carried over unchanged and applied to the brick series 1-438 as a physical certainty rather than a risk to be managed. The series' porous structure accumulates moisture; its construction joints do not meet the airtightness standards required by thermal modeling. Sealing the thermal envelope through facade insulation eliminates uncontrolled air infiltration, which previously dispersed internal moisture; this moisture then concentrates in the wall's cross-section and on interior surfaces. Sotsmisto's strategy requires facade insulation and mechanical supply-and-exhaust ventilation with heat recovery as an inseparable package of measures-not as a precaution, but as a response to the predictable physical mechanism that the properties of building materials make inevitable when sealing the envelope. What does not translate to Ukrainian realities, however, are the credit mechanisms. Estonian housing associations turned to KredEx in 2009, having two decades of institutional development behind them - they were registered legal entities with a proven financial history sufficient to obtain preferential loans in a functioning domestic credit market, whereas Ukrainian HOAs lack comparable experience. The "SocCity" model channels grant funds through the Municipal Revolving Fund rather than disbursing them directly to associations, with the municipality assuming the credit risk during the program's initial stages. Associations build institutional experience through participation in governance - in neighborhood renovation councils and in the commercial property management mechanisms outlined in Section 4 - thereby establishing the credit history that will be necessary for direct borrowing in later stages.

1.5 Mykolaichuka Street: Resolving the Asset's Endpoint

The Lviv project enables the creation of habitable housing units on a municipal scale within six to eight weeks of mobilization, in accordance with Ukraine's public procurement system and with thermal and sound insulation properties sufficient for temporary occupancy. Traditional construction takes 18 to 36 months for a facility of equivalent capacity. This timeframe determines the operational feasibility of the "wave" method - the pilot building must be ready for occupancy before the first resettlement agreement takes effect, and the six-to-eight-week timeline is incorporated into the construction sequence plan, as outlined in Chapter 4.

The "Sotsmisto" strategy envisions transforming the pilot building into permanent municipal social housing upon completion of the renovation cycle in accordance with the 2026 Housing Policy Act, which will serve veterans returning to civilian life, young professionals who cannot afford rent in Kyiv's post-war market, and displaced persons awaiting stable housing. A full comparison of the net present value between conversion, commercial leasing, and decommissioning - with specific assumptions regarding the discount rate and maintenance cost projections - is provided in Section 3. The conclusion that permanent repurposing outperforms all alternatives remains valid under any realistic assumptions regarding parameters: a structure that took six weeks to build and served as logistical infrastructure for a multi-year renovation program makes no economic sense as a demolition candidate once that program is complete. The Housing Policy Act of 2026 directly implements repurposing; Section 4 sets out the management provisions governing it.

Beyond the financial comparison, repurposing has implications for the liquidity profile of the Municipal Revolving Fund. Permanent social housing generates a stable stream of rental income with low volatility between large irregular surpluses, which are created by the completion of the “Maximum” scenario - this is a structurally different nature that is particularly useful for maintaining the Fund’s liquidity during the intervals between the main phases of the program.

Drevits, KredEx, and Mykolaychuk Street jointly confirm that the “Sotsmisto” model draws on proven operational precedents for each of the three core mechanisms - eviction-free management, full compliance with conditions, and rapid relocation logistics. Each transition requires specific institutional adaptations defined by the Ukrainian context, and each adaptation stems from the gap between what each precedent envisioned and what the Ukrainian institutional environment currently provides. Section 2 provides the empirical foundation necessary for these principles and precedents: an analysis of the structural typology that determines which “Sotsmisto” buildings correspond to a particular level of renovation.

CHAPTER 2. ANALYTICAL REVIEW OF DETERIORATED HOUSING STOCK IN SOTSMISTO

The Dniprovskyi district records the third-highest volume of deteriorated housing in Kyiv, surpassed only by Solomianskyi and Shevchenkivskyi districts. Deteriorated stock covers 1.966 million m² and houses over 107,000 residents - a concentration that makes the district both an acute policy problem and a viable scale for piloting district-level renovation models. The Sotsmisto microdistrict merits particular analytical attention because it contains both principal housing typologies present in the district - the 1-438 brick series and the 1-464 large-panel series - in proportions and spatial arrangements that allow differentiated management approaches to operate simultaneously within a single coherent district strategy.

2.1 Building Typologies and Technical Characteristics

Inventory analysis of Sotsmisto's housing stock identifies two structurally and spatially distinct building groups, each presenting a different set of renovation possibilities and operational constraints. The differences between these groups are not superficial: they determine whether renovation can proceed with residents in place or requires temporary evacuation, whether vertical extension is structurally feasible or prohibited, and which financing mechanisms the renovation model can be relevant.

The 1-438 Brick Series

The 1-438 series represents the dominant brick housing typology in the district's deteriorated stock, covering 780,800 m² of total floor area across the Dniprovskyi district. These buildings rest on strip rubble-concrete foundations and carry their loads through a frameless structural scheme with longitudinal load-bearing walls ranging from 0.51 to 0.64 metres in thickness. This wall thickness - substantial by Soviet mass-housing standards - provides a load-bearing reserve that the design originally did not intend to exploit but that contemporary structural analysis confirms as sufficient to carry one to two additional storeys, provided that the foundation condition allows load transfer amplification and that the vertical extension employs a frame system that routes new loads directly to the strengthened foundation rather than accumulating them in the existing masonry (Aheieva et al., 2021).

The longitudinal structural scheme carries a further operational consequence: all load-bearing and structurally significant elements run along the building's external perimeter and internal longitudinal axes, leaving the building's cross-section free of structural constraints on movement through individual floors. This configuration enables insulation work, installation of external lift shafts, replacement of utility risers, and construction of vertical extensions entirely from the building's exterior, without exposing inhabited dwelling units to construction activity. Residents need not vacate their apartments during any phase of the external intervention works - a structural fact that directly enables the non-eviction renovation model and eliminates the resettlement logistics cost that the 1-464 panel series imposes.

The 1-438 series also carries a specific material vulnerability that distinguishes its degradation pattern from the panel series. Construction records from this period document the widespread use of bricks fired at inadequate kiln temperatures, producing units with high water absorption rates - a property that, combined with Ukraine's climate of significant freeze-thaw cycling, activates a progressive deterioration mechanism. Water penetrates the microcracks present in inadequately fired brick; repeated freezing expands these voids and ruptures the material structure; the resulting spalling and delamination progressively reduce the cross-sectional capacity of load-bearing piers and the structural integrity of corner joints. Without external thermal insulation that relocates the condensation zone outside the masonry plane, this degradation process continues unimpeded and eventually reaches the threshold of irreversibility - the point at which load-bearing capacity losses require structural replacement rather than remediation. The thermal insulation intervention in the 1-438 series is therefore simultaneously an energy-efficiency measure and an active structural stabilization operation.

The 1-464 Large-Panel Series

The 1-464 series constitutes the dominant panel-building typology in the Dniprovskyi district, which leads all Kyiv districts in Soviet-era panel-building volume at 1.054 million m². These buildings rest on pile or strip foundations and carry their loads through a frameless scheme with transverse load-bearing walls arranged at bay widths of 2.6 to 3.2 meters. External panels measure 0.35 meters in thickness - a dimension that historical construction records confirm reflects a deliberate design decision to minimize material consumption during the mass-production construction campaigns of the 1960s (Yelizarov & Medvedeva, 1961). That decision, rational within the production logic of the period, now severely constrains modernization options: panels of 0.35 meters offer insufficient thermal mass and no reserve structural capacity for vertical extension, while the transverse load distribution scheme prohibits the modification of internal layouts through wall removal without structural re-engineering that the economics of renovation cannot justify.

The structural consequence most directly bearing on Sotsmisto’s renovation program is the location of the 1-464 series’ primary point of failure. Unlike the 1-438 series, where degradation initiates in the wall material itself, the 1-464 series concentrates its structural vulnerability in the embedded steel connectors that join prefabricated panel elements at their joints. These connectors, exposed to decades of moisture ingress through construction joint sealant failure and panel edge microcracking, undergo progressive corrosion that reduces their cross-sectional area and tensile capacity. Technical inspection data from comparable panel building stock confirms that connection joint wear in Sotsmisto’s 1-464 buildings frequently exceeds 60% of original design capacity - a condition that leaves structures acutely vulnerable to differential ground settlement and to the dynamic loads generated by ground-borne vibration from urban traffic. Joint reinforcement and the stabilization of the foundation-structure interface require access to the building's structural core and cannot proceed with residents occupying the building, making temporary relocation a technical necessity rather than a management preference.

2.2 Analysis of Destructive Factors and MRUB Prioritization

The chronic underfunding of routine structural maintenance in Sotsmisto's housing stock has produced not simple linear wear but accelerating degradation loops in which neglected components create the conditions for the failure of adjacent systems. Analyzing these interactions through the MRUB diagnostic framework (Nowogońska & Mielczarek, 2021) makes it possible to rank intervention urgency across the component hierarchy of both building series according to the weighted sequence indicator $M_i = E_i \times Sz_i$, where E_i represents the systemic consequence weight of abandoning works on a given component, and Sz_i represents the current physical wear level.

The analysis below applies the MRUB consequence taxonomy - which categorizes neglect outcomes across four severity levels: architectural asset devaluation, loss of thermal comfort, serious structural deformation, and catastrophic building failure - to the specific destructive mechanisms active in each series.

Foundation systems and load-bearing structure (highest M_i priority, both series). Foundation failure carries the maximum consequence weight ($E_i = 5$ on the AHP-derived scale) because deterioration at this level propagates irreversibly through the entire structural hierarchy. In the 1-438 series, continuous leakage from failed internal engineering networks saturates the strip rubble-concrete foundation bases, reducing their bearing capacity and accelerating the wall deformation cycle described above. In the 1-464 series, moisture ingress at the panel joint level - the primary degradation pathway -

eventually reaches the pile head connection zone, where joint corrosion combines with differential settlement to impose eccentric loading on columns designed for purely axial forces. Physical wear levels (Sz_i) for foundation and primary structural elements in buildings with maintenance deficits exceeding fifteen years consistently fall in the 45–65% range across comparable Soviet panel and brick stock. Applying $M_i = 5 \times 0.55$ yields a sequence priority that substantially exceeds all secondary interventions. Foundation stabilization and load-bearing structure remediation must precede all other works.

Panel joints and connection elements (highest M_i priority, 1-464 series specifically). The embedded steel connectors that join prefabricated panel elements occupy a structural position with consequential weight equivalent to foundation elements ($E_i = 5$) because their failure mode - sudden loss of tensile capacity across multiple joints under dynamic loading - can trigger progressive panel separation without the gradual warning indicators that masonry degradation provides. At wear levels exceeding 60%, the connection elements carry loads with safety factors below the minimum permissible for inhabited structures under Ukrainian building regulations. This places joint reinforcement on an equivalent priority tier with foundation stabilization in the 1-464 series - both must precede all other interventions, and both require complete building evacuation to execute safely.

External wall fabric and thermal envelope (high M_i priority, differentiated by series). External walls carry a consequence weight of $E_i = 4$ in the 1-438 series, where active material degradation through freeze-thaw cycling reduces load-bearing capacity over time and creates an irreversibility threshold. The thermal insulation intervention halts this process while simultaneously upgrading energy performance - a dual function that raises its effective priority above its thermal consequence weight alone. In the 1-464 series, the external 0.35-meter panels carry a consequence weight of $E_i = 3$ from a thermal standpoint, since panel failure in isolation does not threaten structural integrity, but the dew-point migration into the wall cross-section - caused by thermal resistance values well below contemporary standards - accelerates the corrosion of embedded connectors, thereby elevating the thermal envelope intervention's indirect structural consequence.

