Accelerating the Fuel Switch in Multi-Family Houses: Business Models, Public Sector Roles, and the Geneva Approach

Comprehensive Economic Report

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RENOWAVE
DECARBONIZATION OF THE BUILDINGSTOCK

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Executive Summary

This report examines institutional and **economic pathways for accelerating the transition from fossil to renewable heating** systems in Swiss **multi-family buildings** (aka multi-family houses MFH). Building on earlier analytical work within Renowave 3.2, this report focuses on translating ecosystem-level insights into **concrete institutional design**, financing structures, and risk-allocation mechanisms, drawing on the experience gained through SIG's operational pilot projects and the ongoing discussions in **Geneva on the Municipal Foundation** implementation expected to begin in 2026.

The decarbonization of space heating in multifamily housing (MFH) constitutes one of the most **consequential and complex components of the energy transition in Switzerland**. MFHs account for a large share of residential heat demand, emissions, and capital stock, particularly in urban areas. While regulatory tightening and climate targets increasingly mandate a shift away from fossil heating systems, the **pace of fuel switching in MFHs has remained slow** relative to technical potential and policy ambition. This report examines the **structural reasons** for this gap and analyzes **institutional pathways** capable of accelerating the transition at scale.

The examination consistently finds that the MFH fuel-switch market is **not merely constrained by isolated financing gaps or information deficits**. Rather, it is structurally impaired. **High upfront investment costs, fragmented ownership and decision rights, landlord-tenant incentive misalignment, technical and regulatory complexity, and elevated project-specific risks** interact in a way that systematically suppresses private market activity. These frictions are reinforced by the related issues of limited standardization, thin contractor markets for large-scale heat pump solutions, and **uncertainty around long-term system performance and operating costs**. Taken together, these features **prevent the emergence of a self-sustaining market**, even where individual projects may appear economically viable ex post.

At the same time, a realistic assessment must acknowledge that **fuel switching in MFHs is inherently costly, and that it cannot be assumed to be privately attractive for all building owners** even in the absence of the subtler ecosystem frictions discussed above.

Against this background, the report argues that **a purely incremental adjustment of existing advisory instruments, innovative financing instruments, or subsidy schemes is unlikely to unlock the required scale of investment**. Instead, the analysis suggests that **some form of public sector orchestration** is likely unavoidable if MFH decarbonization is to proceed at the speed implied by climate and energy policy objectives. Orchestration in this context does not imply blanket public ownership or indiscriminate spending, but rather the targeted assumption, coordination, and redistribution of risks that private actors are structurally ill-equipped to bear on their own.

The report develops this argument through the examination of institutional design options, with particular emphasis on contracting-based business models. These models reallocate investment, performance, and price risks away from individual building owners and toward specialized entities with the capacity to manage them. However, earlier work has confirmed that **contracting does not emerge spontaneously in MFH markets**. High transaction costs, long contract durations, capital intensity, and tariff uncertainty deter private providers, especially in the absence of a sufficiently large and standardized project pipeline.

The Geneva case, centered on the role of Services Industriels de Genève (SIG), is analyzed as a concrete response to these challenges. **The Geneva/SIG model demonstrates how a publicly anchored actor can function as co-orchestrator alongside selected engineering firms**: performing territorial energy planning, standardizing technical solutions, mobilizing capital at favorable conditions, and providing performance guarantees that materially reduce perceived risks for building owners. Importantly, the model does not crowd out private actors but reconfigures their role: **SIG orients the market context while engineering firms (as project coordinators) and installers operate as partners within a coordinated value chain**. Two elements are considered essential: **performance assurance**, and **shared governance** through non-profit structures with **full transparency** toward building owners and the public. This means, while the public utility has a strong role in this model, the **emphasis on competitive market participant involvement and on broad information sharing** introduces pragmatic, liberal elements aiming at efficiency and transparency in implementation and learning. The Municipal Foundation model as described has not yet been implemented; practical roll-out is expected in the course of 2026.

The report finds that this **model is not a one-off institutional anomaly, but a replicable template**. Its core elements – public risk absorption, standardized contracting, centralized expertise, and long-term operational responsibility – address structural market failures that are common across Swiss cantons and comparable jurisdictions. At the same time, replication cannot be mechanical: Differences in building stock, heat network availability, administrative capacity, political preferences, and fiscal space imply that any transfer of the Geneva approach **must be adapted to regional realities**. The report therefore proposes a differentiated decision framework, outlining, besides a high-level policy decision tool (in Section 6.1), **three stylized pathways ranging from fully integrated public contracting (Case A) to lighter facilitation and guarantee-based models (Cases B and C) in Section 6.5**.

Finally, the report introduces **Renewable Heat-as-a-Public-Service (HaaPS)** as an interpretative lens for understanding why, **under binding decarbonization constraints and limited individual agency, stronger public delivery roles may be economically coherent** without constituting a prescriptive policy model.[1]

In parallel, energy-system related questions of large-scale electrification of MFH heating have been addressed. **Preliminary simulations for scenario-based analysis suggest that electrification via heat pumps remains defensible under a wide range of plausible future electricity price, grid, and supply conditions**. While uncertainties remain – particularly regarding marginal electricity generation – the results do not support the view that these risks justify delaying or abandoning electrification in MFHs. Instead, they underline the importance of complementary measures, including demand-side flexibility, system-level coordination, and ongoing monitoring.

Overall, the report concludes that **accelerating MFH fuel switching requires moving beyond a narrow focus on individual investment decisions**. What is at stake is the construction of a functioning ecosystem – technical, financial, and institutional – capable of delivering standardized, low-risk solutions at scale. **Public actors have a critical role to play in this process, not as universal financiers, but as orchestrators** that enable markets to function where they otherwise would not.

[1] The companion presentation Renewable Heat-as-a-Public-Service (HaaPS) (Habermacher 2026) provides additional detail on the HaaPS concept as well as more detailed descriptions of the three stylized cantonal implementation Cases A – C.

Contents

1. Introduction and Problem Statement

Decarbonizing heat in multi-family buildings (MFH) is one of the central challenges of Swiss climate and energy policy, particularly in urban areas. Beyond its climate relevance, the scale of the required transformation makes it a major fiscal and institutional issue for cities, cantons, and public utilities. Recent policy decisions illustrate this magnitude: the City of Zurich has proposed a framework credit of CHF 2.3 billion to expand district heating coverage to 60 percent by 2040,[2] while in Geneva the expansion of the reseau thermique structurant (RTS) from roughly 10 percent to 55 percent coverage of overall building heat demand by 2050 is estimated to require around CHF 1.5 billion in investment for the first phase (30% coverage) up to 2030, under direct responsibility of SIG. Against this backdrop, the fuel switch in MFH is not only a technological challenge, but a question of governance, financing, and risk allocation at scale.

1.1 The Challenge: Decarbonizing Heat in Multi-Family Buildings

Climate relevance of the building stock
Buildings account for a substantial share of Switzerland's final energy consumption and CO_2 emissions, with space heating and hot water dominating residential energy use. Achieving national and cantonal net-zero targets therefore requires a deep transformation of the existing building stock.

Why MFH are particularly challenging
Compared to single-family houses, MFH face structurally higher complexity:

- split incentives between owners and tenants,
- fragmented ownership and decision-making,
- higher technical and planning complexity,
- larger investment volumes per project.

These features raise transaction costs and perceived risks, slowing adoption even where technologies are technically mature.

Implementation gap
Current renovation and fuel-switch rates in MFH remain starkly below what would be required to align with long-term climate targets. This gap is not primarily driven by a lack of available technologies *per se*, but by informational, institutional, economic, and organizational barriers.

1.2 Renowave 3.2: Scope and Contribution

Renowave 3.2 focuses on innovative business models and governance arrangements to accelerate the deployment of renewable heat solutions in MFH, with particular attention to public–private interaction, risk allocation, and implementation capacity.

Project scope and collaboration
The work was carried out by HSLU and ZHAW in close collaboration with SIG Geneva as a practice partner. This setup allowed the research to be informed by ongoing policy development and concrete implementation constraints.

Relation to prior work
An earlier peer-reviewed publication emerging from Renowave 3.2 (Zapata et al., 2024, led by

[2] See e.g. NZZ 2025.

ZHAW) provides a systematic analysis of barriers to heat-pump adoption in multi-family buildings and examines contracting models from an ecosystem perspective.
The present HSLU report complements this work by focusing on the subsequent phase: the design and implementation of concrete governance, contractual, and financing arrangements under real-world constraints, informed by close collaboration with SIG Geneva.

Structure of the report
Following this introduction, the report reviews emerging solution types, analyses the Geneva case as a detailed example, discusses open issues and trade-offs in institutional design, and concludes with implications for policy and further work.

In terms of decision tooling, Section 6.1 includes a Box with an explicit, high-level and policy feasibility-based decision flow logic (decision tree). Section 6.5 includes illustrations for three canonical implementation possibilities for Cantons of very diverse ambitions or possibilities for support of the MFH energy transition (presented in more detail in the complementary presentation Habermacher 2026: *Renewable Heat-as-a-Public-Service (HaaPS)*).

Finally, the report briefly proposes Renewable Heat-as-a-Public-Service (HaaPS) as an interpretative lens for understanding why, under certain political and economic conditions, stronger public involvement in MFH heat decarbonization may be economically coherent.

1.3 Note on Methodology and Scope

This report follows an iterative, practice-oriented research approach. Several elements evolved alongside policy developments and implementation experience in Geneva. In particular, exploratory electricity system modeling was developed as a complementary analysis and remains highly preliminary to date. The report should be read as a working paper grounded in real-world implementation, aimed at informing policy and institutional design rather than providing closed-form optimization results.

2. The Economic Rationale for Public Intervention

Why should public actors involve themselves in the market for building heat decarbonization? This section develops the economic foundations for understanding both the market failures present in this domain and the limits of what public intervention can reasonably achieve. A clear assessment of these economics helps design interventions that are both effective and proportionate.

2.1 Structural Market Failures in the MFH Fuel-Switch Market

This section refers to fuel-switch in urban zones or buildings difficult to connect to district heating networks: In urban areas, there is widespread deployment of district heating (DH) systems. However, due to issues relating to the quantity of existing renewable sources, energy density, and topology, a number of neighborhoods will not be accessible by DH. MFHs therefore require individual solutions, and the main technical solution will be air-water heat pumps. It is this type of fuel switch is discussed in this chapter.

The market for heat pump installations in multi-family houses exhibits several market imperfections that, taken together, help explain why renovation rates may remain low even in cases with broadly favorable economics and policy support.

2.1.1 Information Gaps and Asymmetries

Building owners contemplating a fuel switch in a multi-family house face a complex information problem. This is not a single asymmetry, but a combination of information gaps and asymmetric information that operate at different stages of the decision and implementation process. Some affect owners and suppliers alike, while others systematically disadvantage owners in assessing quality, risk, and performance.

First, there is a fundamental information gap at the decision stage on the owner side. For most building owners, replacing a fossil heating system with a renewable alternative in an MFH is not something they have done once or twice before – it is typically something they have never done at all. Unlike routine maintenance or even standard boiler replacement, the MFH fuel switch remains relatively rare and highly specific. As a result, owners often lack even basic orientation: which technologies are feasible, which constraints matter in practice, and what a realistic project pathway looks like. Interview evidence from Swiss market participants indicates that “house owners are not aware that heat pumps can be a good solution for MFHs” and that “there is a lot of uncertainty regarding the technology which might delay their decision process” (Zapata et al., 2024). A particularly persistent belief is that heat pumps may work for single-family houses but not for larger buildings – an assessment that is increasingly outdated, yet continues to shape expectations and delay action. This is therefore not merely a case of owners knowing less than experts, but of owners lacking reliable reference points altogether.

Second, there are information and capability gaps on the supply side, reflecting an immature market rather than a simple owner–contractor asymmetry. Most heating technicians and planners are experienced with single-family installations or with conventional boiler replacements, where systems are relatively standardized and project complexity is limited. MFH fuel-switch projects, by contrast, involve higher technical complexity, tighter spatial and acoustic constraints, and more coordination across trades and planning stages. As one interviewee noted, in larger buildings “the installers can no longer do the whole work by themselves.” This creates a situation in which even willing owners may struggle to identify actors with relevant experience, while potential suppliers may underestimate the scope, risks, and coordination requirements of MFH fuel switches. The issue here is not strategic withholding of information, but missing specialization and fragmented knowledge across the market as a whole.

Third, these gaps are reinforced by genuine asymmetric information linked to the credence-good nature of MFH fuel switching. Building owners cannot reliably distinguish ex ante between high- and low-quality MFH solutions, nor can they verify ex post whether observed performance reflects good design and execution or merely favorable conditions. If a system underperforms, owners typically cannot determine whether the cause lies in poor design, incorrect sizing, installation quality, occupant behavior, or external factors such as weather. Providers, by contrast, have far more information about design choices, risk margins, and long-term performance implications. This weak observability makes it difficult for quality to be rewarded through market mechanisms, dampening incentives for contractors to invest in MFH-specific expertise and slowing learning, specialization, and standardization over time.