Engineering networks - water supply, drainage, heating (high M_i priority, both series). Failed internal networks carry a consequence weight of $E_i = 4$ because continuous leakage from aged pipelines is the primary moisture-loading mechanism for both foundation systems and wall fabric. At current wear levels - internal network wear in Sotsmisto buildings without recent maintenance intervention runs at 60–75% - the probability of active leakage at any given time is high enough that foundation and wall degradation continues even after external insulation works, unless network replacement accompanies or precedes envelope intervention. Engineering network replacement therefore occupies the same intervention phase as envelope and foundation works rather than a subsequent one.

Accessibility infrastructure - lift shafts, entrance ramps, doorway widths (medium-high M_i priority, social consequence dominant). Accessibility deficits carry an E_i weighting of $E_i = 3$ on the structural consequence scale - non-compliance does not threaten building integrity - but the social consequence of continued non-compliance with DBN V.2.2-40:2018 is operationally equivalent to a high-consequence structural failure in the context of post-war urban policy. Five-story buildings without lift access exclude mobility-impaired persons, wounded veterans returning to residential life, and elderly residents from their own homes. Raised entrance thresholds and sub-standard doorway widths compound this exclusion. The practical effect - accelerated outmigration of working-age residents and progressive social homogenization toward elderly and low-mobility populations - undermines the district's economic base and increases long-term municipal social service costs. The “Maximum” scenario integrates external glass lift shaft installation and entrance redesign as non-separable components, treating accessibility remediation as a co-equal priority with energy performance rather than an optional upgrade.

Roof structures and attic spaces (medium M_i priority, precondition for vertical extension). Roof elements carry a consequence weight of $E_i = 3$, with physical wear levels in the 50–70% range for buildings without recent roof maintenance. The strategic priority of roof intervention in the 1-438 series exceeds its standalone consequence weight because the “Maximum” scenario requires structural preparation of the attic zone for superstructure construction. Roof replacement and attic floor reinforcement serve simultaneously as maintenance interventions and as technical pre-conditions for the value-capture mechanism.

The MRUB analysis produces a clear and reproducible intervention sequence for both building series. Foundation stabilization and primary structural remediation - including panel joint reinforcement in the 1-464 series - occupy Phase 1 and cannot be deferred. Engineering network replacement and external wall intervention occupy Phase 2 and must proceed in the same construction mobilization to prevent moisture reloading of newly stabilized foundations. Accessibility infrastructure, superstructure preparation, and commercial conversion works are scheduled for Phase 3, contingent on the completion of Phases 1 and 2. This sequencing governs the design of all three renovation scenarios in Chapter 3.

2.3 District Morphology and Commercial Axes Identification

A morphological analysis of the district allows us to determine the spatial distribution of development potential within the “Sotsmisto” area, creating a geographical basis for assigning individual buildings and groups of buildings to appropriate renovation scenarios. The analysis is based on three variables: street hierarchy and pedestrian traffic intensity, the distribution of building types, and current land-use patterns in ground-floor spaces.

Buildings directly facing the neighborhood’s main thoroughfares (Mir Avenue and Budivelnykiv Street) already have actively functioning ground floors, which have historically fostered a high level of commercialization and ensure stable and intense flows of pedestrian and vehicular traffic. This allows for sustained demand for retail, food service, and services at high rental rates and has the potential to generate a financial surplus for cross-subsidizing the renovation of intra-neighborhood facilities.

However, the current development potential of the “Maximum” scenario lies in scaling this approach to less high-traffic but equally prominent buildings located along adjacent roads (as opposed to isolated buildings set back in courtyards). Currently, isolated, localized development of commercial spaces on the ground floors is already being observed in such locations: local cafes, hair salons, and service centers are appearing. Continuing and systematically encouraging this trend has a dual benefit: it not only expands the basis for value capture but also transforms these streets into livelier and more transit-oriented pedestrian zones. The emergence of active facades and a constant flow of people naturally increases public safety in the evenings thanks to the concept of “natural surveillance” of the space, making the capitalization of these linear sections a priority for the entire Sotsmisto renovation project.

The buildings on these axes, belonging to the 1-438 series, also have structural capacity for superstructure. The combination of revenue from the commercialization of the ground floors and superstructures places these buildings in the “Maximum” scenario category:

the value capture mechanism generates a surplus, which the Municipal Revolving Fund directs toward Phase 1 and Phase 2 works in buildings unable to generate equivalent commercial returns.

Facades on secondary streets (the “Optimal” scenario zone). Buildings on secondary internal streets with moderate pedestrian traffic do not have sufficient demand for ground-floor rentals to justify full commercialization, but are located within walking distance of major commercial thoroughfares and benefit from proximity to public infrastructure improvements-redevelopment of entrances, landscaping of courtyards, and modernization of shared utility networks - provided by district-level reconstruction. These buildings receive an “optimal” package: complete replacement of utility networks, construction of civil shelters in deep basements, and accessibility infrastructure, funded through a combination of allocations from the Municipal Revolving Fund and a direct grant from the EU Fund for Ukraine for the shelter and accessibility components.

Deep inner blocks (the “Minimum” scenario zone). Buildings located in the inner part of residential blocks, set back from the facades of main and secondary streets, generate neither commercial income on the ground floor nor a value of the superstructure sufficient to attract private investment. Their renovation is carried out under the “Minimal” package-thermal modernization, roof replacement, and foundation stabilization-through cross-subsidization from the Revolving Fund, accumulated from revenues generated by the “Maximal” scenario. Preserving mature green spaces in the inner blocks surrounding these buildings is part of the environmental rationale for the “Minimal” scenario: the sixty-year-old tree canopy helps regulate the microclimate, manage stormwater runoff, and ensure residents’ comfort-something that could not be achieved in the event of reconstruction involving demolition.

Clusters of prefabricated buildings and “wave method” logistics zones. The stock of prefabricated buildings in District No. 1-464 - concentrated in areas where the Soviet-era mass construction campaign in the Dnipro District reached its highest density - constitutes a zone within which the “wave method” of temporary relocation logistics operates. The spatial grouping of prefabricated apartment buildings into clearly defined sub-blocks makes sequential reconstruction logistically feasible: a pilot rapid-construction building, located on the periphery of the cluster, serves the residents of the first evacuated building; after the completion of reconstruction and the return of residents, the pilot building accommodates the residents of the next building in line. The geographical compactness of the prefabricated building clusters minimizes the distance residents must travel to temporary housing and ensures their proximity to the district’s social infrastructure - schools, clinics, and established retail services - throughout the entire renovation period.

The stock of brick buildings in District 1-438, concentrated along or near major commercial thoroughfares, constitutes a natural starting point for pilot renovation projects without eviction. These buildings meet three conditions that make them suitable as the first sites for program implementation: structural capacity for vertical expansion, a facade on a commercial axis for first-floor conversion, and a renovation model without eviction that minimizes community resistance in the program’s initial phase. Successfully completed pilot projects in these clusters establish an operational precedent, a contractor supply chain, and community trust - all necessary for subsequent phases, particularly the renovation of prefabricated apartment buildings, which requires greater logistical effort. This morphological differentiation translates the abstract three-tier scenario structure into a spatially specific implementation sequence: “Maximum” scenario works on primary axis brick buildings generate the initial Revolving Fund capital; “Optimal” scenario works on secondary frontage buildings proceed in parallel where EU grant co-financing covers the shelter and accessibility components; “Minimal” scenario works on interior block buildings follow as Revolving Fund accumulation reaches the capital threshold required for each building. Chapter 3 defines the technical content of each scenario in accordance with the structural and morphological parameters established here.

CHAPTER 3. DESIGN OF THREE RENOVATION SCENARIOS

The three renovation scenarios developed in this chapter apply the structural typology and morphological differentiation established in Chapter 2 to produce a differentiated intervention program for Sotsmisto's building stock. The scenarios: “Minimal”, “Optimal”, and “Maximum” - don't represent alternative strategies from which a planner selects one; they represent three simultaneously operating tiers of a single district-scale program, assigned to individual buildings and building clusters according to their structural series, street position, and commercial capitalization potential. The MRUB prioritization sequence derived in Chapter 2 governs the internal component ordering within each scenario. The CCE optimization framework, following Petersen and Svendsen (2012) and Morelli, Harrestrup, and Svendsen (2014), establishes the economic equilibrium point between retrofitting capital expenditure and future energy cost savings that prevents the program from executing thermally aggressive but financially non-recovering insulation overhauls. The cross-subsidization logic, in which the commercial surplus generated by the "Maximum" scenario funds the socially necessary but commercially non-viable components of the "Minimal" and "Optimal" scenarios, determines the sequencing of works across the district and the capital flows into and out of the Municipal Revolving Fund.

The technical and economic assessment methodology follows Schreiber (1993) in comparing intervention scenarios against one another by weighing total capital expenditure against the combined value of extended service life, reduced operational energy costs, increased post-renovation market value, and revenue generated by new commercial or residential space. This comparative framework identifies the "Maximum" scenario as the financially generative tier and the "Minimal" scenario as the fiscally dependent tier, with the "Optimal" scenario occupying a middle position where EU Ukraine Facility grant funding covers the unprofitable civil shelter and accessibility components, while the Revolving Fund covers engineering network replacement.

3.1 Scenario 1: "Minimal" - Energy Efficiency and Service Life Extension

1. Scope and Target Buildings

The "Minimal" scenario applies to buildings in the interior block positions identified in Chapter 2 as the “Minimal scenario zone”: structures removed from primary and secondary commercial thoroughfares that lack the pedestrian throughflow and visibility to support ground-floor commercialisation and whose structural reserve capacity falls below the threshold required for superstructure addition. These buildings receive the baseline modernisation package that extends their service life by fifteen to twenty years, brings their thermal performance into compliance with current standards, and arrests the active degradation processes identified in the MRUB analysis, without activating the value-capture mechanisms that require favourable market conditions.

2. Thermal Envelope Intervention

The foundation of the "Minimal" package is continuous facade insulation applied to the entire external wall surface. For the 1-438 brick series, the insulation system uses vapor-permeable mineral wool boards at a thickness calibrated to achieve the thermal resistance value R [1]≥ 3.5 $m^2 \cdot K/W$[2][3] . Its required under current Ukrainian energy performance standards (DBN B.2.6-31:2021), while maintaining the wall assembly's overall vapor diffusion capacity above the critical threshold that prevents moisture accumulation within the masonry.

[1] Thermal resistance (R): In building engineering, R denotes thermal resistance - the primary measure of a wall assembly's or insulation system's capacity to retard heat transfer between the building interior and exterior.

[2] Regulatory threshold (R ≥ 3.5 $m^2 \cdot K/W$): Under the current Ukrainian building code DBN B.2.6-31:2021 (Thermal Insulation of Buildings), the minimum permissible thermal resistance for external walls of residential buildings in Climate Zone I of Ukraine - which includes the city of Kyiv - is 3.5 $m^2 \cdot K/W$.

[3] Units of measurement ($m^2 \cdot K/W$): m^2 denotes the wall surface area in square metres; K denotes degrees Kelvin, representing the temperature differential between interior and exterior conditions; W (watts) denotes the rate of heat loss through the assembly.

The choice of mineral wool over expanded polystyrene for the 1-438 series is a structural decision, not merely a thermal one. The 1-438 brickwork's demonstrated pathology of moisture accumulation requires a vapor-open insulation system that allows residual moisture to migrate outward rather than concentrate at the masonry-insulation interface. Expanded polystyrene, which creates a vapor barrier at the wall surface, would accelerate the freeze-thaw degradation cycle it is intended to interrupt.

For the 1-464 panel series buildings that fall into the "Minimal" category, expanded polystyrene or mineral wool both remain technically viable. The panel material's lower porosity does not carry the same moisture accumulation risk as the brick series. Insulation thickness targets $R \geq 3.5$ $m^2 \cdot K/W$ in both cases. Window frame replacement uses triple-glazed units with thermally broken frames, addressing both the direct thermal losses through the glazing, which account for approximately 30–35% of total heat losses in unmodernized five-story buildings, and dew-point condensation on the inner frame surfaces, which generates mould growth and accelerates window embrasure degradation.

The CCE analysis for the "Minimal" thermal package establishes the economic equilibrium condition as follows. At current natural gas prices for district heating in Kyiv (approximately UAH 2,800–3,200 per Gcal as of the 2024–2025 tariff period), a standard five-story 1-438 series building with a total floor area of 3,200 m² incurs an annual heating cost of approximately UAH 480,000–540,000 before modernization. Post-renovation modeling projects a

45–55% reduction in specific heat demand following combined facade insulation and window replacement, yielding annual savings of UAH 216,000–297,000 per building. The marginal Cost of Conserved Energy (total capital cost of the thermal intervention divided by the discounted sum of annual energy savings over the residual service life) falls between UAH 140 and UAH 175 per conserved Gcal under a 7% discount rate and a fifteen-year amortisation horizon. This CCE value places the thermal package firmly below the marginal cost of purchasing equivalent energy from the district heating network, confirming that the intervention delivers a positive net present value even without accounting for the market value uplift associated with post-renovation energy certification.

3. Ventilation System Modernization

KredEx's experience points to an undeniable technical limitation: insulating the facade without simultaneously replacing the ventilation system leads to a "greenhouse effect" - deterioration of indoor air quality and moisture accumulation on interior surfaces, since sealing the building envelope eliminates uncontrolled air infiltration, which previously provided natural ventilation. Therefore, the "Minimum" package includes the replacement of outdated gravity ventilation ducts with mechanical supply and exhaust ventilation systems equipped with heat recovery units. Ventilation with heat recovery captures 75–85% of the thermal energy in the exhaust air and transfers it to the incoming fresh air, reducing ventilation heat losses, which account for 20–25% of the building's total heat losses after the envelope is insulated, while maintaining indoor air quality, which could otherwise be compromised by the airtightness of the building envelope after insulation. This component increases the capital costs of the “Minimum” package but simultaneously raises the projected energy savings by 8–12 percentage points compared to measures addressing only the building envelope and eliminates the risk of moisture-related issues associated with incomplete renovation.

4. Foundation Stabilisation

The MRUB analysis in Chapter 2 assigns foundation stabilisation the highest sequence priority across both building series. The "Minimal" scenario executes this intervention through the concrete jacket method. This is technically and economically appropriate approach for buildings where wear levels fall below the catastrophic failure threshold and where the renovation programme does not require the deeper foundation reinforcement that superstructure construction demands. The method constructs additional reinforced-concrete collars around existing foundation block elements for the 1-464 series or around the rubble masonry strip base for the 1-438 series, increasing the foundation's contact area with bearing soils by 30–40% and restoring the load-distribution geometry to design parameters. Simultaneous installation of horizontal damp-proof course membranes across the foundation head eliminates the primary moisture pathway, capillary rising damp from soil through the rubble concrete base into the wall, that the MRUB analysis identifies as the first link in the degradation loop.

5. Heating System Conversion

The transition from centralized district heating connections to rooftop or modular autonomous boiler units serves two functions. Firstly, it removes the building's dependence on the district heating network's supply schedule. The second is temperature parameters, which enable individual metering at the apartment level, allowing residents to regulate their own energy consumption. The Estonian KredEx program documented a 15–20% reduction in heating consumption attributable solely to metering-enabled behavioral change, independent of the physical performance improvements delivered by the envelope intervention. The modular boiler configuration also eliminates the thermal losses that occur in the heat exchange station and the in-building distribution network under the district heating model - losses that typically account for 8–12% of total heat input in buildings of this age and network condition.

Interior-block buildings without thoroughfare exposure cannot attract retail tenants and therefore fall entirely outside the commercial cross-subsidization loop. For these buildings, the “Minimal” package draws on three non-commercial funding streams rather than revolving fund surplus. The OSBB secures a grant covering up to 50% of thermal envelope works through the state-backed “ENERHODIM” program administered by the Energy Efficiency Fund of Ukraine. The municipality covers 100% of lift shaft installation and barrier-free access works from the city accessibility budget - expenditures that qualify as public-realm obligations independent of any building's commercial profile. The remaining structural and engineering network deficit is covered by long-term green credit facilities negotiated through state banking channels, repaid by the OSBB from utility savings generated by the retrofit. This three-stream structure makes “Minimal” renovation viable for buildings that the property market will never reach on its own, without placing the shortfall on the Municipal Revolving Fund's cross-subsidization budget.

3.2 Scenario 2: "Optimal" - Safety, Infrastructure, and Civil Defense

1. Scope and Target Buildings

The "Optimal" scenario applies to buildings on secondary street frontages-the intermediate zone between the primary commercial axes and the deep interior block positions, and to 1-464 panel series buildings irrespective of street position, since the structural intervention depth required for panel joint reinforcement and basement deepening escalates renovation scope beyond the "Minimal" package regardless of commercialization potential. The "Optimal" package incorporates all components of the "Minimal" scenario. It adds three additional intervention groups: complete engineering network replacement, construction of civil protection shelters in deepened basements, and full floor-slab structural reinforcement.

Table 1. *“Optimal” Renovation Package: Capital Expenditure Structure and Funding Allocation per Standard Building*

	"Optimal" Package Components	Cost (UAH)	Funding Source
1	Structural foundation retrofitting and waterproofing	1 850 000	OSBB (HOA) / Municipal credit lines

2	Thermal envelope insulation (mineral wool) and window replacement	2 400 000	"ENERHODIM" Program (50% Grant facility)
3	Complete overhaul of internal utility networks (cold/hot water, sewage, power grid)	1 200 000	Municipal co-financing program
4	Ventilation system with decentralized heat recovery	680 000	Green credit facilities (repaid via energy savings)
5	Installation of two external panoramic glass elevator shafts	1 400 000	Municipal budget (Public Accessibility & Inclusivity Program)
6	Entrance group modernization, access ramps, and barrier-free infrastructure	320 000	Municipal budget (Public Accessibility & Inclusivity Program)
7	Construction of a specialized civil defense shelter (50-person capacity)	950 000	100% Grant funding via the EU Ukraine Facility
	GROSS CAPEX	9 580 000	Total investment volume
	NET CAPEX (Excluding EU-granted shelter facility)	8 630 000	Residual capital required for structural allocation

2. Complete Engineering Network Replacement

At wear levels of 60–75%, the range recorded across Sotsmisto's internal networks in buildings without maintenance intervention in the past fifteen years, pipeline failure probability at any given point in the network is sufficiently high that the thermal envelope and foundation works executed under the "Minimal" package face immediate re-contamination risk from moisture released by network leakage. Engineering network replacement therefore precedes or accompanies all envelope works in the "Optimal" scenario rather than following them in a later phase. The replacement scope covers the main water supply and drainage pipelines from the building entry point to each floor's riser connection; a major electrical network overhaul to accommodate contemporary appliance loads without the chronic overloading that causes fire hazards in undersized Soviet-era circuits; and gas network inspection and replacement where condition assessment warrants it.

The structural consequence of deferred network replacement, beyond moisture re-loading, involves the thermal degradation of the reinforced concrete slab elements that Soviet-era pipelines penetrate at floor transitions. Long-term leakage at these penetration points concentrates moisture in the rebar cover zone, initiates chloride-induced corrosion of the reinforcement, and reduces slab flexural capacity precisely where point loading from piping fixtures imposes concentrated stress. Network replacement eliminates the moisture source; supplementary penetration sealing addresses existing damage at slab penetrations.

3. Civil Protection Shelter Construction

Implementing the “Optimal” scenario faces a serious safety challenge: adapting basements to meet at least the minimum civil defense standards. The problem is that the utility basements in buildings of the 1-438 and 1-464 series were never designed for human occupancy; they are ordinary, unheated utility rooms with ceiling heights of only 1.2–1.6 meters. Of course, the first thought that comes to mind is simply to dig out the basement to the standard 1.9 meters, but this brings us into direct conflict with the building’s structural logic. Completely excavating the soil below the level of the strip foundation of Khrushchev-era buildings risks disaster: under lateral pressure, the foundation blocks will begin to shift, leading to the settling of load-bearing walls and the appearance of cracks throughout the building.

That is precisely why, in the Sotsmisto project, we are abandoning the idea of constructing full-scale, heavy bomb shelters in favor of creating "simplest shelters" in accordance with DBN V.2.2-5:2023. Instead of risky large-scale earthworks, the solution is based on targeted, localized interventions in the basement space. We achieve the required ceiling height exclusively along transit pedestrian passages and evacuation routes, creating these recesses at a safe distance from the stress zone of the foundation blocks. At the same time, the existing brick columns and interior partitions are reinforced with steel collars to increase the structure's resistance to potential emergency loads from above.

To make this damp basement suitable for human habitation, we are completely rethinking its engineering systems. The problem of humidity, dampness, and stagnant air is solved by integrating a compact supply and exhaust ventilation system with a heat recovery unit. To protect against groundwater, the floor is covered with penetrating waterproofing, and comfort is ensured by connecting water supply lines and installing small restrooms. Since the basement is low-lying, forced-draft pumping units are installed to drain wastewater into the building's main sewer system. The result is a fully functional space for the short-term protection of residents during emergencies, which does not disrupt the building's structural integrity and fits clearly within the planned budget of 950,000 hryvnias per facility.

Given the absence of large-scale basement excavation, we completely eliminate the geotechnical risks associated with compromising the stability of the foundations. Instead of extremely expensive and complex procedures such as pressure grouting, safety is achieved purely through architectural and planning methods. Local floor lowering only in passageways does not cause lateral soil displacement beneath the base of the foundation blocks. Regarding blast resistance and the stability of the floor slab above the basement (shelter ceiling), instead of completely dismantling the reinforced concrete slabs of the first floor, a technology is used to reinforce them from below using a system of additional metal beams (channels or I-beams). This significantly increases the structure's load-bearing capacity in the event of a collapse of building elements from above, fully meeting the requirements for the simplest shelters.

The capital costs for such an adaptation of a technical basement are significantly lower than the construction of new civil defense structures and are fully in line with the logic of a limited budget. The investments we have calculated cover three key engineering components that are mandatory for the facility's launch.

4. Floor Slab Reinforcement

The structural reinforcement of first-floor slabs, beyond the shelter-specification requirement, addresses a degradation risk that the MRUB analysis assigns a consequence weight of $E_i = 4$: the loss of ground-floor slab integrity through long-term moisture exposure from basement-level condensation and, in buildings with deferred waterproofing maintenance, from direct water contact during seasonal groundwater table rises. Additional metal beams installed beneath the slab soffit restore the flexural capacity to design parameters and provide the structural platform required for the basement shelter's protective ceiling function.

3.3 Scenario 3: "Maximum" - Economic Value Capture

1. Scope, Target Buildings, and Economic Logic

The "Maximum" scenario applies to buildings on the primary commercial axes: Prospekt Myru, Budivelnykiv Street, and equivalent district thoroughfares, where the combination of pedestrian throughflow, transport connectivity, and district-scale service demand supports commercial tenants at rental rates sufficient to generate investable surplus. These buildings belong predominantly to the 1-438 brick series, whose longitudinal load-bearing wall system provides the structural reserve for superstructure addition. The scenario incorporates all components of the "Minimal" and "Optimal" packages and adds two value-generating elements: vertical extension of one to two storeys using the "Flamingo" independent-frame system, and ground-floor conversion to commercial premises with reconfigured facade apertures for retail visibility.

The economic logic follows the CCE cross-subsidisation framework directly. The commercial surplus generated by the "Maximum" scenario- the difference between the total revenue from superstructure apartment sales and ground-floor commercial space proceeds and the total capital cost of the complete renovation package- constitutes the primary replenishment source of the Municipal Revolving Fund. This surplus finances the non-revenue-generating components of the "Minimal" and "Optimal" scenario, which works in buildings that cannot self-fund their renovation. The program thereby achieves district-wide renovation without exclusive dependence on public budget allocation, distributing the financial burden of the initiative across the buildings whose commercial position enables revenue generation.