Taken together, these overlapping information gaps and asymmetries undermine both demand formation and supply-side capability development. They help explain why MFH fuel switching lags behind its technical potential, even where the underlying technologies are viable.

2.1.2 High Transaction Costs and Fragmentation

A related structural feature of the market is the unusually high transaction cost of making any single MFH project happen. A well-functioning market would require: building owners who understand their options and can articulate their needs; engineers who can design appropriate systems for complex buildings; installers with experience in large-scale heat pump hydraulics; financiers who understand the risk profile of these investments; and a regulatory environment that is predictable across cantons. In Switzerland today, each of these elements is present only partially or unevenly.

The result is a fragmented value chain in which assembling the necessary capabilities for one project requires substantial coordination effort – effort that must be repeated largely from scratch for each subsequent project because no stable, standardized processes have emerged. As one interviewee put it: “Those who have the know-how may not have the human resources to take part in this contracting, the whole contractual, that is, all the hassle that is required with financing and so on. And those who cover this part well usually do not have the technical know-how.” (Zapata et al. 2024, Table 3)

2.1.3 Coordination Failures and the Missing Ecosystem

Beyond information problems and transaction costs, the MFH heat-pump market exhibits a coordination failure: it barely exists as a functioning ecosystem. This is distinct from the information problems discussed above – the issue is not merely that actors lack information, but that the complementary capabilities, standardized processes, and accumulated experience that would make a market function smoothly have not yet developed.

This is a chicken-and-egg problem. Contractors do not invest in MFH capabilities because there is insufficient demand; owners do not demand MFH solutions because capable contractors are scarce. Breaking this cycle requires some actor to absorb the initial coordination costs and risks – a role that private actors have limited incentive to play.

A particularly telling symptom of this incompleteness is the weak emergence of market-based contracting models for MFH heat pumps. Energy supply contracting – where a specialized company finances, installs, owns, and operates a heating system, selling heat rather than equipment to building owners – is well established in other contexts and, in principle, addresses several of the barriers identified above: it reduces upfront capital requirements for building owners, shifts technical and performance risk to actors better equipped to manage it, and aligns incentives by linking revenues to actual heat delivery. Yet such contracting models have not taken hold for heat pumps in Swiss multi-family houses in a context where incentives for fuel switching exist.

Several structural factors contribute to this outcome. First, MFH contracting involves high transaction costs for project development, contract negotiation, and long-term relationship management – costs that are manageable in large industrial settings but difficult to amortize at the level of individual buildings. Second, the model requires sophisticated technical, financial, and risk-management capabilities that go well beyond traditional heating installation and that only a limited number of actors currently possess. Third, contracting requires access to long-term capital at conditions that make the solution economically viable, combined with the ability to absorb performance and demand risks over extended periods.

In this context, market participants consistently point to public-oriented organizations as the main providers – or potential providers – of energy supply contracting. As one interviewee summarized: "Energy supply contracting is a capital-intensive business model. Public organizations have in general easy access to capital at good conditions, unlike private companies, which makes the competition for the latter very hard" (Zapata et al., 2024). This assessment recurs across interviews and reflects a shared perception of where the financial and organizational capacities required for MFH contracting are currently concentrated

Taken together, the observations above point to a set of structural conditions that shape the emergence of contracting models in the MFH context. High transaction costs for project development and contracting, incomplete information and credence-good characteristics that complicate quality assessment, and the concentration of long-term performance and demand risks at the project level all raise the threshold for private entry. In this light, the absence of a robust private contracting market appears less contingent on the presence of public actors in specific regions than on the underlying economics of MFH contracting itself.

2.1.4 Split Incentives and External Effects

The split-incentive problem – with nuances

The landlord-tenant dilemma is frequently cited as a barrier to energy efficiency investments in rental housing, and it does capture a genuine economic problem. In its simplest form: the landlord pays for capital improvements, but the tenant pays the energy bills, creating systematic underinvestment in efficiency.

However, the Swiss institutional context introduces important nuances. Swiss tenancy law allows landlords to pass through a portion of renovation costs to tenants through rent increases – a mechanism specifically designed to address the split-incentive problem. The Swiss Federal Office for Housing (BWO/OFL Bundesamt für Wohnungswesen) has expressed skepticism about whether a landlord-tenant dilemma exists in the traditional sense, precisely because existing rules can make renovations financially attractive for landlords.[3] That said, the practical application varies significantly across cantons. In Geneva, for example, the rules governing cost pass-through to rents are notably bureaucratic and tend to be unfavorable to property owners. An alternative pathway exists, however: investment costs for heat pumps can be passed through via heating charges rather than rent, but only if the arrangement is structured as a contracting model (where a third party

[3] "Due to the tax benefits that the owner can, in many cases, derive from the work carried out, which are not passed on to the tenant, this often results in a positive balance that benefits the landlord. As a result, it seems difficult to speak of a dilemma." (BWO 2013).

owns and operates the heating system). This creates an additional structural incentive favoring contracting-based approaches in contexts like Geneva.

Overall, the reality is more complex than either the simple dilemma or its simple solution would suggest. Depending on the specific circumstances of the building, the landlord, and the contemplated renovation, Swiss law can create incentives that are too weak (the classic underinvestment problem), roughly appropriate, or actually too strong (leading to renovations that benefit landlords at tenants' expense). What results is not a uniform bias but rather a systematic miscalibration – sometimes in one direction, sometimes in the other – that depends on factors varying across situations. Most fundamentally, the difficulty of getting incentives systematically right is the missing direct 1:1 link between the owners' incentives and the combined cost of fuel and CO2 emissions, which any indirect, technocratic rule set (what costs can be passed through under what conditions) is unlikely to ever replicate perfectly.

This has an implication for policy design: simple interventions aimed at "solving" the split-incentive problem may help in some cases while making things worse in others. The heterogeneity of situations calls for either highly tailored interventions or, alternatively, interventions that address barriers common across situations regardless of the landlord-tenant configuration.[4]

External effects: climate and local pollution

The climate externality is the most straightforward market failure. Building heating in Switzerland accounts for a substantial share of CO2 emissions; these emissions impose costs on society that may not be sufficiently reflected in the private costs of fossil fuel heating; and therefore the market produces more fossil heating and less renewable heating than would be socially optimal. This is a standard case for intervention – either through carbon pricing to internalize the externality or through direct support for low-carbon alternatives. While there is a carbon tax on fossil heating fuel (currently 120 CHF/tCO2e), this value may be too low relative to the global climate cost of carbon emissions[5] – or relative to the ambition of phasing out building emissions within the coming decades. In addition, split incentives often inhibit carbon pricing from exerting its full theoretical incentive effect in the building sector.

What deserves additional attention is the local pollution externality. Combustion of heating oil and natural gas produces not only CO2 but also local air pollutants including particulate matter and nitrogen oxides. These impose health costs on local populations – costs that are more significant in dense urban environments. Unlike CO2, whose climate impact is global and independent of where emissions occur, local pollution effects depend on where combustion takes place. Replacing a gas boiler in a dense urban neighborhood thus produces local benefits beyond climate protection. Based on ecoplan (2022) and Schleiniger (2016), Habermacher (2022) argues that, when translated into a per-carbon unit value, this benefit could be in the order of 20–40 CHF/tCO2e for Switzerland on average, and potentially much higher in a dense city like Geneva.

For policy purposes, this strengthens the case for geographically targeted interventions in urban areas and suggests that the social value of fuel switching may be higher than carbon accounting alone would indicate.

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[4] This has been addressed in more detail in the report Habermacher (2022) "Economie du développement du marché PAC bâtiments collectifs non-rénovés (edmPAC)" for SIG.

[5] Economic estimates of the social cost of carbon vary widely, with very many estimates much above 120 CHF/ tCO_2e, but also some equally prominent estimates being below. For some discussion of how subtle modelling assumptions like the ever-controversial discount rate can severely impact the economic estimates, see, e.g., Feddersen et al. 2015.

In today's geopolitical context, it may also be seen as a significant upside of renewable energy supply that dependencies on – and support of – undemocratic foreign regimes via usual fossil fuel trade patterns can be reduced. The dependence on foreign suppliers for PV modules may be seen as a lesser of two issues.[6]

2.1.5 Summary: Why the Market Does Not Self-Correct

The MFH fuel-switch market exhibits multiple, mutually reinforcing imperfections: information gaps and asymmetries on both buyer and seller sides; high transaction costs and fragmentation; coordination failures that prevent a functioning ecosystem (including a private contracting sector) from emerging; split incentives that are real but institutionally nuanced; and external effects from both climate and local pollution.

This multiplicity has a clear implication for policy. Interventions that address only one barrier – for example, subsidies that reduce upfront costs, or information campaigns that educate building owners – may have limited effect if other barriers remain binding. Effective policy will likely need to address multiple failures simultaneously, which helps explain why comprehensive approaches like the Geneva model (discussed in Section 5) have emerged as a promising path forward.

At the same time, not every aspect of slow renovation rates reflects market failure. As the next section argues, an exclusive focus on market imperfections risks overlooking cases where slow uptake reflects more fundamental economic burdens rather than remediable failures.

2.2 Fuel-Switch Decisions at the Individual and Project Level: A Differentiated View

The previous section identified structural market failures. However, not everything that slows fuel-switch or renovation rates is straightforwardly a market failure. At the level of individual building owners and specific renovation projects, this section develops a more differentiated view – one that distinguishes remediable frictions from situations in which renovation may be economically unattractive even in a well-functioning market, and where inertia can therefore be rational from the viewpoint of prevailing policy and price conditions, including existing carbon pricing.

2.2.1 Financing in Context: When It Matters — and When It Does Not

A natural starting point for thinking about low renovation rates is financing: perhaps building owners want to renovate but cannot access the necessary capital. This framing has intuitive appeal – upfront costs for heat pump installations in multi-family houses are substantial, typically CHF 3000–4000 per kW, which for a medium-sized building can reach several hundred thousand francs.

Survey evidence from Renowave 3.1 provides perspective on how owners themselves rank barriers. Among single-family house owners planning energy renovations, 56% rated access to financing as a significant challenge – just below the 57% who cited technical and structural complexity as a major challenge. For multi-family house owners, access to financing was rated as significant by only 44%, while technical complexity (64%) and the difficulty of passing costs to tenants (65%) ranked higher (Drometer et al., 2023). That the difficulty of passing costs to tenants appears to be a particularly

[6] Even if the substitution with renewable electricity currently increases another dependence on foreign markets supplying PV panels in particular, solar panels, once purchased, guarantee 20 years of independence, in contrast to a fossil fuel-based installation whose operation requires a relatively continuous stream of imports. In the medium-term it would be possible to produce PV panels in new locations, in contrast to fossil fuels whose deposits are concentrated in a limited range of major fossil fuel producing countries.

severe and the most complex burden is suggested also by the experience of SIG in Geneva, according to discussants.[7]

This pattern suggests that financing matters, but is one barrier among several rather than the dominant constraint. The survey also found heterogeneous situations among those planning renovations: roughly one-third could finance from their own resources, one-third had applied for external financing (with mixed outcomes), and one-third had not yet addressed the financing question at all.

This heterogeneity is central for policy design. For some owners, financing access is genuinely the constraint that prevents renovation. The survey suggests this may be particularly true for younger owners (aged 31–40 showed both higher rejection rates and stronger interest in financing support) and for properties already highly leveraged (17% of surveyed properties had loan-to-value ratios between 67% and 80%, where additional borrowing becomes more difficult, see Drometer et al., 2023).

For other owners, financing availability is not the binding constraint. Institutional investors and professional property managers regularly finance investments of comparable scale and have established relationships with financial institutions. If they are not renovating, other factors are more likely responsible. Similarly, for owners who can finance from their own resources, the question is not whether they can finance but whether they want to.

In short, better access to finance can be decisive for a subset of owners, but it does not address the majority of reasons why projects stall. This distinction matters because it anticipates why financial instruments, even well-designed ones, tend to have limited transformative power at the scale required. Section 2.3 examines these limits in more detail.

2.2.2 Genuine High Costs and Risk Exposure

A less comfortable but important observation is that, for some buildings, energy renovations and fuel switching can be genuinely expensive relative to their benefits, even when energy savings, carbon costs, and available subsidies are taken into account. In these cases, the binding constraint is not primarily a market failure but high real costs – again understood as net opportunity costs under the prevailing policy and price environment, including existing carbon pricing: aging building stock with structural constraints, limited space or acoustic requirements, the need for customized engineering solutions, and high labor costs in Switzerland. At the same time, energy prices – despite carbon taxation – often remain low enough for fossil heating to remain privately competitive in many situations.

Evidence from Renowave 3.1 is consistent with this interpretation. Among owners planning renovations, roughly half cited “insufficient financial return” as a significant challenge (51% for single-family houses, 53% for multi-family houses). Among owners not planning any measures, this share rose to 62%, making it the most frequently cited barrier in that group. These responses suggest that a substantial share of owners may be reacting rationally to economic signals rather than being held back primarily by informational barriers, financing frictions, or institutional obstacles (Drometer et al., 2023).

One implication is that even under idealized conditions – perfect information, fully internalized externalities, and frictionless access to finance – some buildings would still not be renovated or fuel-

[7] It is noteworthy that not all cantons have similarly restrictive regulations or handling of cost pass-through to tenants, and Geneva is one of the cantons standing out for restrictive rules in that regard.

switched because their private costs exceed their private benefits. Depending on the social valuation of avoided emissions and other external benefits, some of these cases may also remain difficult to justify even from a social perspective once standard market failures are accounted for. These cases are difficult to address through incentive-based policies alone: inducing renovation tends to require high subsidy levels that imply large transfers relative to the efficiency gains achieved.

At the same time, not all policy support targets these “non-moving” buildings. For a subset of projects that do occur, support can accelerate decisions or shift choices that would otherwise be delayed or implemented differently. In such infra-marginal cases, subsidies do not correct a market failure in a narrow efficiency sense and partly function as transfers. These transfers may nevertheless find some justification on distributional grounds (smoothing burdens across owner types) or strategic grounds, such as – subsidy implementation details permitting – accelerating learning effects, building supply-side capacity, reducing coordination risk, or sustaining political support for a rapid decarbonization pathway.

From a first-best perspective, if society has made a firm commitment to decarbonize the building stock within a relatively short time horizon, stronger carbon pricing in the heating sector would be the most direct and economically coherent instrument to align private incentives with societal objectives. In practice, however, substantial increases in carbon prices for heating fuels appear politically difficult in the near term.

Against this background, the reliance on second-best instruments – such as targeted subsidies, guarantees, public contracting, or hybrid public–private models – should not be interpreted as a denial of underlying cost realities (or as a simple *distortion of incentives* economically speaking). Rather, these instruments reflect a pragmatic response to a setting in which some decarbonization measures are genuinely costly, first-best pricing instruments are constrained, and policy nevertheless aims for a rapid and comprehensive transition.

2.2.3 Transaction Costs and Information Burdens at Owner Level

While Section 2.1 discussed information problems and transaction costs as structural features of an immature market, this subsection focuses on how these frictions are experienced at the level of individual building owners, in the form of time, coordination, and cognitive burdens that can remain substantial even where financing conditions and expected financial returns would, in principle, allow for an economically justifiable retrofit.

Undertaking an MFH renovation requires the owner to: assess the building’s current state; identify technically feasible options; obtain and compare quotes from contractors (who may have limited MFH experience); navigate cantonal subsidy programs with varying requirements; coordinate with tenants; arrange financing; manage construction; and – maybe most importantly, given the relative rarity of projects – handle complications. Each step involves time, effort, and uncertainty.

For a professional property manager, these can be streamlined, and the costs absorbed into normal operations. For a private individual who owns one or two rental properties as a retirement investment, the cumulative burden may be substantial relative to their capacity, time, and interest. This suggests that owners with greater capacity to manage transaction costs – such as those with professional support or relevant experience – may face fewer barriers, independent of financing access.

2.2.4 Interim Synthesis: Why Inaction Can Be Rational

Taken together, the project-level barriers in MFH renovations are heterogeneous. Financing is sometimes genuinely binding, but often not. In many cases the decisive constraints are high real costs, asymmetric risk, and the cumulative burden of planning, coordination, and uncertainty. In addition, ownership situations and decision processes are diverse: multi-family buildings are owned by pension funds, insurance companies, professional property companies, private individuals in all types of personal and financial situations, cooperatives, and condominium associations – each facing different constraints. A condominium association may struggle to reach agreement among owners with divergent interests. An elderly private owner may rationally prefer not to undertake a 20-year investment, reflecting personal preferences for simplicity and flexibility as well as the external framework conditions (e.g. limited carbon prices, see above). An heir may lack both interest and knowledge to manage a major renovation. Renowave 3.1 found that uncertainty about future use of the property was a significant barrier for 24% of owners planning measures – and for 51% of those not planning any measures (Drometer et al. 2023/Renowave 3.1).

These are not prototypical market failures. They reflect the reality of a heterogeneous ownership landscape and help explain why aggregate renovation rates remain low even when average economics look favorable.

This differentiated view also helps explain why isolated policy instruments tend to underperform. Even well-designed financing improvements will primarily affect the subset of owners for whom financing is genuinely the binding constraint, while having limited influence on owners whose barriers lie elsewhere. As a result, the aggregate impact of such instruments remains constrained, despite their relevance in specific cases. The following section therefore examines more closely why financial instruments alone – while valuable – are rarely sufficient to induce renovation at the scale required.

2.3 The Limited Power of Financial Instruments Alone

The previous section established that financing constraints, while real for some owners, are often not the dominant barrier to renovation decisions. This section examines more closely why financial instruments alone – at least in the incremental forms currently deployed in practice – tend to have limited transformative power, and what role they can realistically play within a broader policy approach. The focus is deliberately on moderate instruments such as interest rebates, preferential loans, and guarantees, often considered as light policy options, rather than on hypothetical scenarios involving, e.g., near-complete public cost coverage.

2.3.1 The Magnitude of Interest Rate Effects

A useful starting point is to consider the quantitative effect of improved financing terms. From a purely actuarial perspective, credit risk on Swiss renovation loans is typically low. Estimates for single-family housing renovation loans suggest default probabilities on the order of 0.2–0.4%, with loss-given-default of roughly 2–4% (Cakir; Renowave 3.1), implying an actuarially fair expected-loss component of roughly 0.1% of loan volume. For such cases, Renowave 3.1 concludes that this component is small and that its elimination alone is unlikely to materially affect loan uptake.[8]

[8] It should be noted that Renowave 3.1 focuses on single-family housing, where risks are low and standardized. Energetic renovation projects in multi-family buildings (Renowave 3.2) can involve higher overall project risk, due to lacking technical maturity. However, this difference matters more for implementation and coordination and implications for who exactly finances the renovation and who is responsible for delivery, but it does not, by itself, mean the credit worthiness of large building owners for renovations is incomparably worse than that of SFH owners, and it therefore does not turn suggest incremental interest-rate reductions become a decisive lever.

In practice, market spreads will often be higher. They reflect not only expected losses but also liquidity considerations, administrative costs, capital charges, profit margins, and marketing strategies. Multiple market data points revealed during Renowave Pillar 3 works provide contextual indications of how such effects can still be notable. For example, an Ethos survey of institutional investors found required spreads of approximately 0.4% above cantonal bonds even if cantonal guarantees remove credit risk for technically complex and novel energy-renovation projects in Geneva (Ethos 2024), suggesting that factors beyond expected default losses influence pricing. Similarly, several Swiss banks offer interest-rate reductions of roughly 0.3–0.8% on "sustainable" mortgage products (Bezzola-Buechler, working paper) even without explicit guarantees, highlighting how interest rates can depend on additional functions such as serving as a promotional tool or part of broader sustainability strategies rather than merely reflecting basic risk-based pricing.

Regardless of whether one takes a purely actuarial view or a market-based view, the effect of modest spread reductions remains limited relative to total project cost. By way of illustration, for a renovation costing CHF 300'000 and financed over 15 years, eliminating a 0.3% spread would reduce annual financing costs by roughly CHF 480 on average – each year around 0.15% of total project cost, summing to around 2.2% over the loan lifetime.[9]

Interest-rate reductions are sometimes viewed as fiscally inexpensive instruments. From an economic perspective, however, this is largely a matter of accounting: a lower interest rate constitutes an implicit subsidy equal to the present value of foregone interest payments. When rate reductions are modest, the associated subsidy is modest as well, and so is its economic magnitude.

While such reductions are not negligible in absolute terms, they are typically insufficient to be transformative for projects whose private economics are dominated by upfront cost, the total amount to be repaid, complexity, or uncertainty. Accordingly, taken in isolation and at realistic magnitudes, interest-rate effects tend to have limited leverage in most renovation decision contexts.

This arithmetic helps explain a core finding from Renowave 3.1: a guarantee that merely reduces the expected-loss component reflected in interest rates – without addressing project costs, implementation complexity, or coordination requirements – will typically have only limited influence on renovation decisions.

2.3.2 Evidence from Practice: Schwyz and Similar Programs

The canton of Schwyz provides instructive evidence on the real-world impact of favorable financing. The Schwyzer Kantonalbank (SZKB), supported by the cantonal guarantee fund, offers a "Handschlag-Hypothek" for energy renovations with notably attractive terms: simplified application procedures, no formal property valuation in most cases, 0% interest in the first year and 0.5% thereafter, and streamlined approval processes. The maximum loan amount is CHF 75'000 with maturities of up to ten years (SZKB 2024; Bürgschaftsfonds Kt. Schwyz 2024).

If access to financing were the binding constraint, such a product might be expected to generate substantial uptake. In practice, uptake has been modest: in 2024, 22 loans totaling CHF 866'000 were issued (Bürgschaftsfonds Kt. Schwyz 2024). This is not evidence of failure – it is possible that

[9] With linear amortization, the outstanding balance declines from CHF 300'000 to zero over 15 years. Interest savings of 0.3% on a declining balance yield total savings of approximately CHF 7200 over the loan's lifetime, or CHF 480 per year on average. Of the total undiscounted project cost including financing, of at least approximately 324'000 over the lifetime, the interest discount corresponds to 0.15% annually or 2.2% in total over the lifetime, a magnitude almost guaranteed to not making a pivotal difference in nearly all potential projects.

the program has enabled renovations that would otherwise not have occurred – but it does not indicate the release of large pent-up demand.

The modest uptake admits at least two interpretations. One interpretation is that the product's design still excludes a subset of owners for whom equity constraints are binding: as a mortgage-based instrument, it requires collateral and typically a 20% equity contribution. For owners who could service loan payments but lack sufficient equity, an unsecured variant ("Handschlag-Kredit") might in principle reach additional projects, albeit at the cost of higher risk exposure for the guarantee fund (Bezzola-Buechler, working paper).

An alternative interpretation is that access to financing and the precise terms of credit are simply not the primary constraint for most potential renovators. Even a comparatively generous special program – offering interest conditions more favorable than what would result from a mere elimination of the risk premium – has struggled to trigger a large number of otherwise unrealized renovation projects. In this reading, the limited uptake reflects the dominance of other barriers rather than shortcomings of the financing instrument itself.

For multi-family buildings, the Renowave 3.1 survey likewise does not suggest that financing conditions dominate perceived barriers: access to financing is considered important by a substantial share of MFH owners, but is ranked below technical and organizational complexity, difficulties in cost pass-through to rents, and concerns about overall project profitability (Drometer et al. 2023 / Renowave 3.1).

Other "sustainable mortgage" products show similar patterns. The SZKB's fixed-rate mortgage with sustainability bonus offers interest-rate reductions of up to 0.3%. For a typical renovation loan, this translates into modest absolute savings and is unlikely to influence decisions in most cases. Similarly, analysis of ZKB's environmental loan suggests that even a relatively generous 0.8% interest discount yields total savings of only about CHF 2000 over a five-year, CHF 50'000 loan – less if the loan amortizes rapidly.

Taken together, these cases illustrate not the ineffectiveness of favorable financing per se, but the limited behavioral impact of even very attractive credit terms when other constraints remain unchanged. These include equity requirements, project complexity and basic costs, coordination effort, and the level of operating-cost savings, including those driven by fuel prices and carbon taxes. A nuanced interpretation is that such products may well enable a subset of otherwise unrealized projects, but that this subset remains small relative to overall renovation needs.

2.3.3 What Investors Require: Evidence from the Ethos Survey

The preceding considerations capture why slightly improved financing terms often have limited effect on owners' willingness to bear the costs of renovation. A complementary perspective emerges from the capital-supply side and is particularly relevant for firms or organizations offering energy renovation solutions to building owners.

In late 2024, the foundation Ethos surveyed institutional investors on their willingness to finance energy infrastructure in Geneva. With a cantonal guarantee, investors reported median required spreads of roughly 0.4% above cantonal bond yields, likely reflecting mainly liquidity premium rather than credit risk (Ethos 2024).

Without a guarantee, the picture changes sharply. More than half of respondents expressed no interest in unguaranteed instruments. Those remaining required spreads around 1.2–1.4%, alongside extensive due-diligence requirements concerning governance structures, project management, and lending practices. These requirements imply not only higher financing costs but also substantially higher transaction costs and organizational demands.

The implication is that guarantees matter less as marginal cost reducers than as market-access enablers. While the difference in annual financing costs between guaranteed and non-guaranteed instruments is meaningful, the more important effect is that without guarantees, large pools of institutional capital simply remain unavailable. Guarantees determine whether a market exists at all, not merely the price at which capital is supplied.

This also suggests that guarantees can have effects that go well beyond the mere actuarial value of the (often limited) expected losses they may ultimately absorb.

2.3.4 The Hierarchy Principle and Its Limits

The view that interest rate reductions may be a preferable, low-cost intervention to be favored over heavier solutions such as explicit subsidies is consistent with a broader proportionality logic in Swiss administrative practice. Information and advisory measures should be considered before financial interventions. Where financial instruments are used, the logic favors less fiscally intensive instruments – such as guarantees or repayable loans – where these are sufficient to achieve the policy objective, reserving a-fonds-perdu contributions for cases where other instruments are inadequate. This understanding is consistent with the Federal Council's message on the Subventions Act (Botschaft zum SuG, 1986).