2. Pilot Financial Model: Standard 1-438 Building on Primary Commercial Axis

To establish the cross-subsidization arithmetic on an empirical rather than declarative basis, the study develops a pilot financial model for a representative five-story 1-438 series brick building of 3,200 m² existing floor area situated on a primary commercial thoroughfare in the Dniprovskyi district. The model structures costs and revenues across four analytical components: baseline capital expenditure, superstructure residential value capture, ground-floor commercial value capture, and the consolidated fund balance with cross-subsidization ratios.

Table 2

Capital Expenditure Breakdown for a Representative 1-438 Series Building on a Primary Commercial Axis

	Work Component / Intervention Description	Gross Cost (UAH)	Funding Source / Allocation Category

1	Foundation reinforcement (concrete jacket method & damp-proof course)	1 850 000	Revolving Fund / Non-revenue structural base
2	Continuous mineral wool façade insulation & window replacement	2 400 000	Revolving Fund / Non-revenue energy package
3	Internal engineering network overhaul (water, drainage, electrical)	1 200 000	Revolving Fund / Non-revenue infrastructure
4	Decentralized mechanical ventilation system with heat recovery units	680 000	Revolving Fund / Non-revenue air quality package
5	External glass lift shaft installation (two structural shafts)	1 400 000	Revolving Fund / Value-capture enablement
6	Roof replacement & attic floor structural reinforcement	780 000	Private Capital / Superstructure preparation
7	Entrance redesign & structural barrier-free access works	320 000	Revolving Fund / Non-revenue inclusivity package
8	Civil protection shelter construction (50-person capacity in deepened basement)	950 000	EU Ukraine Facility Grant (Excluded from net loop)
9	Two-storey 'Flamingo' steel frame superstructure (1,200 m2 gross area)	28 800 000	Private Capital / Developer physical CAPEX
10	Delegated investment developer incentive margin (fixed at 20%)	5 760 000	Private Capital / Developer return premium
11	First-floor residential to commercial apartment conversion re-engineering	960 000	Revolving Fund / Value-capture commercial CAPEX
	Total Gross Program Expenditures (Gross CAPEX)	45 100 000	Full Architectural & Financial Volume
	Net Program Expenditures (Net of EU Shelter Grant)	44 150 000	Net Liability for Cross-Subsidisation Loop

Component 1: To provide an empirical basis for cross-subsidy calculations, this study developed a pilot financial model for a typical five-story brick building of the 1-438 series with a usable area of 3,200 square meters, located

on the main shopping street in the Dniprovskyi District. The model's organizational and financial architecture is based on the principle whereby the Municipal Revolving Fund acts as the primary developer and fund manager, while a private developer is engaged solely as a general contractor to perform construction work for a fixed fee. The model clearly structures all cash flows across four interrelated components, including basic capital expenditures for building renovation, instruments for capturing the value of residential superstructure, capitalization of commercial spaces on the first floor, and the fund's final balance, which determines the actual cross-subsidy ratio.

The first component of the model covers the basic capital expenditures for the engineering and energy modernization of the existing building, totaling 9,580,000 hryvnias. This budget covers the comprehensive reinforcement of the foundation by installing a concrete shell with a waterproofing layer, which requires 1,850,000 hryvnias, as well as full thermal insulation of the facade with mineral wool and the replacement of windows with modern triple-glazed units at a cost of 2,400,000 hryvnias. The major overhaul of the building's internal water supply, drainage, and electrical systems is estimated at 1,200,000 hryvnias; the installation of decentralized ventilation systems with heat recovery amounts to 680,000 hryvnias, and the installation of two external glass elevator shafts to ensure accessibility requires 1,400,000 hryvnias. The renovation of the entrance areas costs 320,000 hryvnias, and the replacement of the old roof, along with the reinforcement of the attic floor structure to accommodate future loads, is estimated at 780,000 hryvnias.

Since the safety component - namely, the construction of a basic shelter in the basement at a cost of 950,000 hryvnias - is fully covered by a non-repayable grant from European partners, the net capital costs of the building modernization program amount to 8,630,000 hryvnias. This amount is to be covered by the project's internal financial flows without drawing on direct funds from the city budget.

The second component of the model describes the mechanism for capturing value through the vertical expansion of the building. Thanks to the installation of a system of independent lightweight frames, a two-story attic addition is being constructed on the site, creating 1,200 square meters of new living space, divided into twenty comfort-class apartments of 60 square meters each. The physical construction of this project, based on the standard market cost for the Kyiv region of 24,000 hryvnias per square meter, requires 28,800,000 hryvnias. Taking into account the private developer's 20% margin as the contractor, amounting to 5,760,000 hryvnias, the total cost of constructing the superstructure is 34,560,000 hryvnias. After this amount is paid to the developer, all new space is transferred to the Municipal Fund. To free up the first floor for commercial use, the Fund conducts a non-cash asset swap, transferring four new apartments on the attic floor with a total value of 13,200,000 hryvnias to the four owners of the first-floor units, which fully compensates for their logistical inconveniences and eliminates the need for direct monetary compensation from the city budget. The Fund independently sells the remaining sixteen attic apartments, with a total area of 960 square meters, on the open market at a price of 55,000 hryvnias per square meter, generating gross housing revenue of 52,800,000 hryvnias. After deducting construction costs and the contractor's margin, the net housing surplus in the Fund's account amounts to 18,240,000 hryvnias.

The third component of the financial model is based on the commercialization of the vacated first floor. The four removed apartments are converted into 240 square meters of commercial space with high foot traffic, facing the street frontage. Modifying the load-bearing walls, creating separate entrances, and installing storefronts costs 4,000 hryvnias per square meter, totaling 960,000 hryvnias in investment for the repurposing. Due to their location on the main commercial axis, these spaces are leased at a rate of 550 hryvnias per square meter per month, generating 1,584,000 hryvnias in annual revenue. To immediately generate working capital, the Municipal Fund does not hold these assets on its balance sheet but capitalizes this income stream over a fifteen-year planning horizon using a conservative discount rate of 7 percent. This allows the commercial premises to be sold immediately to private investors as a ready-made rental business at the asset's localized market value of 14,420,000 hryvnias, instantly converting future rent into real liquidity.

The fourth component summarizes the program's consolidated balance sheet and clearly demonstrates the mechanics of cross-subsidization. The consolidated gross revenue of the Municipal Revolving Fund from capturing the value of the property consists of 52,800,000 hryvnias from the sale of residential attic spaces and 14,420,000 hryvnias from the capitalization of the commercial front, which together provides an inflow of 67,220,000 hryvnias. The total project costs include 8,630,000 hryvnias in net capital investments for the modernization of the building itself, 34,560,000 hryvnias for the construction of the superstructure, including the contractor’s margin, and 960,000 hryvnias for construction work on the first floor, totaling 44,150,000 hryvnias. Thus, after covering absolutely all expenses for the renovation and expansion of the pilot project, the Municipal Revolving Fund’s account retains a net surplus of 23,070,000 hryvnias. Since this surplus is accumulated by the municipal structure rather than by private individuals, it becomes a designated financial resource for fully covering the capital costs of renovating those intra-neighborhood buildings in the district that, due to their geographical location, lack their own commercial potential and the possibility of adding additional floors.

Table 3

Consolidated Financial Balance

Financial Indicator / Performance Metric	Value (UAH / %)	Operational Notes & Market Parameters
Gross Residential Revenue	52,800,000	Sale of 16 attic units (960 m2) with the rate of UAH 55,000/m2 (4 units swapped)
Gross Commercial Asset Capitalization	14,420,000	240 m2 active facade monetized over 15-year horizon with the rate of 7% discount rate
Total Generated Value-Capture Revenue	67,220,000	Combined liquid inflows into the Municipal Revolving Fund
Total Program Expenditures (Net CAPEX)	44,150,000	Combined structural, energy, superstructure, and commercial costs
Net Surplus Capital for Revolving Fund	23,070,000	Liquid profit retained on the municipal balance sheet

Private Developer ROI (Investor Perspective)	20%	UAH 5,760,000 margin against UAH 34,560,000 total superstructure volume
Annual Municipal Rental Income Potential	1,584,000	Alternative fund model: lease at UAH 550/m2/month instead of immediate sale
Cross-Subsidisation Ratio: "Minimal" Coverage	1 : 4.4	Generates baseline funding to modernize 4.4 interior-block buildings
Cross-Subsidisation Ratio: "Optimal" Coverage	1 : 2.9	Generates safety funding to modernize 2.9 secondary-frontage buildings

At this surplus level, each "Maximum" scenario building developed along Sotsmisto's primary commercial axis generates sufficient liquid capital to fully cross-subsidise either 4.4 interior-block buildings under the "Minimal" package, at a net renovation cost of UAH 5,200,000 per building, or 2.9 secondary-frontage buildings under the "Optimal" safety package, at a net renovation cost of UAH 7,800,000 per building. These ratios confirm that the investment delegation model maintains financial self-sufficiency at the district scale and advances systematic urban reconstruction without dependence on non-repayable public budget transfers, provided that the sequencing of "Maximum" scenario works on primary-axis buildings generates Revolving Fund capital ahead of, or concurrent with, "Minimal" and "Optimal" works in the cross-subsidized zones. Chapter 4 specifies the organizational and financial mechanisms that enforce this sequencing and govern capital flows between program tiers.

3. Vertical Extension: The "Flamingo" Independent-Frame System

The "Flamingo" system - P-shaped structural steel frames installed on independent foundations driven alongside but not connected to the existing building foundations, routes all superstructure loads directly to the ground through the new frame without transmitting additional loads to the existing 1-438 masonry. This structural independence eliminates the risk that superstructure construction imposes on existing residents: since the new foundations carry all new loads, the existing building's structural elements continue to operate at pre-construction load levels throughout the construction period and after completion. The frame columns rise alongside the building's external walls and connect at attic floor level via horizontal beams that form the structural platform for the new floors. A technical floor between the top of the existing building and the base of the superstructure conceals the structural transfer zone and accommodates the shared mechanical systems serving both old and new sections.

The “Flamingo” system generates an additional market value mechanism beyond the direct revenue from superstructure apartment sales. Upper-floor units equipped with lift access, the external glass lift shafts that the "Maximum" scenario installs serve both the existing building and the superstructure, and command a 20–25% price premium over comparable units in equivalent unmodernized buildings in the same district location. This premium reflects the combination of new construction quality, energy performance certification, lift access, and the upgraded building envelope visible from street level. The premium applies across all upper-floor units, including those in the existing building, raising the post-renovation market value of the entire building stock and supporting the capitalization assumptions in the Municipal Revolving Fund model.

4. Ground-Floor Commercialisation: Active facades

Ground-floor conversion to commercial premises activates what urban design literature terms “active facades”: street-facing building envelopes with transparent display windows, direct pedestrian access at grade, and commercial activity visible from the public realm. Active facades at ground level increase the perceived safety of street space by generating natural surveillance - occupied commercial premises attract pedestrian presence throughout the day, reducing the vacancy and visual neglect that make residential ground floors in deteriorating districts vulnerable to informal occupation and vandalism.

The mechanism for converting ground-floor apartments to commercial premises operates through a value-exchange transaction rather than compulsory acquisition. The developer offers ground-floor apartment owners an exchange: their existing unit, valued at market rate, against a new superstructure apartment of greater area and higher market value, equipped with lift access. The exchange eliminates cash compensation requirements from the Revolving Fund, the value differential between the existing and offered apartment constitutes the resident's compensation in kind, and produces a unified commercial ground-floor zone under single management, capable of attracting anchor tenants whose lease requirements exceed the area of any individual former apartment. Ground-floor retail, cafe, and service operations oriented toward district residents and commuters generate the rental income stream whose capitalised value contributes to the surplus calculation in the pilot financial model above.