This hierarchy reflects sound fiscal logic. A guarantee that is never called imposes no direct budgetary cost beyond administration. A loan recovers its principal over time, with the subsidy limited to any interest concession. A grant represents immediate and irreversible expenditure.

However, this hierarchy is conditional and requires nuanced application. Administrative costs can invert it in practice, particularly for small projects. More fundamentally, the hierarchy assumes that the weaker instrument can actually achieve the policy objective. If renovation costs exceed perceived private benefits, cheaper or more accessible financing will not induce investment. In such cases, guarantees are not mainly a low-cost substitute for subsidies, but an ineffective one.

Interest-free loans are also not fiscally neutral: their implicit subsidy equals the foregone return on public capital and is economically equivalent to a grant of the same present value.

Finally, where public benefits exceed private benefits, subsidies need not correspond to a net social loss. In the context of climate mitigation and reduced fuel dependence, they can be understood as contributions to a public good. Even in such cases, lean instruments may remain preferable where effective, but the need for broader intervention should not be viewed as a failure of policy design.

2.3.5 Synthesis: What Financial Instruments Can and Cannot Accomplish

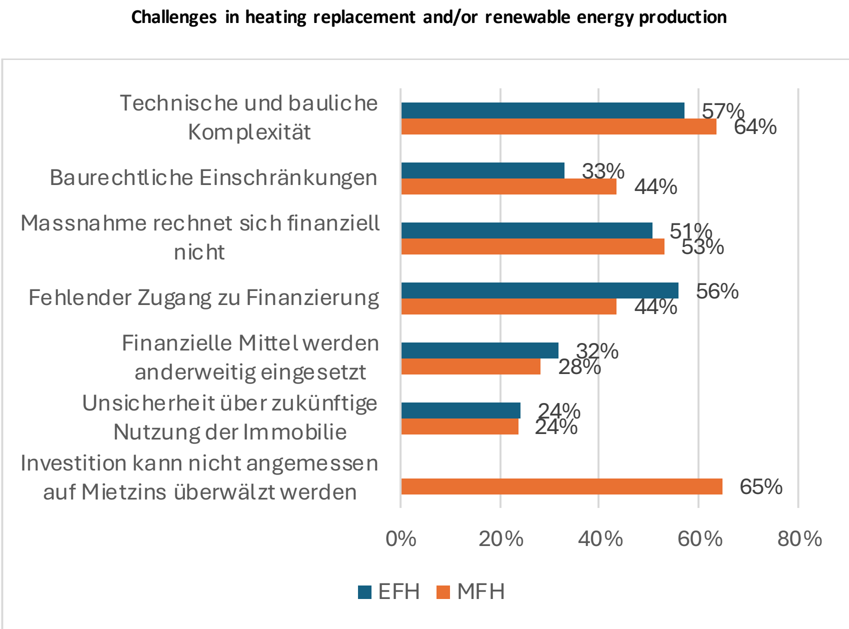
Taken together, the evidence supports a nuanced view of financial instruments in the renovation context.

Incremental reductions in financing costs – on the order of 0.5–1.0 percentage points – are welcome but rarely decisive. They improve project economics but are unlikely, on their own and at realistic magnitudes, to drive renovation decisions in most cases.

Guarantees play a more important role in enabling access to capital markets, particularly institutional investors, by reducing perceived complexity and due-diligence burdens. Their primary value lies in market creation rather than price reduction.

At the same time, financial instruments alone cannot address many of the dominant non-financial barriers to renovation: coordination failures, transaction costs, capability gaps, ownership structures, and uncertainty about performance and responsibilities. When deployed in isolation and at realistic levels of support, financial instruments should therefore not be expected to drive large-scale transformation on their own.

Their appropriate role is as one component of a broader intervention strategy. The Geneva model discussed in Section 5 illustrates how guarantees can be embedded within an integrated framework that combines public orchestration, risk allocation, ecosystem development, and financing to address multiple barriers simultaneously.



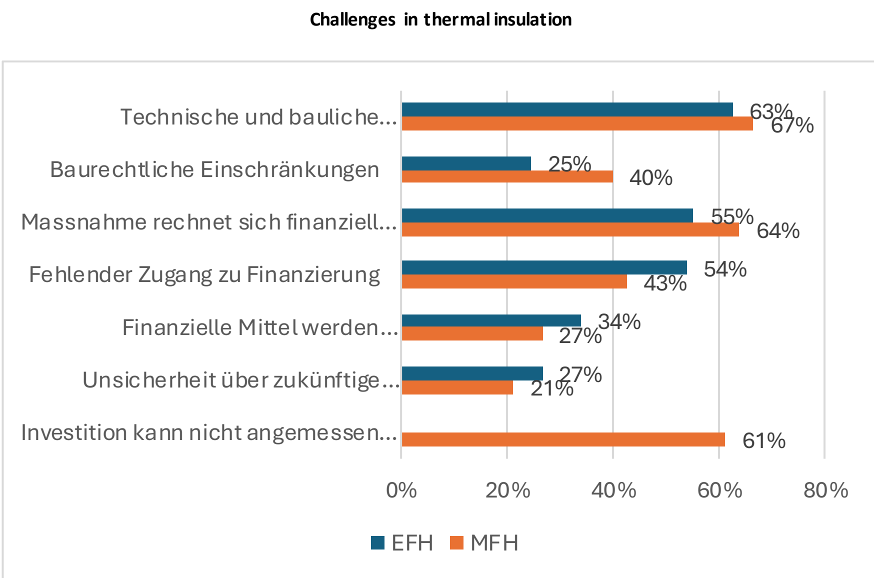


Figure 1 Survey Results: Challenges for Heating replacement and/or renewable energy production (top) and for thermal insulation (bottom), for owners planning renovations. N = 150 to 170 (SFH) and 75 to 85 (MFH). Data source: Own survey results in Renowave 3.1 (Drometer et al., Dec 2023).

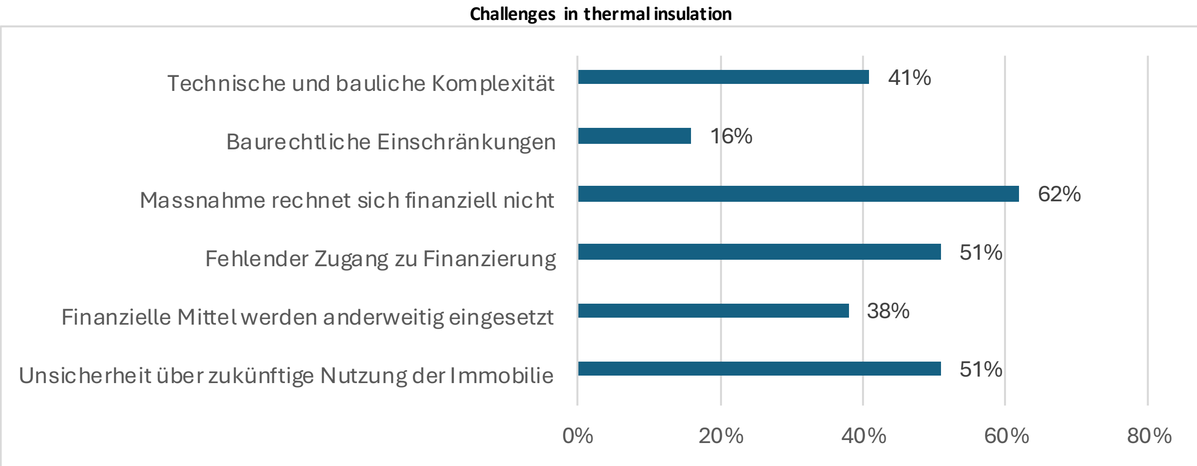


Figure 2 Survey Results: Challenges for owners not planning renovations. N = 37 (SFH + MFH). Data source: Own survey results in Renowave 3.1 (Drometer et al., Dec 2023).

2.4 Implications: What Elements Would Effective Intervention Include?

The preceding sections identified multiple barriers to heat pump adoption in multi-family buildings: information barriers and asymmetries, coordination failures, split incentives, and external effects, alongside further related factors such as high costs, heterogeneous ownership situations, and limited contractor capabilities. Financial instruments were found to have limited effectiveness in addressing most of these barriers. This section considers what the analysis implies for the design of effective interventions.

The Role of Ecosystem Development

If capital access were the primary constraint, interventions focused on financing – guarantees, loans, or subsidies – would be expected to increase renovation rates substantially. The evidence reviewed in Sections 2.2 and 2.3 suggests this is not the case for most potential renovators. The barriers appear to lie less in capital availability than in a more diverse set of – sometimes rather idiosyncratic – circumstances and barriers that prevent building owners from prioritizing the fuel switch, among which is the absence of a developed market ecosystem: experienced contractors, standardized processes, established business models, and accumulated project experience.

In developed markets, building owners can obtain quotes from multiple qualified contractors, compare standardized offerings, access established financing products, and rely on track records to assess contractor quality. In the Swiss MFH heat pump market, these conditions are largely absent. Contractors with relevant experience are few; projects require substantial customization; and both parties face considerable uncertainty regarding outcomes.

Ecosystem development involves costs and risks that individual market participants may be unwilling to bear. Investments in contractor training, process standardization, and pilot projects generate benefits that accrue broadly rather than exclusively to the investing party. This constitutes a coordination problem: individually rational behavior does not produce collectively optimal outcomes.

Public Orchestration as a Response

One response to this coordination problem is public sector involvement in market orchestration – not necessarily direct provision of services, but coordination and facilitation of conditions under which private provision becomes viable.

Public entities may be positioned to play this role for several reasons. They typically have access to capital at lower cost than private actors. Their longer time horizons allow absorption of early-stage risks. They possess convening authority to coordinate fragmented actors. Zapata et al. (2024) found that in the current Swiss market, public-oriented organizations are the primary actors offering energy supply contracting for MFH heat pumps, as private contractors generally lack the necessary combination of capital access, risk tolerance, and technical capability.

This suggests that relying solely on spontaneous private market development may result in slow progress. If policy objectives require faster adoption, public orchestration may be necessary to accelerate ecosystem development.

Balancing Intervention Scope
Public orchestration involves trade-offs. Standard economic reasoning favors minimal intervention, given risks of distortion, inefficiency, and crowding out of private activity. At the same time, the analysis suggests that limited interventions addressing only financing may be insufficient to overcome the identified barriers.

The appropriate scope of intervention depends on empirical judgments about the pace of private market development, the urgency of policy objectives, and the institutional capacities available. These factors vary across contexts. What can be observed is that the relevant choice is not between intervention and non-intervention, but among different forms and degrees of intervention, each with associated benefits and costs.

Zapata et al. (2024) review two relatively well understood roles the public can adopt to ensure basic services for MFH decarbonization are available to willing building owners: Contractor (Figure 3), and Facilitator (Figure 4).

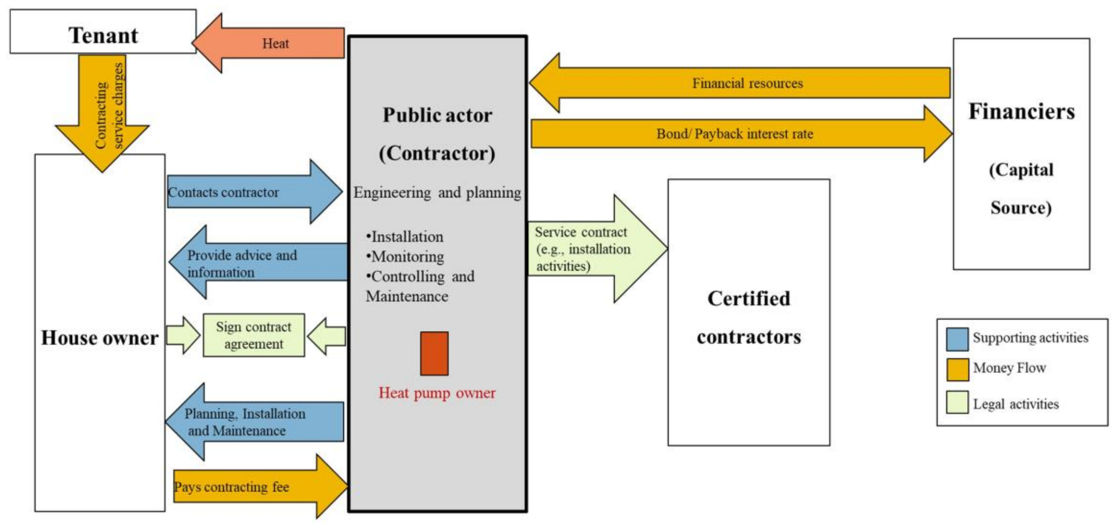


FIGURE 2
Public actor as contractor.

Source: Zapata et al. (2024)

Figure 3 Public Role as Contractor in Zapata et al. 2024

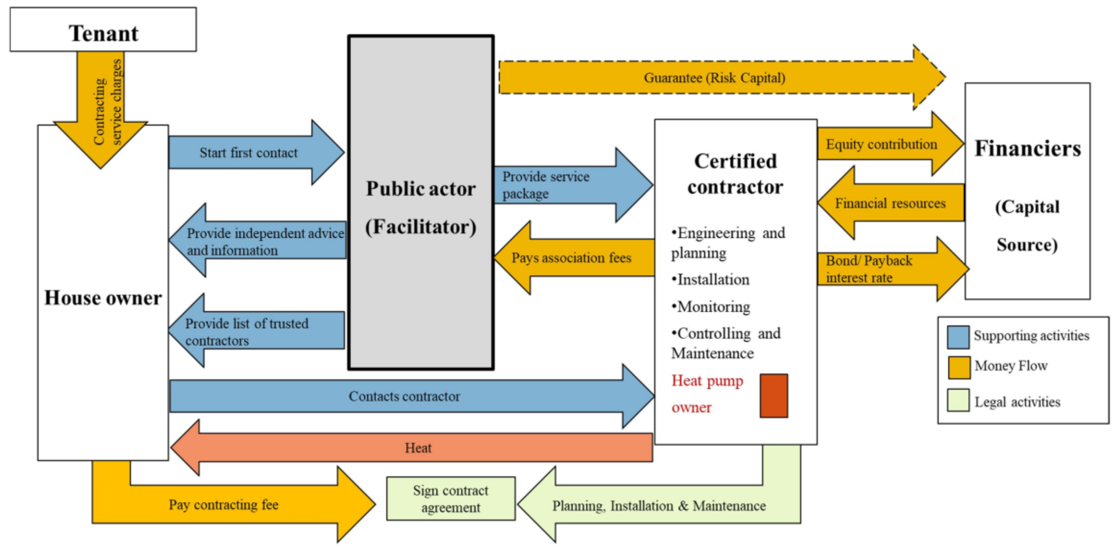


FIGURE 3
Public actors as facilitator.

Source: Zapata et al. (2024)

Figure 4 Public Role as Facilitator in Zapata et al. 2024

Among these, assuming sufficient technical capacity on behalf of the public actor, contracting is arguably the most direct way to ensure the availability of a straightforward offering to the MFH owners. Risks left open include:

- Tariff estimation risk: Zapata et al. (2024) emphasize this as a major risk, as factors such as the lack of standardization or the risk of the evolution of future basic energy prices (including electricity) make it impossible to determine what precisely the economically justified and 'fair' tariff would be.
- Transaction costs and remoteness: Insufficient standardization, low numbers of projects per year with the associated limited experience, and the need for finding highly individual bespoke solutions for each project anew, as well as the potential remoteness of the organization from the situation and people involved with any given building in the larger canton/region, risk to imply major transaction costs even in a somewhat coordinated case.
- Ecosystem-level learning: The public organization may amass learning, but such learning may remain contained to the incumbent; it won't naturally become available to all potential third-party market participants with a potential to contribute to a healthy long-term ecosystem development.
- Speed and scale: A unique centralized organization may lack the capacity and/or drive to deploy the solution at the scale and speed required, even assuming the building owners are interested in finding a solution for early renovation/fuel switch.
- Exit: ideally intervention lasts as long as necessary to establish a functioning ecosystem. There is an inherent risk that instead it is perpetuated, due to fundamental entrepreneurial drives of the organizations involved, and potentially due to external reasons related the other remaining risk listed above.

Besides these specific risk factors involved for any given project and/or for the ecosystem, one more fundamental risk with both approaches, contractor and facilitator, is what we observe equally in the case of SFH, where both, energetic envelope improvements and fuel-switch measures are technically fully established with well understood and managed risks: Even if the market is in place, there can remain strong inertia with most owners of existing buildings preferring to wait until a seemingly indefinite future rather than to actively engage with the topic of building renovation and/or fuel switch. That suggests, the mere availability of solutions for the building energy transition may not itself represent a strong enough pull factor towards rapid decarbonization, opening the question for whether a stronger 'push' is required to effectively increase the rate at which existing MFH decarbonize.

Conclusion on Design Considerations
Several considerations follow for the design of public interventions in this domain.

First, and as mentioned above, given the interdependence of barriers, interventions addressing multiple constraints simultaneously may be more effective than those targeting single barriers. Programs improving financing without addressing contractor capabilities, or developing contractor capabilities without creating demand, may yield limited results.

Second, if public involvement aims to develop a private market rather than replace it, intervention design should incorporate mechanisms for eventual withdrawal. Sunset clauses, transition plans, and periodic review can support this objective.

Third, where public involvement entails assumption of risks, allocation of those risks among parties warrants deliberate attention. Risks arising from market immaturity that are expected to diminish over time differ from risks more fundamentally inherent to the underlying activity.

Fourth, public orchestration creates potential for inefficiency and misallocation. Transparency mechanisms and accountability structures can help mitigate these risks – but they must be designed and their implementation scrutinized carefully to avoid them becoming alibi solutions with insufficient effectiveness.

Structure of Subsequent Sections
The remainder of this report develops these themes further. Section 3 examines the energy system context, assessing whether large-scale electrification of building heat remains appropriate given uncertainties in electricity markets. Section 4 presents a framework for institutional design and risk allocation. Section 5 analyzes the Geneva model as a case study of public orchestration, examining how its design addresses the barriers identified in this section. Section 6 considers adaptation of similar approaches to other cantonal contexts.

3. Energy System Context: Is Electrification the Right Path?

The preceding sections argued that public sector involvement may be necessary to accelerate heat pump adoption in multi-family buildings. Before endorsing substantial public commitments to this path, however, it is prudent to verify that electrification of building heat remains sensible under plausible future conditions. This section presents a preliminary assessment of whether the strategy is robust to uncertainties in how electricity markets may evolve.

The analysis here is deliberately framed as a sanity check rather than a definitive forecast. Electricity markets in 2040 or 2050 are genuinely uncertain, and any model projecting prices or system configurations decades ahead involves substantial speculation. The purpose is not to provide precise predictions but to assess whether the economics of heat pump adoption could be undermined by plausible developments in the electricity system – and to identify which factors matter most for this assessment.

3.1 The Strategic Question: Why Consider Energy System Evolution?

Heat pumps convert electricity to heat. A building that switches from a gas boiler to a heat pump shifts its energy consumption from the gas market to the electricity market. If this transition occurs at scale – as contemplated in Swiss and European climate strategies – the implications for electricity demand are substantial, particularly in winter when heating needs peak.

Three questions arise for anyone contemplating or facilitating such investments. First, will electricity remain affordable in winter? A common concern is that massive electrification of heat, combined with the phase-out of dispatchable generation and reliance on variable renewables, could lead to extreme seasonal price variation – high prices in cold, dark winter periods when solar generation is minimal and demand peaks. If, say, energy cost components of winter electricity prices were to reach, say, 0.50 CHF/kWh or higher as a regular occurrence, the economics of heat pumps would look quite different than under current assumptions.

Second, can the electricity grid accommodate the additional load? Heat pump adoption increases peak electricity demand, potentially requiring substantial grid reinforcement. If grid constraints proved binding or grid costs escalated dramatically, this would affect both the pace at which heat pumps could be deployed and the total system cost of the fuel switch.

Third, what is the actual sustainability impact, in particular regarding carbon emissions? Heat pumps are presumed to reduce emissions because they use electricity (whose production is or will become low-carbon in Switzerland) rather than fossil fuels (which are not). But the *marginal* electricity consumed by a Swiss heat pump on a cold winter evening may be generated by a gas plant somewhere in Europe, complicating the carbon accounting. If marginal electricity remained carbon-intensive even in future decades, the climate rationale for the fuel switch would warrant reexamination. In this regard, it is important to keep in mind that – as a usually ignored, but nonetheless important and barely contested fact – under current market system conditions, mainstream green electricity certificates tend to barely have any direct causal effect on carbon emissions implied by the decision to consume a given amount of electricity.[10]

[10] Green electricity certificates are an accounting mechanism which officially attributes certain electricity sources to a given consumption activity, but the current near-zero prices for the certificates provide strong economic evidence that the

None of these concerns necessarily invalidate the case for heat pumps. But they do suggest that before committing substantial public resources to accelerate adoption, it is worth checking whether the strategy remains defensible under a range of plausible scenarios. The analysis that follows represents a preliminary attempt at such a check, so far at least for part of the relevant questions.

3.2 Modelling Approach and Key Assumptions

The analysis employs SeSaPo, an interregional dynamic dispatch and capacity expansion model developed for energy system analysis, with emphasis on allowing particularly large-scale, granular, and flexible simulations (up to billions of equations to be co-solved and no restrictions to linear relations). The model simulates hourly electricity market operation across a year (8760 hours), for multiple representative years until 2050, capturing the temporal granularity needed to assess seasonal and diurnal price patterns in a system with high shares of variable renewables. The model has the capability to endogenously simulate forward-looking investment decisions into new production capacities for the various technologies and regions modelled.

The geographic scope used for the analysis covers core Western Europe: nine regions most relevant for the Swiss electricity market, including Switzerland and its four neighboring countries (Germany, Austria, France, Italy) plus Belgium, Denmark, Luxembourg, and the Netherlands. Interconnections between regions are modelled, allowing power to flow from areas of surplus to areas of scarcity as in the real market. Switzerland's position as an interconnected node within this larger system is reflected in the analysis.

Two operational modes are considered. In the Technocratic mode, infrastructure capacities are largely prespecified to 2050, reflecting the dirigiste nature of energy governance prevalent in Switzerland and Europe. Capacity timelines for renewables, conventional plants, storage, and interconnectors are defined exogenously based on published scenarios and policy trajectories, with the model calculating resulting market prices and system operation given this infrastructure. In the Market mode, more investment decisions are endogenous: subject to policies such as carbon pricing and renewable support schemes, the model determines whether and how much additional capacity is economically justified. This mode provides insight into what might happen if policy were less directive and market forces played a larger role.

The baseline parameterization draws on multiple sources including the ENTSO-E Ten-Year Network Development Plan (TYNDP 2022), VSE Energiezukunft 2050, and various published fuel and carbon price forecasts. Monetary values are expressed in real terms (inflation-adjusted).

3.3 Salient Features of Future Electricity Markets

Rather than attempting to replicate any single detailed scenario, the modelling approach identifies approximately fifteen salient features of future electricity markets that are likely to matter for the questions at hand. Each is implemented at a high level, recognizing that perfect fidelity to any

permission to issue renewable certificates even for e.g. the vast amounts of decade-old legacy hydropower stations (combine rather disastrously with limited high-willingness-to-pay demand to) prevent any significant scarcity on the market for mainstream green electricity certificates, so that purchasing one certificate unit usually will not in any noticeable degree lead to a comparable expansion of the total amount of green electricity production (see e.g. Langer et al. 2024; Anders et al. 2022; S&P 2021.

particular projection is neither achievable nor – for the purpose of a sanity check – necessary. The goal is to ensure that the major dynamics shaping future electricity systems are represented, so that results are not an artifact of ignoring important factors.

Base system
The foundation establishes current electricity system fundamentals: historical demand patterns through 2024 (from ENTSO-E and Swissgrid), current generation capacities by technology type, hourly time-series for demand and renewable output based on weather data, fuel prices aligned with historical values and traded futures, and stochastic availability of power plants as a proxy for unplanned outages.

Hydrogen
Hydrogen is treated as playing a minor and simplified role. While sometimes portrayed as central to future energy systems, its economics remain challenging and large-scale deployment uncertain. The model allows limited hydrogen imports and small-scale hydrogen CHP if economically viable, and includes medium- and long-term storage with hydrogen-like characteristics (low round-trip efficiency, high capital costs, possibility for relatively large, long-term storage volumes), but does not assume hydrogen becomes a dominant energy carrier.

Carbon capture and storage
CCS is similarly treated as a modest contributor. Consistent with TYNDP and IEA projections that attribute only a small share of captured CO_2 to fossil fuel power generation, the model permits limited amounts of gas generation with CCS – more as a backup for residual hard-to-avoid emissions than as a primary decarbonization pathway. In the Technocratic mode, a small exogenous CCS capacity is specified; in the Market mode, CCS can build if economics warrant, up to higher limits.

Biomass and geothermal
These sources provide limited but potentially valuable flexibility. Biomass capacity is constrained by sustainable feedstock availability, with the EU-wide pool restricted to modest quantities. Its value lies in flexible dispatch during cold, dark periods when other renewables are scarce – though biomass cannot be stored indefinitely and is prioritized for harder-to-decarbonize sectors. For Switzerland specifically, wood, biogas, and waste incineration are modelled with separate capacity trajectories, partly as CHP following heat demand patterns. Geothermal can build endogenously if financially viable, with a cumulative potential of up to approximately 2 TWh annually.

Conventional thermal capacity
Fossil fuel plants follow differentiated phase-out trajectories. The model assumes that if Europe pursues net-zero seriously, maintaining large idle fossil capacity becomes uneconomical; hence faster retirement than some scenarios assume. In the Technocratic mode, 90–95% of unabated fossil capacity is retired by 2050. In the Market mode, a somewhat slower forced retirement (around 80%) is combined with the option for remaining plants to shut if economics warrant, testing whether carbon prices alone drive decarbonization. Switzerland is treated separately, with no new fossil capacity in the Technocratic mode and only limited gas CHP permitted in the Market mode if economically justified despite emission pricing.