The investor under the investment delegation model acquires ownership rights exclusively over the newly created spaces, superstructure apartments and commercial premises, while the existing building's primary structure remains under the collective ownership of the homeowners' association. The association receives a comprehensively modernised asset, priority management rights over the commercial premises upon lease renewal, and a share of commercial rental income designated for the building's ongoing maintenance reserve. This arrangement gives the association a direct financial stake in maintaining the commercial occupancy of the ground floor - aligning the association's incentives with the long-term revenue assumptions of the Municipal Revolving Fund model.

CHAPTER 4. ORGANIZATIONAL AND FINANCIAL IMPLEMENTATION MECHANISMS

Executing the Sotsmisto renovation strategy requires more than an engineering programme: it demands an organisational architecture that minimises social friction, sequences capital deployment to match construction logic, and distributes institutional roles among the municipality, private investors, housing associations, and international funding bodies in ways that each actor finds operationally viable. This chapter specifies the three interlocking components of that architecture: differentiated resettlement logistics, the financial instrument stack, and the public-private interaction model, and then subjects the whole to a systematic risk analysis that identifies the conditions under which the programme's self-financing assumptions hold and the contingency mechanisms that apply when they do not.

4.1 Differentiated Resettlement Strategies

Resident resistance driven by fear of eviction has historically constituted the primary operational barrier to comprehensive renovation in Ukrainian cities - not regulatory complexity, not financing shortfalls, but the unwillingness of residents to accept the physical displacement that standard construction practice requires. The Sotsmisto strategy addresses this barrier by differentiating resettlement logistics according to building structural type, producing two distinct operational models whose social friction profiles differ as fundamentally as the structural characteristics that determine them.

1. The Odesa Precedent: Resettlement as a Socio-Logistical Process

The analytical foundation for this differentiation draws on the documented experience of the initial Khrushchev-era housing reform in Ukraine, specifically the Cheryomushki residential complex in Odesa (Meerovich & Antonenko, 2018). The Odesa case supplies three operational lessons that the Sotsmisto model incorporates directly.

The first lesson concerns the pace of displacement. The Cheryomushki program demonstrated that wholesale simultaneous eviction, moving all residents of a building or block out at once, generates acute social stress, overloads the temporary housing supply, and produces the community hostility that stalls subsequent renovation phases. Phased, sequential displacement, by contrast, distributes disruption over time, allows social networks to reconstitute around the temporary accommodation arrangement, and maintains residents' sense of agency over the process.

The second lesson concerns the information environment. Resident resistance in the Odesa case concentrated disproportionately in the period before construction began, when information about the program's scope, timeline, and return conditions remained incomplete. Residents who received detailed, legally binding documentation of their return entitlements, specifying the exact address, floor, and apartment area to which they would return upon completion of the renovation, withdrew their opposition at rates substantially higher than those of residents who received only general assurances. The Sotsmisto model therefore treats legally formalized return agreements, signed before any displacement occurs, as a non-negotiable precondition for initiating works on any building in the 1-464 wave sequence.

The third lesson concerns the social geography of temporary accommodation. Residents displaced to locations outside their neighborhood, more than a walking distance from their habitual social infrastructure, reported significantly higher levels of distress and experienced significantly greater administrative friction than residents accommodated within or immediately adjacent to the renovation zone. This finding directly informs the spatial positioning of the rapid-assembly pilot building: it sits at the perimeter of the 1-464 cluster, within the same neighborhood, to maintain residents' access to the schools, clinics, and retail that constitute their daily urban environment throughout the displacement period.

2. Resettlement Model for the 1-438 Brick Series: Non-Eviction Renovation

The 1-438 series receives apartment-by-apartment renovation without resident displacement. The structural logic that makes this possible, longitudinal load-bearing walls confining all structurally significant elements to the external perimeter and internal longitudinal axes, allows all construction activity to proceed from the building's exterior without opening any inhabited floor to construction access. Insulation system installation, external lift shaft erection, utility riser replacement running in external chases, and superstructure frame erection via the "Flamingo" independent-frame system all execute without requiring residents to vacate.

The operational sequence within the non-eviction model divides works into three phases. The preparatory phase covers foundation reinforcement, external engineering riser installation, and roof structural preparation - works that generate construction noise and vibration but do not interrupt residents' access to utilities or dwelling interiors. The active envelope phase covers facade insulation installation, window replacement, and external lift shaft construction - works that require temporary scaffolding across the building's external face and involve brief interruptions to individual window openings during frame replacement, managed floor-by-floor on a three-to-five day access schedule agreed with each household in advance. The superstructure phase covers vertical extension construction above the existing roof line and ground-floor commercial conversion - works that produce overhead construction activity above the uppermost inhabited floor and ground-floor access disruption for the affected apartment owners, both managed through the asset-exchange mechanism described in Chapter 3.

Residents experience construction noise and temporary disruption to individual utility connections during riser work. They do not experience displacement, loss of neighborhood access, uncertainty about return conditions, or the social dislocation that temporary relocation generates. The social cost of the non-eviction model is therefore materially lower than that of any resettlement alternative, and the governance literature reviewed in Chapter 1 consistently identifies reducing this social cost as the single most effective determinant of community cooperation with renovation programs.

3. Resettlement Model for the 1-464 Panel Series: The Wave Method

The 1-464 series requires a complete resident evacuation for the deep structural interventions assigned to Phase 1 by the MRUB analysis: panel joint reinforcement, permeation grouting, and basement deepening for civil shelter construction. These works require access to the building's structural core at panel joint locations, ground-level excavation immediately adjacent to foundation pile heads, and basement floor-lowering operations that generate differential settlement risk incompatible with continued habitation. The evacuation requirement is structural, not administrative; it cannot be resolved through phasing or scheduling adjustments.

The wave method converts this unavoidable displacement from a crisis into a managed sequential logistics operation. The rapid-assembly pilot building, constructed at the cluster perimeter using the Mykolaichuka Street technology before the first wave of displacement begins, provides the temporary accommodation that makes sequenced displacement operationally viable without reliance on the broader municipal temporary housing stock - a stock that post-war demand pressures render insufficient for the additional burden that district-scale renovation would impose if the wave method were not available.

The operational sequence proceeds as follows. Residents of Building 1 receive legally formalized displacement agreements specifying temporary accommodation in the pilot building, a construction timeline of twelve to eighteen months, and binding return conditions for a modernized apartment with equivalent or greater floor area in the renovated Building 1. Upon execution of the agreement, residents of Building 1 transfer to the pilot building; renovation of Building 1 proceeds under the full "Optimal" or "Maximum" package. Upon completion, residents of Building 1 return; residents of Building 2 execute their displacement agreements and, in turn, transfer to the pilot building. The sequence advances through the cluster until all buildings have completed renovation, at which point the pilot building is converted to permanent municipal social housing stock under the 2026 Housing Policy Act.

4. Governance Architecture: Decentralised Co-Design

Managing the socio-logistical complexity of both resettlement models requires institutional arrangements that extend substantially beyond standard municipal project management. The governance analysis of Lowndes and Sullivan (2008), reviewed in Chapter 1, identifies the devolution of decision-making authority to neighborhood-scale entities as the mechanism that defuses the civic resistance consistently generated by top-down municipal orders. The Sotsmisto implementation model operationalizes this principle through three institutional instruments.

The first instrument is the Sub-District Renovation Council, established for each renovation cluster and comprising elected representatives of the buildings within the cluster, a municipality delegate, and a technical advisor appointed jointly by the municipality and the housing associations. The Council holds genuine co-design authority over the construction schedule, the temporary accommodation arrangements, the design of shared courtyard improvements, and the criteria for selecting commercial tenants at ground-floor level. Its decisions bind the municipality's project management unit on all matters within the Council's defined competence. This authority is real rather than consultative; its absence would replicate the pattern that both the London Assembly Planning Committee (2020) and the Neighborhood Council Review Commission (2007) identify as the primary driver of resident opposition to municipal relocation initiatives.

The second instrument is the legally formalized building renovation agreement, executed between the municipality, the housing association, and each individual apartment owner before any works commence on a given building. The agreement specifies construction scope, timeline, disruption mitigation obligations, return conditions for displaced residents, and the asset-exchange terms for ground-floor apartment owners. Its legal enforceability on both parties means the municipality commits to completing works on the specified schedule; the resident commits to permitting the access works required, thereby removing the information asymmetry that the Odesa case identified as the primary source of pre-construction resistance.

The third instrument is the community engagement protocol that the project management unit implements over the six months preceding construction mobilization for each building. The protocol covers public information sessions, site tours of completed buildings in the renovation sequence, individual household consultations on displacement arrangements, and the establishment of a dedicated complaints-resolution channel that responds within 48 hours. The protocol follows the communication pattern that KredEx program documentation identifies as the single most cost-effective investment in renovation program management: resident opposition that is constructed before the project begins costs multiples more to resolve than opposition that constructive engagement prevents.

4.2 Financial Instruments: Grant Funding and the Municipal Revolving Fund

The Sotsmisto strategy distinguishes structurally between two categories of financial instruments: non-repayable external grants that cover the non-revenue-generating components of renovation, and the self-replenishing Municipal Revolving Fund that channels the commercial surplus from "Maximum" scenario works toward the cross-subsidized tiers. These two categories do not compete; they operate in sequence and in complementarity, with grant funding covering the program's structural fiscal deficit while the Revolving Fund accumulates the capital required for district-wide replication.

1. Non-Repayable External Funding

EU Ukraine Facility grants cover the civil defense shelter construction component of the "Optimal" scenario in full, UAH 950,000 per building at the baseline parameters of the pilot financial model, without requiring revenue matching from program proceeds. The Facility's post-war reconstruction priority criteria explicitly include civil protection infrastructure, eliminating the commercial return requirement that would otherwise make shelter construction incompatible with private investment logic.

International technical assistance from EU advisory programs, bilateral development cooperation, and multilateral urban reconstruction platforms covers design development, structural condition assessment, energy audit costs, and project management capacity support during the program's initial phases. This assistance reduces the municipality's upfront capital commitment and builds the technical and institutional capacity that the program requires at scale: the contractor competency base, the energy audit certification infrastructure, and the cost estimation methodologies that enable subsequent renovation rounds to proceed with reduced consulting expenditure.

Targeted environmental and climate transition funds, including Green Climate Fund windows available to Ukraine under bilateral financing arrangements, cover utility network replacement and individual heating unit installation where these qualify as climate mitigation investments under the applicable fund criteria. Network replacement reduces ongoing methane leakage from aging gas infrastructure; autonomous boiler unit installation reduces thermal losses in centralized district heating and supports metering-enabled demand reduction, which constitutes a measurable climate contribution.

2. The Municipal Revolving Fund: Operational Mechanics

The Municipal Revolving Fund operates as a ring-fenced financial account separate from the general municipal budget, governed by a dedicated management board comprising municipal finance representatives, housing association delegates, and an independent fiscal monitor appointed by the Kyiv City Council. Ring-fencing prevents accumulated surplus from reversion to the general budget - the mechanism that has historically caused Ukrainian municipal investment programmes to dissipate their capital before reaching their stated objectives.

The Fund's replenishment sources divide into three streams. The primary stream is the net surplus generated by each "Maximum" scenario building: at the parameters of the pilot financial model in Chapter 3, UAH 23,070,000 per building. The secondary stream is the rental income generated by the pilot building's conversion to permanent municipal social housing upon completion of the renovation cycle - UAH 1,584,000–1,800,000 annually at market-comparable social housing rental rates for the Dniprovskyi district, providing a steady low-volatility income that supports the Fund's liquidity between "Maximum" scenario surplus events. The tertiary stream is contributions from housing associations' commercial space management income, designated at 15% of net rental revenue toward the building maintenance reserve that the Fund administers on behalf of the association.

The Fund's deployment logic follows a strict sequencing rule: "Maximum" scenario construction mobilisation on primary-axis buildings must generate the cross-subsidisation capital before "Minimal" scenario works begin on interior-block buildings dependent on that capital. This sequencing prevents the programme from committing expenditure on non-revenue-generating works before the revenue that covers them has materialised. The municipal project management unit enforces this sequencing through a capital commitment gate: "Minimal" and "Optimal" scenario works on cross-subsidised buildings receive construction contracts only after the Revolving

Fund account registers the completed "Maximum" scenario surplus transfer for the corresponding cluster.