Hydropower

Capacity including run-of-river, seasonal dams, and pumped storage is treated as exogenous in both modes, with only modest capacity changes over time. Switzerland's substantial pumped hydro provides valuable flexibility that is captured in the regional modelling.

Nuclear
Nuclear capacity is likewise exogenous – reflecting that nuclear decisions are driven by political will rather than pure economics – with capacity timelines specified from outside the model based on announced policies and plausible trajectories.

Variable renewables and batteries
Solar PV and wind are the dominant growth categories. For Switzerland, the Technocratic mode specifies PV reaching approximately 38 TWh annually (33 GWp) by 2050, with the Market mode allowing a range depending on economics. Wind capacity follows intermediate trajectories with modest potential (up to 5 TWh). Both onshore and offshore wind are included for other European regions, with offshore playing a growing role particularly in northern countries. Battery storage is modelled both as embedded with PV systems (residential and industrial scale, with 2.5-4-hour storage ratings) and as standalone capacity that can build if price spreads justify it.

Electric vehicles
EV demand is incorporated as a growing component of electricity consumption, with assumptions somewhat below some published projections – reflecting a view that lighter vehicles and diversified mobility options may moderate EV electricity demand growth. A portion of EV charging is treated as flexible, contributing to demand-side response.

Data centers and digitalization
Server demand driven by digitalization and AI growth is included as an additional demand component. The baseline assumes moderate growth. It has to be noted that this is an area of substantial uncertainty; if AI-related power consumption accelerates dramatically, European electricity markets could be materially affected.

Heating demand
The electrification of heating is embedded in baseline demand projections and hourly patterns. The model does not simulate individual building heat balances but captures the aggregate effect of heat electrification on system demand, including the winter-peaking character of heating load. Heat pump flexibility – the ability to shift consumption using building thermal mass – is reflected in the demand-side response modelling (see next point).

Demand-side response
DSR is implemented in multiple forms, mostly as time-shiftable load (shifts of hours to days, with limited amounts shiftable over weeks) and to a smaller extent as demand that can be purely curtailed (i.e. genuine net demand reduction overall instead of mere timing-shift). Up to 12% of annual demand is assumed capable of responding by 2050 – though in practice only small fractions would shift in any given period, and only when prices reach elevated levels. Even if the assumed DSR options may correspond to more flexibility than may traditionally be assumed based on historic empirical surveys that failed to test how society can adjust to (i) really large price spreads and (ii)

with decades worth of time to adopt infrastructure and habits,[11] the model is arguably still conservative on DSR; actual flexibility could prove greater if pricing and technology evolve favorably.

Carbon pricing
Emission prices are assumed to rise from current levels (around €80/tCO_2, consistent with 2025 ETS futures) toward €150–200/tCO_2 by 2050, avoiding both the most bearish and most bullish forecasts. This trajectory influences the economics of any remaining fossil generation and the value of CCS. Plants with CCS are assumed to capture approximately 90% of emissions, with the residual 10% subject to carbon pricing.

Interconnectors
Cross-border transmission capacities are based on TYNDP and VSE projections, enabling power flows that arbitrage price differences between regions. Switzerland's imperfect market coupling (outside full EU integration) is reflected through slightly sluggish interconnector behavior. The model permits examination of scenarios with faster or slower interconnector expansion.

Distribution grid
Grid costs and constraints within Switzerland receive simplified treatment through four distribution nodes representing different grid levels and connection types (residential, commercial/industrial, generation). Peak flows determine required grid capacity, with costs differentiated by voltage level. Three modes are available: no grid consideration (copperplate), unconstrained grid (costs observed but not optimized), and economically constrained grid (costs minimized through smart operation). This captures key dynamics – PV-driven midday peaks stressing lower-voltage grids, heat-driven winter evening peaks – without the complexity of full network modelling.

Limitations
Several potentially important factors are not modelled or are modelled only partially. Large-scale thermal seasonal storage – storing summer heat for winter use – could affect the economics of heating electrification but is not yet included in the simulations run. Detailed within-country grid constraints beyond the simplified Swiss treatment (see above on Distribution grid) are not captured; actual congestion could affect local deployment feasibility. Marginal carbon intensity of electricity, which differs from average intensity, is not yet explicitly calculated in the current version. Proper estimation of marginal carbon intensity would require sophisticated attribution of which generators respond to incremental Swiss demand, or it could be modelled using a more elegant statistical approach analyzing carbon responses in the simulation model to more general demand variations. In both cases a pertinent carbon impact analysis would have to carefully account for the complex and tight interaction between (i) basic demand and supply interaction (modelled) and (ii) existing dynamic policy regimes (such as modelling additional subtleties of the dynamic rules of the EU ETS which is currently modelled in a simplified way), and - usually entirely ignored but important for answering marginal net system impacts of energy consumption choices – (iii) expectable medium-term policy changes in response to market conditions. Much simpler approaches are implemented in many existing studies on CO2 emissions, but the view taken here is that these estimates often yield

[11] See Habermacher 2024 for an intuitive explanation as to why historical studies almost certainly underestimate the true potential of DSR.

an incomplete and ultimately misleading picture (with often quasi carbon free estimates for electricity consumed for example in Switzerland, without sufficient justification).

3.4 Tentative Results and Their Interpretation

The results discussed here should be understood as preliminary and indicative. The modelling involves substantial simplifications, the underlying scenarios are themselves uncertain, and systematic validation remains ongoing. With these caveats firmly stated, several observations emerge from initial exploration of model outputs.

Winter Prices: Elevated but Not Extreme
Across the scenarios examined, winter electricity prices are higher than summer prices – reflecting the seasonal scarcity created by solar-dominated generation meeting heating-driven demand – but do not reach the extreme levels sometimes feared. Prices in cold winter periods are elevated relative to current levels and relative to summer, but remain within ranges that would not fundamentally undermine heat pump economics.

Several factors contribute to this result. First, demand-side response dampens price spikes: when prices rise substantially, flexible loads reduce consumption, limiting how high prices can go. Second, interconnection allows Switzerland to draw on the broader European system; while winter is tight across much of Europe, different regions experience their tightest periods at different times, and the integrated market helps smooth country-specific peaks. Third, even with solar dominance, other generation sources – wind, hydro, some geothermal, and remaining dispatchable plants including some biomass capacity and potentially some limited hydrogen power generation – provide output in winter; the system does not become entirely dependent on summer solar surplus.

The Technocratic and Market modes produce somewhat different results, with the Market mode showing more price volatility in some scenarios where investment may not perfectly anticipate needs. However, neither mode produces the catastrophic price scenarios that would call the fuel switch strategy into question.

Beyond the modelling performed, the relative stability of prices seems to be a plausible result also because usually considered limits to renewables buildout, driven among others also by zonal restrictions and/or local renewables resistance, could plausibly be surpassed if electricity prices (energy component) were really to become systematically x-fold higher than today's levels, in which case the realization of a potentially significantly higher share of the vast technical potentials for wind and PV buildout could become extremely highly attractive even in many locations where the incentives for implementations are currently very limited absent from a purely local/financial perspective, a factor which is likely to play a strong moderating effect on longer-term market price developments.[12]

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[12] As an illustrative example, Switzerland itself has a substantial technical wind energy potential of around 30 TWh per year, even after accounting for common exclusion criteria such as 300 m buffer zones around buildings (BFE / Meteotest AG, 2022). This potential is widely regarded as difficult to realize in practice, reducing plausible implementation to much lower values, not least because of local opposition in densely populated areas. At present, local residents typically bear visual and landscape impacts while capturing little direct economic benefit from nearby renewable generation. If, however, electricity prices – and thus the monetary value of generation – were to rise substantially, the distribution of costs and benefits could change. Higher local value creation could translate into tangible financial upside for affected communities,

The tentative finding of limited increases of future winter electricity prices despite the relative seasonal scarcity of solar PV, seems also at least broadly consistent with observations from existing long-term power market forecasts, even if it is well-known that such forecasts are by nature highly uncertain and tend to change substantially across years even for the same target future periods.

Why Energy Costs May Matter Less Than Expected

A further consideration, separate from the modelling, is that energy costs represent only one component of total heating costs for heat pump systems. Heat pumps are capital-intensive: the upfront investment in equipment and installation is substantial, while ongoing energy costs, though not negligible, are a smaller share of total lifecycle costs than in fossil fuel systems. A doubling of electricity prices would increase total heat pump operating costs substantially, but would not double the total cost of heat pump ownership.

Moreover, the electricity price relevant to end consumers includes not only wholesale energy costs but also grid fees, levies, supplier margins, and taxes. These components are less volatile than wholesale prices and provide a stabilizing effect on retail rates. A wholesale price spike that triples for a few hours or days may translate into a much smaller percentage change in a consumer's seasonal cost.

This is not to suggest that electricity prices are irrelevant – they matter for both consumer economics and system efficiency – but rather that the heat pump investment case is somewhat insulated from moderate wholesale price volatility.

Grid Capacity: A Real Constraint, Difficult to Quantify

The modelling includes a simplified treatment of Swiss distribution grid costs, identifying the peak flows that would determine required grid capacity. Results suggest that large-scale PV deployment creates substantial stress on lower-voltage grids during sunny midday periods, while heat pump adoption increases peak demand in winter evenings. Both effects can require grid reinforcement, with costs that are difficult to estimate precisely given the complexity of actual grid topology.

The analysis suggests that grid costs are a real factor but not necessarily prohibitive. Smart charging of electric vehicles, demand response from heat pumps, and local battery storage can all reduce peak flows and thus grid investment needs. The extent to which these flexibility options will actually materialize affects both grid costs and system economics more broadly.

A more detailed assessment of grid constraints at the level of specific utilities or regions would require local data and analysis beyond the scope of this study. What the high-level modelling suggests is that grid costs warrant attention in deployment planning but do not appear to be a fundamental obstacle to heat pump adoption.

3.5 Marginal Carbon Intensity: A Note on What We Do Not Yet Know

The climate case for heat pumps rests on the assumption that electricity is – or will become – substantially less carbon-intensive than fossil fuels. For Switzerland, with its hydro-dominated electricity supply, *average* carbon intensity is indeed low, already today. However, the relevant

potentially increasing acceptance, especially in a context where higher electricity prices directly weigh on household budgets.

metric for evaluating heat pump emissions is not average intensity but *marginal* intensity: what emissions result in the integrated system, in response to the *additional* electricity consumed by the heat pump? I.e., what is the *expected causal effect* of the fuel switch or of the heat pump's energy consumption, on net carbon emissions?

This question is complex because electricity markets are interconnected across Europe. The marginal generator responding to Swiss demand at any given hour might be a gas plant in Germany, a coal plant in Poland, or additional imports that displace generation somewhere else in the system. In particular, it may also be a complex amalgamate of dynamic effects such as, for an illustrative example, (i) additional generation from a storage plant in the very short run; (ii) additional fuel generation a few hours, days, or months later to make up for the additional storage drain in the periods before; (iii) higher carbon prices later, and, ultimately, (iv) at least partial extra buildout of renewables with a medium-term, partial compensating effect for the earlier implied extra emissions. The answer overall varies by hour, season, and the specific configuration of the European power system.

The present analysis does not calculate marginal carbon intensity, which would require a more sophisticated attribution methodology than employed in the presently considered model runs (see explanations above, in the paragraph on Limitations in section 3.3). This is acknowledged as a limitation and an area for future research.

That said, several considerations suggest the climate case for heat pumps is likely to remain sound, even if perfect quantification is still missing. First, under decarbonization trajectories consistent with European climate commitments, even marginal generation should become progressively less carbon intensive as the overall system decarbonizes. Second, heat pumps typically achieve coefficients of performance (COP) of 3 or higher (even with seasonal adjustment for the cold winter weather where heat pumps lose efficiency), meaning one unit of electricity delivers three or more units of heat; even if marginal electricity has some carbon content, the efficiency gain relative to direct fossil combustion provides substantial headroom. Third, policy mechanisms such as the EU Emissions Trading System cap total emissions from the power sector, meaning that emissions caused by heat pump electricity consumption are offset by required reductions elsewhere. It is important to consider that in reality, the ETS does not represent an airtight mechanism removing all marginal emissions concerns. After all, the ETS and the economic electricity and economic system are highly complex, and, potentially more importantly, the evolution of the ETS itself is subject to future political choices which are affected by the future demand and supply equilibrium, as are any separate renewable energy policies too. Nevertheless, the ETS policy does tend to moderate the response of systemwide emissions to local changes in electricity demand, while not perfectly, still to some significant degree.

Taken together, these effects do not support the conclusion that marginal carbon intensity can be ignored – it is a real issue that merits careful analysis – but that under plausible decarbonization trajectories, electrification of building heat remains likely to deliver climate benefits. Policies should nonetheless pay attention to achieving the highest feasible efficiency (COP) in heat pump installations, as this improves the climate-case under any potential viewpoint/analysis methodology.

While the tentative results therefore suggest the carbon content of future electricity may not be a major concern, it is difficult to compare this finding to existing electricity system projections, as – as mentioned above – these almost exclusively ask questions about *average* emissions or rely on otherwise somewhat narrower concepts of non-average emission that do not fully answer the question of what a fully consequential marginal power emission intensity really is.

3.6 Implications for Policy and Business Model Design

The analysis presented in this section, despite its preliminary nature, supports several conclusions relevant to policy and business model design.

First, electrification of building heat appears defensible under the range of scenarios examined. This does not mean the strategy is without risks or that outcomes are certain, but it does suggest that concerns about extreme winter electricity prices or system infeasibility do not warrant abandoning the approach. The sanity check, provisionally, passes.

Second, the analysis does not establish that electrification is a silver bullet requiring no complementary measures, nor that it is the optimal approach in every specific circumstance. Uncertainty remains about future electricity prices, grid costs, and carbon intensity. Policy and business model design should therefore incorporate mechanisms for managing these uncertainties: hedging against electricity price risk, incentivizing flexibility provision from heat pump systems, and monitoring actual outcomes as the strategy is implemented.

Third, demand-side flexibility emerges as an important factor for system economics. Heat pump systems that can shift consumption in response to price signals reduce both their own operating costs and system-wide costs. Business models and technical designs that incorporate such flexibility – through thermal storage, smart controls, or flexible tariff structures – deserve attention.

Fourth, grid constraints warrant consideration in deployment planning. While not prohibitive at the aggregate level, grid capacity may be binding in specific locations or networks. Coordination between heat pump deployment and grid planning can reduce costs and avoid bottlenecks.

Fifth, the uncertainties identified above – regarding electricity prices, grid capacity, and carbon intensity – suggest that heat pumps are best understood as one component within a broader portfolio of measures rather than the sole solution. Several complementary approaches merit consideration alongside building-level electrification. Seasonal thermal storage – capturing summer heat or surplus renewable generation for winter use – could substantially ease the seasonal imbalance that drives winter price concerns, though such systems remain at relatively early stages of deployment. District heating networks, where heat sources of sufficient scale are available, can achieve efficiencies difficult to match with individual building systems and may be preferable in dense urban contexts; they also offer additional options for efficient renewable heat generation options at scale; Geneva's own thermal network development reflects this logic. On the supply side, a diversified portfolio of local electricity and heat sources strengthens system resilience: beyond hydropower, PV, and wind, this includes geothermal where geological conditions permit, agricultural biomass residues, and wood. Wood merits particular attention given its increasing scarcity: the priority should be ensuring its most judicious use through cascading principles[13] – first for long-lived material applications where feasible, then for energy, ideally in combined heat and power

[13] On the optimized cascading use of biomass, see, e.g., Höglmeier et al. 2015.

configurations in locations where both outputs can be utilized. Such measures create actual economic system benefits that imported electricity, especially in the medium-term future where marginal electricity still has some significant risks to be related to fossil fuels in the integrated system, may not easily fulfil equally well (irrespective of potential green electricity certificate purchases, as pointed out in the previous subchapter). The point is not that heat pumps are insufficient, but that they best fulfill their sustainability promises within a system designed with multiple complementary elements.

Sixth, separate elements of the energy security dimension deserve brief mention. Electrification of heat, combined with domestic and European renewable generation, reduces dependence on imported fossil fuels. In a geopolitical context where such dependence carries risks – both economic and strategic – this consideration strengthens the case for the fuel switch. The alternative dependency, on imported PV modules and other manufactured equipment, exists but can reasonably be viewed as a lesser concern.[14]

With the energy system viability of heat pump adoption tentatively confirmed – acknowledging the limitations and uncertainties of this assessment – the report turns in subsequent sections to questions of institutional design: how public sector involvement should be structured to effectively support the transition.

A final implication of the electricity system assessment is that decarbonizing heat via heat pumps remains, to some extent, a strategy under uncertainty. While the expected direction of impacts is positive, the medium-term evolution of electricity prices, system costs, and marginal carbon intensity cannot be predicted with precision. At the same time, the fuel switch entails substantial infrastructure costs in some cases – particularly in large, older buildings – which may exceed commonly applied monetary valuations of avoided emissions.

One way to interpret this combination of uncertainty and heterogeneity is that a uniform, building-by-building optimization logic may not be the most effective or politically feasible approach. Instead, there is a case for collective solutions that partially socialize transition costs and emphasize simple, broadly applicable pathways over individually tailored optima. In many instances, the costs and constraints driving decarbonization outcomes are less the result of current owner choices than of an aging building stock designed under very different energy paradigms. Against this background, collective approaches can be understood not as a rejection of economic rationality, but as a pragmatic response to uncertainty, legacy constraints, and the need for coordinated system transformation.

[14] Not least because of their longevity with 20+ years expected lifetimes for the most essential elements, which compares well against the requirement for a steady import of fossil fuel for any conventional heating systems (given the impracticality of multi-year or multi-decade fuel storage facilities).

4. Framework for Institutional Design and Risk Allocation

The preceding sections established that the market for heat pump installations in multi-family buildings exhibits multiple barriers – coordination failures, information asymmetries, capability gaps, and split incentives – and that (moderate) financial instruments alone have limited power to address them. Section 3 confirmed that electrification of building heat remains defensible under plausible energy system scenarios. The question that follows is how public sector involvement should be structured if it is to be effective.

The analysis in Section 2 pointed toward a particular type of arrangement as potentially well-suited to address the identified barriers: energy supply contracting. Under this model, a specialized entity finances, installs, owns, and operates the heating system, selling heat to building occupants rather than selling equipment to building owners. Such arrangements can in principle address multiple barriers simultaneously: they eliminate upfront capital requirements for building owners, transfer technical and performance risk to parties with greater expertise, create ongoing incentives for system optimization, and provide a framework within which ecosystem capabilities can accumulate. If the barriers to MFH heat pump adoption are to be overcome through structured intervention rather than waiting for organic market development, contracting arrangements of this general type represent a natural starting point. As we have seen, a basic contracting setup can nevertheless leave multiple questions and risks open.

This section develops a framework for thinking about institutional design and risk allocation in such arrangements. How should risks be distributed among the parties involved? What role should public entities play – as guarantors, as orchestrators, or as direct contractors? How should interventions be designed so that they catalyze market development rather than permanently displacing private activity? The framework developed here provides analytical structure for assessing any proposed intervention model; Section 5 then applies it to examine one concrete example.

4.1 What Can Go Wrong, and for Whom?

Decarbonizing heating systems in existing multi-family buildings involves risks that are both more numerous and more difficult to allocate efficiently than in conventional fossil-fuel heating systems. Market failure in this domain is not driven by a single obstacle but by the interaction of multiple risks that are unevenly distributed across actors and often poorly aligned with their capacity to manage them. Understanding these risks in concrete terms – and identifying who typically bears them in the absence of targeted public intervention – is useful for coherent institutional design.

Companion work within Renowave on energy contracting business models (Zapata et al., 2024) distinguishes broad risk categories – financial, technical, regulatory, behavioral. The present section complements that analysis with a concrete, actor-oriented framing, examining what can go wrong for each party – drawing on general economic risk analysis principles, interview evidence from Swiss market participants, and the project process mapping developed in earlier phases of this research. This stakeholder-oriented makes clearer who is exposed to what, and where mitigation strategies might be directed.

4.1.1 What Can Go Wrong for the Building Owner?

The building owner's central concern is straightforward: will the system actually heat the building adequately and affordably? Behind this simple question lie several distinct risk categories.

Design and technical feasibility risk
The system may be inappropriately designed for the building's actual heat demand. From a risk-allocation perspective, the information gaps discussed in Section 2 translate into a feasibility and

design risk borne by the building owner: many owners remain uncertain whether heat pumps are viable in MFHs, and the perception persists that they work for single-family houses but not for larger buildings (Zapata et al., 2024). This skepticism is reinforced by industry actors and affects proposal quality and comparability: due to complexity and limited confidence in higher-capacity applications, heat pumps have often been judged infeasible for existing MFHs (SIG-éco21, Chaleur Renouvelable program documentation). The information gap means owners may either reject suitable solutions or, if they proceed, struggle to evaluate whether a proposed system is appropriately sized. If the system proves undersized, comfort suffers; if oversized, efficiency and economics suffer.

Contractor capability risk
The contractor may lack the capability to deliver. Most heating installers are experienced with single-family installations, where hydraulics are relatively simple and products standardized. As buildings grow larger, projects become substantially more complex, and – as interviewees noted – installers can no longer do the whole work by themselves (Zapata et al., 2024). Building owners generally cannot assess contractor competence in this specialized segment.

Construction and integration risk
Installation costs may exceed initial estimates, or technical difficulties may arise during implementation. In existing multi-family buildings, such risks are amplified by building-specific constraints, limited standardization, and the need to integrate new systems into heterogeneous and often aging building stock. Empirical evidence from recent Swiss pilot projects shows that ancillary works and system integration can vary substantially across otherwise similar installations, even for comparable heat-pump technologies, making ex ante cost estimation difficult (Zapata et al. 2024, citing field experience from recent Swiss pilot projects). While experienced contractors can in principle manage construction risk, its magnitude is highly project-specific and difficult to benchmark in immature markets.

Cost and affordability risk
Costs may exceed expectations or what the owner considers acceptable. Renewable heating solutions for multi-family buildings are approximately five times more expensive in upfront investment than conventional fossil systems (SIG-éco21, Chaleur Renouvelable program documentation). Under these conditions, owners contemplating self-financed installations face a stark cost differential that often leads them to simply replace old fossil systems with new ones. Under a contracting arrangement, the heat tariff is typically fixed at contract inception, shifting the investment burden – but interview respondents from real estate companies emphasized that clients often perceive contracting as expensive (Zapata et al., 2024). Whether this perception reflects actual cost differences or simply unfamiliarity with the model, it creates acceptance barriers.

Cost pass-through and rental-law risk
For rental buildings, uncertainty exists about whether and to what extent investment and operating costs can be transferred to tenants. Tenants pay energy and maintenance costs, while investment costs fall on the owner. Swiss tenancy law permits landlords to pass through certain renovation costs via rent increases, but the rules are complex and the boundaries contested. Renovations that trigger disputes with tenants – or that face challenge under tenant protection provisions – create legal and administrative burdens that many owners prefer to avoid. Unlike pure financing risks, cost pass-through risk is institutional and distributional in nature; its mitigation often requires explicit contractual arrangements, regulated tariff structures, or public involvement in asset ownership and governance. According to information received by SIG, there is still some uncertainty as to the legal feasibility of passing through all energy contracting costs to tenants over long amortization periods (Rüegg 2022), but long payback periods, i.e. distributing the investment costs, for example over up to 20 years, are particularly valuable for limiting tariff levels when the infrastructure is long-lived and interests are low, as currently is the case. In the separate case of energy savings contracting, where

payback times tend to be shorter, the VMWG (Verordnung über die Miete und Pacht von Wohn- und Geschäftsräumen; ordinance on residential and commercial tenancy) generally permits pass-through of costs for obtaining and providing the heating energy (Art. 6a–Art. 6c VMWG, 2020), but the period during which the investments can be passed on to tenants is limited to 10 years, and the annual tariff is not allowed to exceed the "energy cost savings" for the tenant, which could theoretically lead to a challenge in some cases if fossil fuel prices drop to values lower than originally foreseen.

Operator continuity risk
The contractor may fail or withdraw, leaving the owner with an orphaned system. Long contract durations – typically 15 to 25 years – expose owners to the risk that their counterparty will not remain viable or committed throughout. While the physical heating installation typically remains in place, operator failure can disrupt operation, maintenance, and billing, and may lead to costly renegotiation or service interruptions. The severity of this risk depends strongly on asset ownership and contract design; it can be mitigated through step-in rights, separation of asset ownership from service provision, and the involvement of public or quasi-public counterparties.

4.1.2 What Can Go Wrong for the Contractor?

For contractors offering energy supply contracting, the risks are substantial and help explain why so few private firms operate in this segment.

Technical complexity and threshold effects
The technical complexity of MFH installations creates a threshold effect. As one program manager noted: a project with more than six apartments is complex – it is no longer routine work; the project must be accompanied from the beginning through to operation to optimize performance (Rüetschi, quoted in Phase5, 2021). This complexity means that the skills and processes developed for single-family installations do not transfer straightforwardly to larger buildings, and contractors who attempt MFH projects without adequate preparation face elevated failure risk.

Tariff estimation and long-term revenue risk
As discussed in Section 2, the dominant concern identified in interviews is tariff estimation risk: the heating tariff must be calculated in advance and is subject to large uncertainty regarding project realization (Zapata et al., 2024). For contractors, this risk is particularly acute because it combines up-front pricing commitments with limited ability to fully control realized costs and performance over long horizons. If actual system performance falls short of projections – whether due to design errors, installation problems, or building characteristics that differ from assumptions – the contractor faces a choice between absorbing losses or attempting to renegotiate with an unhappy client. As one interviewee noted, this can tie the contractor to an unprofitable contract for years.