The empirical basis for the Fund's financial architecture draws on Shi and colleagues' (2019) analysis of Shanghai's urban renewal fiscal failures. In Shanghai's early renewal phases, municipal governments assumed 100% of the financial burden for relocation, resettlement, and structural repair without transferring land-use rights or receiving land-transfer fees, creating multi-billion-yuan deficits that housing security budgets could not absorb. The Sotsmisto model avoids this fiscal trap by structuring the program so that private investment capital - mobilized through the investment delegation mechanism - bears the superstructure construction cost in exchange for commercial returns, and the municipality acts as regulator and guarantor rather than as primary capital provider. The component-based optimization framework of Petersen and Svendsen (2012) confirms the financial logic of this arrangement: property replacement rates below 1% annually concentrate the program's capital and carbon savings in the existing stock, while the CCE cross-subsidization arithmetic demonstrates that deep retrofitting with targeted vertical additions preserves structural assets and generates commercial surplus without exhausting the public budget.

4.3 Organizational Interaction Model: Investment Delegation

The investment delegation model, enshrined in the 2026 Housing Policy Act, resolves the structural complexity of public-private partnership arrangements that have historically prevented their deployment in Ukrainian housing renovation. Standard PPP frameworks require extensive ex-ante risk allocation negotiations, independent regulatory approval processes, and financial closure procedures that extend project preparation timelines by two to four years. The investment delegation model substitutes a streamlined bilateral agreement, between the municipality as regulator and guarantor and the developer as construction and commercial rights holder, for the full PPP apparatus, while preserving the accountability mechanisms that protect residents' ownership rights.

Under the investment delegation structure, the municipality grants the developer the right to construct additional floors and to use ground-floor premises for commercial purposes in exchange for the developer's legally binding commitment to execute comprehensive major repairs throughout the entire building to the specifications and timeline agreed in the building renovation agreement. The developer acquires ownership rights exclusively over the newly created spaces - superstructure apartments and commercial premises. The building's existing primary structure remains under the collective ownership of the homeowners' association; the municipality retains no ownership stake in the renovated asset. The association receives a comprehensively modernized building, priority management rights over the commercial premises upon lease renewal, and a maintenance reserve contribution stream from the commercial tenant income designated to the Revolving Fund.

This ownership architecture aligns each actor's incentives with the program's long-term objectives. The developer's commercial return depends entirely on completing the renovation to the specified standard: only a fully modernized building with functioning lift access, an energy-certified envelope, and completed commercial premises commands the market prices at which the financial model in Chapter 3 projects revenues from the superstructure apartment and commercial space. Any reduction in renovation scope directly reduces the developer's commercial asset value. The municipality's guarantee function: providing the construction permit and land-use rights that the developer requires - creates a credible commitment device without requiring the municipality to deploy capital it does not have. The homeowners' association's maintenance reserve contribution from commercial income creates a long-term fiscal stake in maintaining commercial occupancy, aligning the association's management incentives with the program's revenue sustainability assumptions.

1. The “Single Courtyard” Strategy: Shared Territorial Management

The renovation program addresses the fragmented ownership of inter-building spaces: a structural feature of Soviet-era microdistrict planning that assigned courtyard territories to individual building cadastral plots without accounting for the functional interdependence of shared green spaces, pedestrian routes, and utility corridors, through the “Single Courtyard” territorial consolidation strategy.

Rather than demarcating plot boundaries with physical fencing, the strategy merges the courtyard territories surrounding the cluster's renovation buildings into unified recreational and service zones, managed collectively by the cluster's housing associations or by a dedicated municipal landscape service. Consolidation eliminates the spatial fragmentation that prevents coherent landscape design: a shared 2,500–3,500 m² courtyard space accommodates standardized children's and sports facilities at scales that individual 400–600 m² plot allocations cannot support. The Sub-District Renovation Council holds co-design authority over the shared courtyard program, ensuring that facility placement responds to the documented preferences of the resident population rather than to a standardized municipal template.

Parking management converts existing detached garage clusters, the single-story masonry structures that occupy significant inter-block territory in Soviet-era microdistricts, into peripheral multi-story parking facilities or visitor surface lots at the neighborhood's vehicular access points. Removing through-vehicle traffic from the consolidated courtyard zones and designating them as pedestrian-priority spaces reduces the noise and safety conditions that drive outmigration of families with children - one of the demographic withdrawal patterns that the MRUB analysis identifies as an indirect social consequence of physical deterioration. Investor funds and municipal improvement grants finance the landscape works; the Revolving Fund covers the portion attributable to the public-realm improvement function, which directly supports the commercial value of ground-floor premises.

4.4 Risk Analysis: Financial and Social Risk Matrix

The program's self-financing logic rests on a set of market and institutional assumptions that carry measurable failure probabilities. The analysis below applies a standard probability × impact matrix to the primary financial and social risks, identifies the threshold conditions under which each risk materializes, and specifies the contingency mechanisms incorporated into the program design to manage each. (see Table 4)

Table 4

Financial and Social Risk Mitigation Matrix: Sotsmisto Renovation Program

Risk Description	Prob.	Impact	Critical Threshold Condition	Institutional Contingency Mechanism
1)Real estate market contraction (drop in superstructure apartment sales revenue)	Moderate	High	Market price falls 20%: UAH 55,000 → UAH 44,000/m². Gross residential revenue drops UAH 52.8M → UAH 42.2M. Net Revolving Fund surplus falls UAH 23.1M → UAH 12.5M. Cross-subsidisation ratio: 4.4 → 2.4 'Minimal' buildings per 'Maximum' cycle.	Pre-sales start gate: investment delegation agreement requires binding pre-sale commitments for ≥60% of superstructure apartments before construction mobilisation. Eliminates municipal exposure to post-construction price shifts.
2)Developer withdrawal after permit issuance, but before construction completion	Low	High	Breach of construction milestone deadlines defined in the building renovation agreement.	Performance bond: 15% of total superstructure construction value held by municipality as security. Covers completion via alternative contractor. Bond appears as a standard non-negotiable condition in the investment delegation agreement template.

3)Ground-floor commercial vacancy (lower capitalisation yields from ground-floor lease)	Moderate	Moderat e	Effective rental yield drops to 70%: UAH 550 → UAH 385/m²/month. Capitalised asset value falls UAH 14.4M → UAH 10.1M. Revolving Fund surplus reduced by UAH 4.3M.	Flexible tenant mix clause: if retail/food-service tenants fail to secure lease within 6 months of fit-out, agreement permits conversion of up to 50% of commercial area to professional services and co-working operators. Stabilises occupancy at lower volatility.
4)Resident refusal to execute displacement agreements for 1-464 wave method buildings	Moderate	Moderat e–High	Minority of apartment owners refuse displacement; municipality cannot legally proceed without unanimous owner consent. Wave method sequence stalls at the refusing building.	Two-stage mediation: (1) 60-day structured mediation by Sub-District Renovation Council with independent mediator; (2) if deadlocked, wave skips the building and returns after adjacent completed renovations shift local information conditions.
5)Construction cost inflation eroding renovation CAPEX estimates	High	Moderat e	Sustained inflation exceeds the built-in 15% contingency reserve (UAH 1,437,000 on net CAPEX of UAH 8,630,000). Cross-subsidisation margin erodes.	Annual recalibration gate: Revolving Fund board updates unit cost estimates before each construction contract. If cross-subsidisation ratio falls below 1:2.0, board freezes new 'Minimal' commitments and runs one additional 'Maximum' asset cycle.
6)EU Ukraine Facility grant eligibility criteria changing - loss of civil shelter funding	Low–Moderate	Moderat e	Shelter construction loses grant eligibility. UAH 950,000 reverts to Revolving Fund cost base, reducing net surplus by 4.1%: UAH 23.07M → UAH 22.12M.	Internal cost absorption: the 4.1% reduction does not materially affect cross-subsidisation ratios. Grant reduces burden but is not a structural dependency. Programme remains self-sustaining without it.

Note. Probability and impact ratings reflect qualitative assessment based on Ukrainian post-war construction market conditions, 2022–2025. Threshold conditions and contingency mechanisms operationalize the governance provisions of the 2026 Housing Policy Act and the Municipal Revolving Fund management mandate (Section 4.2). UAH figures correspond to the baseline parameters of the pilot financial model in Table 3.

The risk matrix confirms the program's financial self-sufficiency under all scenarios except a simultaneous severe market contraction (Risk 1, a 30%+ price decline) combined with sustained construction cost inflation exceeding the 15% contingency reserve (Risk 5). Under this combined stress scenario, the program requires a temporary bridge loan facility - pre-negotiated with a Ukrainian state bank under the 2026 Housing Policy Act's municipal infrastructure financing provisions - that the Revolving Fund services from future "Maximum" scenario surpluses. This bridge facility serves as the program's backstop rather than its primary financing mechanism; it is activated only under macroeconomic stress that would simultaneously impair virtually all private investment in the construction sector.

CONCLUSIONS

The study of the three-tier renovation model for the Sotsmisto neighbourhood in Kyiv's Dniprovskyi district allows us to draw the following managerial, financial, and institutional conclusions.

1. The model is self-financing - conditionally

The central question of this study was whether a district-scale renovation programme can finance itself without structural dependence on municipal budget transfers. The answer is yes, but only under one condition: sequencing. A single "Maximum" scenario building on a primary commercial thoroughfare generates UAH 23,070,000 in net surplus for the Municipal Revolving Fund after all construction and developer costs. That surplus is sufficient to fully cover the "Minimal" renovation package for 4.4 interior-block buildings, or the "Optimal" package for 2.9 secondary-frontage buildings. EU Ukraine Facility grants cover civil shelter construction - UAH 950,000 per building - entirely outside the cross-subsidisation loop.

The sequencing rule is non-negotiable: "Maximum" scenario buildings must generate Revolving Fund capital before "Minimal" scenario contracts are signed. Reversing this order collapses the financial architecture. We recommend embedding this requirement as a formal capital commitment gate in the Municipal Revolving Fund's operating mandate.

2. Hypothesis 1 confirmed: value capture covers cross-subsidisation

The first hypothesis - that attic storey construction and ground-floor commercialisation generate sufficient revenue to cover lifts and shelter installation for buildings unable to self-finance - is confirmed by the pilot financial model. Gross value-capture revenue from a single primary-axis 1-438 building totals UAH 67,220,000. After deducting all programme expenditures of UAH 44,150,000, the net surplus of UAH 23,070,000 covers the lift component alone (UAH 1,400,000 per two shafts) for sixteen interior-block buildings. Underground shelters fall outside the cross-subsidisation mechanism entirely, covered by EU grant.

Under stress conditions - a 20% collapse in Kyiv residential prices to UAH 44,000/m² - the surplus compresses to UAH 12,510,000 and the cross-subsidisation ratio falls from 4.4 to 2.4 "Minimal" buildings per "Maximum" cycle. The programme remains self-sustaining. We consider Hypothesis 1 fully confirmed under both baseline and adverse market conditions.

3. Hypothesis 2 confirmed conceptually; quantitative confirmation requires implementation monitoring

The second hypothesis - that differentiating resettlement logistics by building type reduces social friction compared to standard displacement - is confirmed structurally and comparatively, but not yet numerically.

For the 1-438 brick series, non-eviction renovation is not a policy preference but a structural inevitability: the longitudinal load-bearing wall configuration confines all works to the building's exterior. The Drewitz case (Busà, 2024) documents what this looks like at scale - 60–70% heating demand reductions with no wholesale evacuation.

For the 1-464 panel series, temporary displacement is equally inevitable: panel joint reinforcement and basement deepening require structural core access. The wave method converts unavoidable disruption into a managed sequence. Three lessons from the Odesa Cheryomushki precedent define what makes it work: phased rather than simultaneous displacement, legally formalised return agreements signed before anyone moves, and the pilot building located within the neighbourhood boundaries. None of these is complicated. All of them are non-negotiable.

The quantitative cost comparison between the wave method and standard displacement cannot be completed without implementation monitoring data. We recommend establishing this comparison as the primary performance indicator for the programme's first operational phase.

4. Hypothesis 3 confirmed: converting the pilot building to social housing is the optimal outcome

The third hypothesis - that converting the rapid-assembly pilot building to permanent municipal social housing produces better long-term budgetary returns than any alternative - is confirmed by net present value analysis.

At social rental rates of UAH 1,584,000–1,800,000 annually, discounted over fifteen years at 7%, the pilot building's asset value as permanent social housing reaches UAH 14,000,000–15,800,000. Demolition and land remediation generate zero. Equivalent new social housing construction (1,200 m² at UAH 24,000/m²) demands UAH 28,800,000 in capital expenditure before developer margin. The pilot building converts to a long-term municipal asset at no additional capital cost. That is not a close comparison.

In accordance with the Housing Policy Act of 14 February 2026, we recommend transferring the pilot building to municipal social housing stock upon completion of the renovation cycle. The city acquires a capital asset for long-term rental to veterans returning from front-line service, young professionals priced out of Kyiv's post-war market, and displaced persons awaiting stable accommodation - without additional expenditure on new construction.

5. Limitations of the study

Four constraints on the conclusions should be acknowledged.

The financial model draws on Kyiv market data from 2024–2025 - a wartime dataset that may not represent the post-war conditions under which the programme will predominantly operate. Cross-subsidisation ratios require recalibration against actual construction tenders before any cluster commits to expenditure.

The MRUB wear level estimates use district-level technical inspection data, not individual building-level structural assessments for each building in Sotsmisto. The prioritisation sequence is a reliable planning parameter. It is not a substitute for building-specific condition surveys before Phase 1 contracts are signed.

The cost comparison between the wave method and standard displacement remains qualitative. The procedural logic is supplied by the Odesa Cheryomushki precedent; the cost data will emerge from implementation monitoring of the programme itself.

The cross-subsidisation ratios are calibrated to Kyiv's property market. Cities such as Zaporizhzhia and Kherson may see residential prices 40–60% lower than the pilot model assumes. The model does not travel to secondary cities without city-specific recalibration.

6. Directions for further research

We identify four priority directions. City-specific financial calibration for Zaporizhzhia, Kherson, Mykolaiv, and Chernihiv - to establish the minimum residential sale price and commercial rental rate at which the cross-subsidisation arithmetic holds without supplementary grant funding. This is computational, not theoretical work, and it would make the Sotsmisto model directly applicable rather than aspirationally transferable. A longitudinal social impact study tracking 1-464 residents through the full renovation cycle - wellbeing indicators, social network preservation, one-year and three-year return rates - compared against a control group displaced through standard municipal procedures. This would confirm or quantify the social cost reduction claimed by Hypothesis 2.

A dedicated carbon lifecycle assessment applying Power's (2008) methodology to the specific material and energy parameters of the 1-438 and 1-464 series. This would produce the carbon reduction verification that climate finance mechanisms require before committing funding to renovation programmes of this type. An examination of whether the investment delegation mechanism - commercial rights conditional on verified comprehensive repair - can operate under the property law frameworks of Georgia, Moldova, or the Baltic states that still carry Soviet-era panel stock. The renovation challenge is similar across the region; whether the mechanism transfers requires legal analysis this study did not undertake. The most practically valuable contribution, however, will come from implementing the programme and measuring what actually happens: construction costs against model estimates, resident agreement execution rates, Revolving Fund surplus accumulation, post-renovation market value uplift. That monitoring dataset transforms what this thesis proposes into what the field can verify. The model is well-grounded and internally consistent. That is where analysis stops and implementation begins.

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Appendix A

Programme for Comprehensive Reconstruction of Deteriorated Housing Stock: Dniprovskyi District Extract

ПРОГРАМА КОМПЛЕКСНОЇ РЕКОНСТРУКЦІЇ
КВАРТАЛІВ (МІКРОРАЙОНІВ) ЗАСТАРІЛОГО ЖИТЛОВОГО ФОНДУ

№ п/п	Шифр кварталу (мікро-району)	Межі кварталу (мікрорайону)	Примітки
43.	Др-15	Бортничі: вул. Є.Харченка, вул. Нижній Вал, вул. І.Дяченка, 2-й провулок Чехова	
44.	Др-16	Бортничі: вул. І.Дяченка, вул. Борова, вул. Івана Богуна, вул. Є.Харченка,	
45.		окремо розташовані будівлі уздовж вул. Російської, вул. Ялтинської, пров. Поліського, вул. Зрошувальної, вул. Славгородської, вул. Тростянецької, вул. Горлівської, вул. Світлої, вул. Колекторної, вул. Заплавної (Бортничі)	
		Деснянський район	
46.	Дс-1	просп. Лісовий, вул. Мілютенка, вул. Шолом-Алейхема, вул. Братиславська	
47.	Дс-2	просп. Лісовий, вул. Кубанської України, вул. Шолом-Алейхема, вул. Мілютенка	
48.	Дс-3	вул. Шолом-Алейхема, вул. Мілютенка, вул. Кіото, вул. Братиславська	
49.	Дс-4	вул. Шолом-Алейхема, вул. Кубанської України, вул. М.Матеюка, вул. Мілютенка	
50.	Дс-5	вул. Космонавта Волкова, просп. Лісовий, вул. Кубанської України	
51.	Дс-6	Биківня: вул. Радистів (непарна сторона)	
52.	Дс-7	Биківня: вул. Радистів (парна сторона)	
53.		окремо розташовані будівлі в сел. Биківня: уздовж просп. Броварського, вул. Г.Косинки	
		Дніпровський район	
54.	Дн-1	вул. Попудренка, вул. Будівельників, вул. Червоноткацька, пров. Будівельників	матеріали інвентаризації відсутні
55.	Дн-2	вул. Попудренка, вул. Бажова, вул. Краківська, вул. Будівельників	матеріали інвентаризації відсутні
56.	Дн-3	вул. Бажова, вул. Червоноткацька, вул. Будівельників, вул. Краківська	матеріали інвентаризації відсутні
57.	Дн-4	вул. Попудренка, бульв. Праці, вул. Краківська, вул. Бажова	матеріали інвентаризації відсутні
58.	Дн-5	вул. Краківська, бульв. Праці, вул. Червоноткацька, вул. Бажова	
59.	Дн-6	вул. Попудренка, вул. Пожарського, вул. Краківська, бульв. Праці	матеріали інвентаризації відсутні
60.	Дн-7	вул. Краківська, вул. Пожарського, вул.Червоноткацька, бул. Праці	матеріали інвентаризації відсутні
61.	Дн-8	вул. Попудренка, вул. Г.Хоткевича, вул. Червоноткацька, вул. Мініна	
62.	Дн-9	вул. Червоноткацька, вул. Будівельників, бульв. Верховної Ради, промисловий майданчик Київського метрополітену	матеріали інвентаризації відсутні
63.	Дн-10	вул. Червоноткацька, вул. Бажова, бульв. Верховної Ради, вул. Будівельників	матеріали інвентаризації відсутні
64.	Дн-11	вул. Червоноткацька, вул. Пожарського, бульв. Верховної Ради, вул. Бажова	матеріали інвентаризації відсутні
65.	Дн-12	вул. Червоноткацька, вул. Ю.Поправки, бульв. Верховної Ради, вул. Пожарського	
66.	Дн-13	бульв. Верховної Ради, просп. Ю.Гагаріна, вул. Будівельників	

№ п/п	Шифр кварталу (мікро-району)	Межі кварталу (мікрорайону)	Примітки
67.	Дн-14	Пр.-т. Ю.Гагаріна, пров. Карельський, вул. І.Сергієнка, вул. П.Усенка	
68.	Дн-15	просп. Ю.Гагаріна, вул. П.Усенка, вул. І.Сергієнка, вул. В.Сосюри	
69.	Дн-16	вул. Будівельників, вул. Г.Чупринки, просп. Миру	
70.	Дн-17	вул. Будівельників, просп. Ю.Гагаріна, просп. Миру, вул. Г.Чупринки	
71.	Дн-18	вул. Тампере, просп. Соборності, вул. Вифлеємська	
72.	Дн-19	просп. Миру, просп. Соборності, вул. Тампере	
73.	Дн-20	просп. Соборності, Харківське шосе, вул. Березнева, вул. Каунаська, вул. Регенераторна	
74.	Дн-21	Харківське шосе, вул. Празька, пров. Устима Кармелюка, вул. Лохвицька	
75.	Дн-22	22-1 – вул. Астраханська, вул. Празька; 22-2 – вул. Гродненська, вул. Празька, вул. Азербайджанська	
76.	Дн-23	бульв. Дарницький (непарна сторона)	
77.	Дн-24	вул. Миропільська, вул. О.Бойченка, вул. Юності, вул. Міста Шалетт	
78.	Дн-25	вул. Воскресенська, бульв. Перова, просп. Алішера Навої	
79.	Дн-26	просп. Алішера Навої, бульв. Перова, вул. П.Запорожця, територія Київської міської клінічної лікарні № 3	
80.	Дн-27	вул. С.Стальского, вул. Курнатовського, вул. П.Запорожця, бульв. Перова	
81.	Дн-28	вул. С.Стальского, бульв. Перова, вул. П.Запорожця, вул. Старосільська	
82.	Дн-29	вул. Е.Вільде, вул. Генерала Карбишева, вул. І.Микитенка, вул. Курнатовського	
83.	Дн-30	вул. Братиславська, вул. Генерала Карбишева, територія Навчально-наукового інституту № 2 по підготовці слідчих та криміналістів МВС України в м. Києві	
84.	Дн-31	вул. М.Кибальчича, вул. Генерала Карбишева, вул. Е.Вільде, вул. Курнатовського	
85.	Дн-32	вул. М.Кибальчича, вул. Курнатовського, вул. І.Микитенка, бульв. Перова	
86.	Дн-33	вул. М.Кибальчича, бульв. Перова, вул. Пухівська, вул. В.Сєрова	
87.	Дн-34	вул. Алматинська, вул. Олекси Довбуша, вул. Марганецька, вул. Рогозівська	
88.	Дн-35	вул. Алматинська, залізничні колії, вул. Олекси Довбуша	
89.		окремо розташовані будівлі уздовж вул. Алматинської, вул. В.Вишиваного, вул. Хорольської, вул. Двінської, вул. Воскресенської	
		Оболонський район	
90.	О-1	вул. Вишгородська, вул. Полярна, вул. Автозаводська, пров. Автозаводський (8,38 га)	
91.	О-2	вул. Вишгородська, пров. Автозаводський, вул. Автозаводська, вул. Берестецька (10,07 га)	

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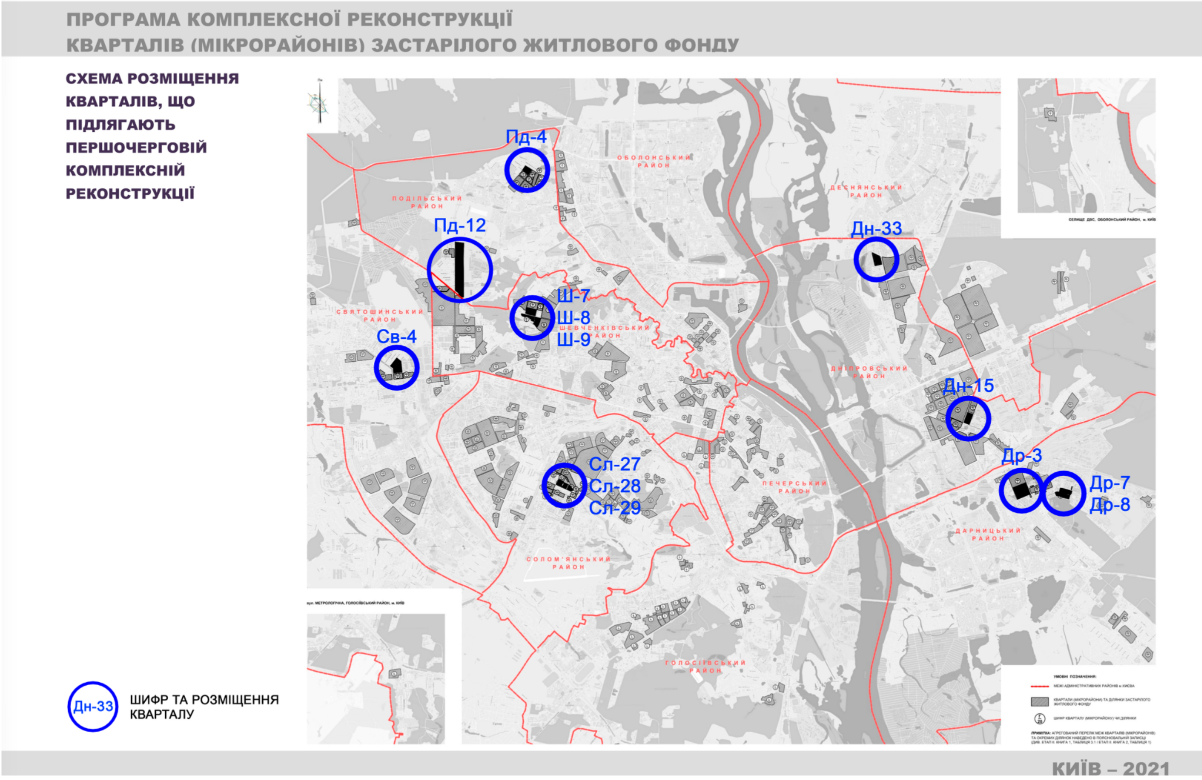

ПРОГРАМА КОМПЛЕКСНОЇ РЕКОНСТРУКЦІЇ
КВАРТАЛІВ (МІКРОРАЙОНІВ) ЗАСТАРІЛОГО ЖИТЛОВОГО ФОНДУ

КВАРТАЛИ, ЩО ПІДЛЯГАЮТЬ ПЕРШОЧЕРГОВІЙ РЕКОНСТРУКЦІЇ

КВАРТАЛ Дн-15.
ПРОСП. Ю.ГАГАРІНА, ВУЛ. П.УСЕНКА, ВУЛ. І.СЕРГІЄНКА, ВУЛ. В.СОСЮРИ

ОСНОВНІ ХАРАКТЕРИСТИКИ ІСНУЮЧОЇ ЗАБУДОВИ

№ п/п	Адреса	Кількість поверхів, шт.	Кількість квартир, шт.	Загальна площа квартир, м2	Чисельність населення, осіб
	Житловий фонд, віднесений до застарілого				
1	просп. Ю.Гагаріна, 4А	3	24	1828.08	67
2	просп. Ю.Гагаріна, 8А	3	24	1919.67	71
3	просп. Ю.Гагаріна, 8Б	3	24	1855.23	74
4	вул. Сергієнка, 3А	3	24	1851.02	62
5	просп. Ю.Гагаріна, 4	3	24	1466.86	55
6	просп. Ю.Гагаріна, 6	3	19	1127.92	64
7	просп. Ю.Гагаріна, 8	3	24	1453.46	57
8	просп.Гагаріна Юрія, 2/35	5	165	9161.90	469
9	просп.Гагаріна Юрія, 10 / 2	5	68	3944.27	190
10	вул. Усенка, 4	5	112	2603.60	342
	Всього		508	27212.01	1451
	Житловий фонд, не віднесений до застарілого				
1	вул. Івана Серпієнка, 1	6	88	4887.00	233
	Всього		88	4887.00	233
	Всього по кварталу		**596**	**32099.01**	**1684**

ОСНОВНІ ТЕХНІКО-ЕКОНОМІЧНІ ПОКАЗНИКИ (ОРІЄНТОВНІ)

№ п/п	Назва показника	Одиниця виміру	Значення	
			Існуючий стан	Проектні пропозиції
1	Площа території кварталу	га	5.85	5.85
2	Площа житлової території кварталу	га	4.61	4,22
3	Загальна площа квартир	м2	32099.01	63796.77
	в т.ч. застарілий житловий фонд	м2	27212.01	
4	Загальна вбудованих нежитлових приміщень	осіб		2400
5	Чисельність населення	осіб	1684	2834
6	Щільність населення	осіб/га	288	484
7	Щільність житлового фонду	м2/га	5487	10905
8	Житловий фонд, що підлягає знесенню	м2		11502.24
9	Житловий фонд, що підлягає реконструкції	м2		15709.77
10	Орієнтовні обсяги нового будівництва	м2		45600.00

Примітки:
1. Передбачено розміщення окремо розташованого закладу дошкільної освіти на 120 місць;
2. Щільність населення перевищує нормативну для мікрорайону (450 осіб/га), у зв'язку з відсутністю повного переліку об'єктів повсякденного рівня обслуговування населення

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Figure 1. *Blocks designated for comprehensive reconstruction in the Dniprovskyi district, Kyiv*

Note. Fragment of the official district zoning map. Source: Kyiv City State Administration (2021).

02 Cost of Conserved Energy (CCE) Methodology

THEORETICAL BASIS · PETERSEN & SVENDSEN (2012)

— Determines the real capital cost to conserve 1 Gcal via physical retrofitting vs. purchasing 1 Gcal from the centralized utility network.

— When CCE falls below the district heating tariff, retrofitting generates net positive returns — the intervention becomes financially self-liquidating.

$$CCE = \text{Annualized Capital Expenditure (UAH)} \div \text{Annual Energy Savings (Gcal)}$$

Where annuity factor (Capital Recovery Factor α) is derived as:

$$\alpha = r \div [1 - (1 + r)^{(-n)}]$$

r = discount rate · n = amortization horizon in years

— Application: Proves that "Minimal" insulation packages on interior-block buildings shift from sunken municipal social costs into financially self-liquidating assets — a precondition for the Revolving Fund cross-subsidisation logic.

Figure 2. Cost of Conserved Energy (CCE) Methodology

03 CCE Empirical Calculation & Grid Parity

Parameter	Value	Context
Total Thermal CAPEX	UAH 2,400,000	Mineral wool facade + window upgrade
Operational lifespan (n)	20 years	Standard wet-facade amortization horizon
Municipal discount rate (r)	7.0%	Applied to public infrastructure projects
Capital Recovery Factor (α)	0.09439	Derived from 20-year cycle parameters
Annualized Capital Expenditure	UAH 226,536	Fixed nominal weight per annum
Annual energy savings	190 Gcal/yr	50% reduction on 380 Gcal/yr baseline
CCE (output)	UAH 1,192.30	Annualized CAPEX ÷ Gcal saved
Grid heating tariff	UAH 1,654.41	Current municipal network rate

CONCLUSION: CCE (UAH 1,192.30) < Grid Tariff (UAH 1,654.41)
Net saving = UAH 461.11 per Gcal · 28% efficiency margin · absolute economic feasibility confirmed.

Figure 3. CCE Empirical Calculation & Grid Parity

04 Municipal Revolving Fund Indicators — Maximum Scenario

Financial Indicator	Value	Operational Notes
Gross residential revenue	UAH 52,800,000	16 attic units × 960 m² @ UAH 55,000/m² (4 units swapped)
Gross commercial capitalisation	UAH 14,420,000	240 m² ground floor monetised over 15 yr @ 7% discount
Total value-capture revenue	UAH 67,220,000	Combined liquid inflows to municipal balance sheet
Total intervention CAPEX	UAH 44,150,000	Structural, energy, elevator, commercial re-engineering
Net retained surplus	UAH 23,070,000	Liquid profit for cross-subsidisation of non-revenue blocks
Private developer ROI	16.67%	UAH 5,760,000 return on UAH 34,560,000 total volume
"Minimal" subsidy ratio	1 : 4.4	1 Maximum building fully funds 4.4 interior-block buildings
"Optimal" subsidy ratio	1 : 2.9	1 Maximum building fully funds 2.9 secondary-frontage buildings

Figure 4. Municipal Revolving Fund Indicators - Maximum Scenario

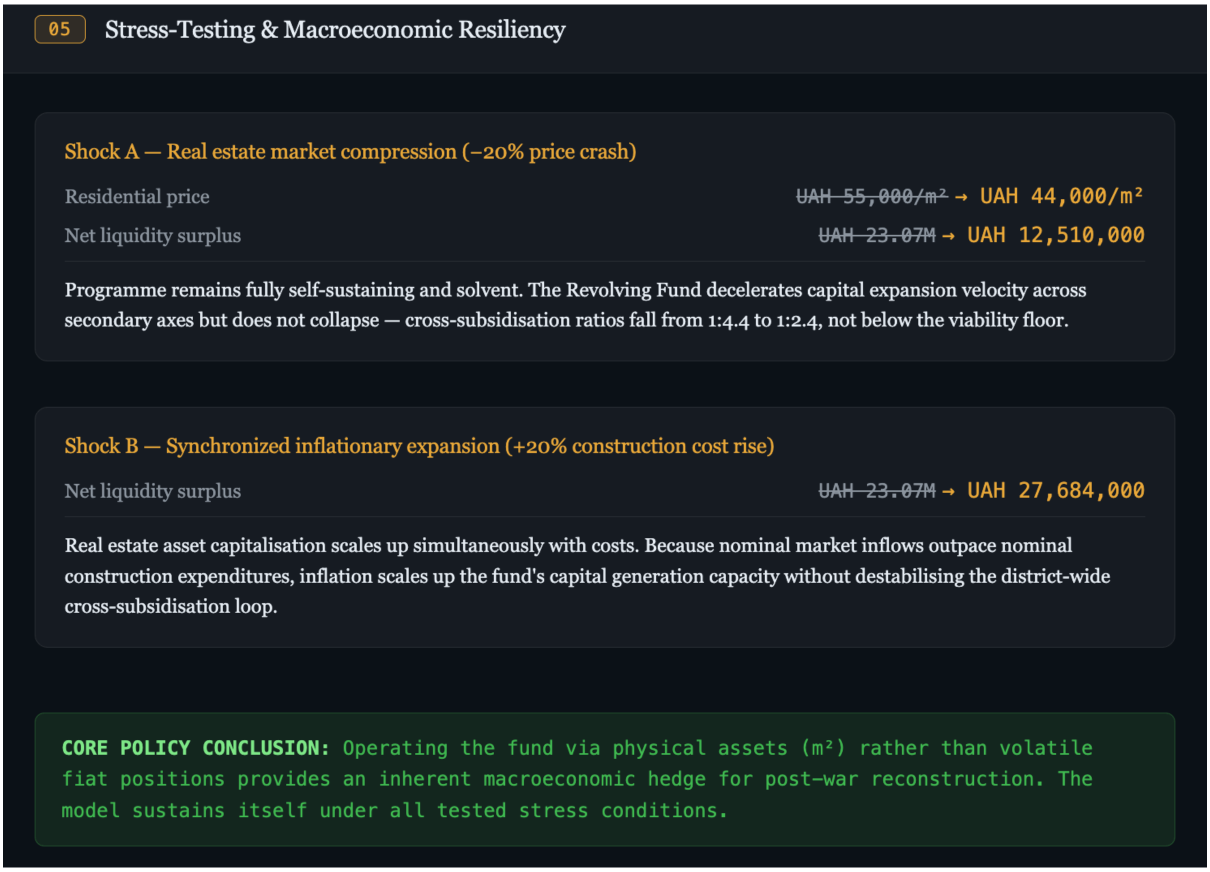

Figure 5. Macroeconomic Resiliency