Input cost volatility
The risk is compounded by electricity price uncertainty: heat pumps require electricity as input, and if prices rise substantially over the contract term, operating costs increase while the tariff may be fixed or slow to adjust. Capital-intensive low-carbon heating systems are inherently sensitive to financing conditions and interest-rate fluctuations as well. Rising financing costs increase levelized heat costs even when technical performance remains unchanged.

Transaction costs and dual capability requirements
Transaction costs for entering contracting are high. Interviewees identified this as the most frequently mentioned barrier to contracting (more than 10 mentions across 13 interviews, a much higher count than any other risk). The problem is that contracting requires not only technical know-how – which heating firms possess – but also legal and administrative capabilities for contract negotiation, financing arrangements, and long-term relationship management. As one analysis

summarized: those who have the technical know-how may not have the resources for the contractual and financing dimensions, and those who cover the administrative part well usually do not have the technical know-how (Zapata et al., 2024). Small and medium enterprises in the heating industry generally lack this dual capability.

Capital access constraints
Financing the upfront investment is challenging for private contractors. Energy supply contracting is capital-intensive: the contractor must finance equipment and installation costs that will be recovered only gradually through heat tariff payments over many years. Unlike public entities, private firms generally cannot access capital at low rates, placing them at a structural disadvantage (Zapata et al., 2024).

Offtaker default risk
Counterparty default – the risk that building owners or tenants fail to pay for heat delivered – is by contrast considered modest. Interview evidence suggests that even if an original occupant becomes insolvent, another will take over the contract; people need heat, and the contractual obligation transfers with occupancy (Zapata et al., 2024). This risk, while not zero, is not among the primary concerns.

4.1.3 What Can Go Wrong at the Ecosystem Level?

Beyond the risks facing individual parties, there are risks that affect the market as a whole – and that no individual actor has strong incentive to address.

Capability development failure
The most fundamental ecosystem risk is that the necessary capabilities may simply not develop. In the interviews conducted, lack of technical know-how for MFH heat pump installations was mentioned 12 times as a barrier – more than any other single factor for heat pump adoption generally. Installers experienced with single-family systems do not automatically acquire the skills needed for larger, more complex buildings. Training and experience accumulation require investment, but individual firms capture only part of the benefit: once trained, workers may move to competitors, and demonstrated project success creates reference points that benefit the entire market. This classical dynamic can discourage private investment in capability building in the private sector.

Standardization failure
Standardization may fail to emerge. Unlike heat pumps for single-family houses, there are no standard hydraulic schemes for multi-family buildings that ensure optimal system functioning (SIG-éco21, Chaleur Renouvelable program documentation). Large heat pumps have historically been used in industrial settings and do not fully meet residential requirements such as noise insulation (Zapata et al., 2024). Without standardized products, hydraulic configurations, and processes suited to multi-family residential buildings, each project requires substantial customization, raising costs and risks. Engineers working on MFH projects are entering new territory, requiring the development of new energy concepts for each installation.

Regulatory fragmentation
Regulatory fragmentation across cantons compounds the problem. Interviewees noted that regulations regarding noise, aesthetics, and building modifications vary substantially across Swiss municipalities: "if I have apartment buildings of type X in different cities, I could have the same heating concept for all of them... however, depending on where I am, I have endless requirements. That's a disaster, and it's also a huge uncertainty for the investor in terms of cost" (Zapata et al., 2024). This fragmentation inhibits the development of standardized approaches that could reduce costs through replication.

Subsidy and support-scheme risk
Uncertainty regarding the availability, level, and continuity of public financial support affects the ecosystem as a whole. Changes to investment subsidies, operating support, or eligibility criteria can significantly affect project bankability and investment timing. Abrupt program changes or short planning horizons tend to encourage strategic delay and "wait-and-see" behavior, particularly in early market phases where investment decisions are already perceived as risky. This form of risk is policy-induced and therefore highly sensitive to credibility, commitment horizons, and signaling by public authorities.

For institutional design, the key point is that these risks are not naturally internalized by any single actor and therefore remain unaddressed without an explicit allocation or coordinating mechanism. If no actor invests in developing capabilities, standardizing products, or harmonizing approaches across jurisdictions, the market remains stuck in a low-activity equilibrium unless an actor (often the public sector) is mandated and equipped to carry these ecosystem-level risks during the build-up phase.

4.1.4 What Can Go Wrong for the Public Sector?

If public entities intervene to address these market failures – through guarantees, direct contracting, or orchestration – they assume risks of their own.

Guarantee exposure at scale
Guarantees may be called at scale. A public guarantee is a contingent liability that becomes an actual liability if the guaranteed party fails. If many projects underperform simultaneously – due to systematic design errors, an unexpected technology problem, or a macroeconomic shock affecting electricity prices or building owner solvency – guarantee calls could impose substantial fiscal costs. The Swiss experience with Hochseeschifffahrtsbürgschaften (ocean shipping guarantees), where inadequate risk assessment and monitoring led to hundreds of millions of CHF in losses, illustrates what can go wrong when guarantees are extended without sufficient attention to the underlying risks (see, e.g., NZZ 2019).

Discrimination, favoritism, and loss of neutrality
Public orchestration and direct involvement in project development or contracting can also create risks of selective access and unequal treatment. Where project pipelines are limited, contracts are bespoke, and competitive price signals are weak or absent, public entities may – intentionally or not – favor certain technologies, business models, regions, or implementation partners over others. This can disadvantage smaller firms, new entrants, or actors lacking established relationships with the public sector, even if they are technically capable.

Such effects need not result from explicit favoritism. They can arise from path dependence, reliance on familiar partners, risk aversion in partner selection, or administrative convenience. Over time, this may reduce contestability, slow learning and innovation, and undermine both the perceived fairness and the legitimacy of public intervention. In extreme cases, it can also lead to legal or political challenges that weaken the durability of the intervention framework. While such risks are not absent in private markets, they are typically more strongly constrained by competitive pressure, price signals, and the threat of market exit than in settings where public entities exercise significant discretion in partner selection and project allocation.

Operational inefficiency
Public entities operating as contractors may do so inefficiently. Without competitive pressure, costs may drift upward, innovation may lag, and service quality may suffer. The advantages that justify public involvement – access to cheap capital, long time horizons, convening authority – do not guarantee operational excellence. Subtle details in the external and internal governance of the

public entity, as well as of the staff's motivations and constraints can reduce or increase this risk with any given public entity, but it will generally not be possible to fully rule out significant inefficiencies due to various issues that can mostly arise in the absence of effective competition.

Entrenchment and crowding out
Temporary intervention may become permanent. Public programs create constituencies – staff, contractors, political supporters – with interests in continuation. What begins as market development support may evolve into an entrenched public role that crowds out private activity rather than enabling it. Designing for eventual exit is easier said than done.

4.1.5 Synthesis: Implications for Risk Allocation

Building owners face risks they cannot easily assess or mitigate, particularly regarding contractor capability and system appropriateness. Contractors face risks – especially tariff estimation and the requirement to combine technical, financial, and contractual capabilities – that help explain why private firms largely avoid this segment today. Ecosystem-level risks fall on no one in particular and therefore remain largely unaddressed. Public intervention, while potentially closing some of these gaps, introduces its own exposure, including fiscal risk, operational inefficiency, and governance risks related to neutrality and equal treatment.

The central question is therefore how these risks can be allocated to actors best positioned not only to bear potential losses, but also to actively manage and reduce the underlying risks, and which institutional arrangements enable such allocation. The following sections develop principles for such allocation and examine what role guarantees and public orchestration can play.

4.2 Principles for Efficient Risk Allocation

Building on the actor-specific risk patterns identified in Section 4.1, this section distils general principles for how risks should be allocated in MFH heating projects. The question of who should bear which risks admits no universal answer, but several principles from the literature on public-private partnerships and infrastructure finance provide guidance.

Allocate risks to those best positioned to manage them
A foundational principle is that risks should be allocated to parties who can assess them accurately, influence them through their actions, and absorb them if they materialize. Technical performance risk, for example, is best borne by parties with technical expertise – contractors who can assess feasibility, engineers who can design appropriate systems, operators who can optimize performance. Placing this risk on building owners, who typically lack technical expertise, creates inefficiency: owners cannot accurately price the risk they are assuming and cannot take actions to mitigate it.

Counterparty risk is generally best borne by parties with diversified exposure. A single building owner faces concentrated risk if their one contractor fails; a large utility or public entity with many contracts can pool this risk across a portfolio. Similarly, interest rate risk may be more efficiently borne by entities with access to sophisticated financial instruments for hedging than by individual building owners or small contractors. As seen in Section 4.1, these risks manifest differently depending on whether they are borne by owners, contractors, or financiers.

Distinguish systemic from idiosyncratic risks
Some risks are specific to individual projects (idiosyncratic) while others affect all projects in a category (systemic). A construction defect in one building is idiosyncratic; a change in electricity tariff regulation affects all heat pump installations. This distinction matters for risk allocation.

Idiosyncratic risks can in principle be diversified away through pooling: a portfolio of many projects will see some perform better and others worse than expected, with variations canceling out on average. Private actors with sufficient scale can manage such risks. Systemic risks, by contrast, cannot be diversified within a single market – all projects are affected simultaneously. Where systemic risks are uninsurable in private markets, there may be a case for public backstops that spread these risks across the broader tax base or across time.

Recognize risks stemming from market immaturity
A distinctive feature of the MFH heat pump market is that many risks are elevated precisely because the market is immature. Design risk is higher than it would be in a mature market because fewer reference projects exist, simulation tools are less validated, and contractors have less experience. Financial risk is higher because lenders lack track records on which to base credit assessments. Transaction costs are higher because processes are not yet standardized.

These market-immaturity risks are expected to diminish over time as the ecosystem develops. This has an important implication: public support to absorb such risks may be justified during an initial phase but should not be permanent. The rationale for intervention weakens as the market matures and private actors become capable of bearing risks that were initially too uncertain for them to price or absorb.

Attend to incentive effects
Risk allocation is not merely a matter of efficiency; it also shapes incentives. A party that bears a risk has incentive to manage it; a party shielded from a risk does not. This creates the familiar problem of moral hazard: if contractors know that a public guarantee will cover their losses, they may take less care in project selection and execution than they otherwise would.

The design challenge is to provide risk-sharing that enables activity that would not otherwise occur, without creating incentives for reckless behavior. Partial risk-sharing – where the private party retains meaningful exposure – can help preserve incentives. So can monitoring and oversight mechanisms that condition public support on demonstrated competence and compliance with standards.

4.3 The Role of Guarantees: Benefits and Limitations

Public guarantees occupy a prominent place in discussions of how to accelerate building renovation. Their appeal is obvious: a guarantee is a contingent liability that may never be called, imposing no direct fiscal cost unless things go wrong. Compared to direct subsidies, which represent immediate expenditure, guarantees appear to offer leverage – potentially catalyzing large volumes of private investment with limited public commitment (see also the discussion on guarantees in Section 2).

Theoretical attractions
Swiss administrative law reflects this logic in what might be called a hierarchy principle for public financial interventions. The Subsidies Act (Subventionsgesetz) and its accompanying jurisprudence establish that weaker instruments should be preferred where they can achieve policy objectives (see also Bezzola-Büchler, unpublished working paper). Information and advisory services should be considered before financial interventions. Among financial instruments, guarantees – as contingent liabilities – should in principle be preferred to loans; loans, being repayable, should be preferred to direct grants. This hierarchy reflects both fiscal prudence and a proportionality principle: intervention should be limited to what is necessary.

A further attraction of guarantees is their potential to unlock institutional capital. As documented in Section 2.3, the Ethos survey of institutional investors found that without a cantonal guarantee, 56% of responding investors declared no interest in financing energy infrastructure, and those remaining interested required substantial risk premia. With a guarantee, required spreads dropped dramatically, and the pool of willing investors expanded. Guarantees thus function not merely as marginal cost reducers but as market-access enablers.

Limitations in practice
The empirical evidence reviewed in Section 2 – including experience with the Schwyz Handschlag-Hypothek – shows that guarantees and other favorable financing instruments address an important but narrow dimension of the problem: access to capital. They do not, on their own, resolve the dominant non-financial barriers in MFH renovation, including coordination failures, information asymmetries, capability gaps among contractors, and high transaction costs in project development.

For institutional design, the implication is that guarantees should be understood as enabling instruments rather than standalone solutions. Their primary value lies in facilitating market access for capital providers and project developers under specific conditions, not in triggering large-scale renovation activity in the absence of complementary measures.

Guarantees as complements
The mentioned hierarchy principle from Swiss administrative law – preferring guarantees to more costly instruments where they can achieve policy objectives – thus requires careful application. The principle's own logic implies that the lighter instrument should be chosen only if it is actually capable of achieving the objective. Where the barriers to be overcome are not primarily financial, a guarantee may satisfy the formal preference for lighter instruments while failing to address the substantive problem. In such cases, adherence to the hierarchy could become counterproductive, selecting an instrument for its fiscal appearance rather than its effectiveness.

4.4 The Case for Public Orchestration

If guarantees alone are insufficient, and if multiple barriers must be addressed simultaneously, what form should public intervention take? One answer emerging from both theoretical analysis and observed practice is public orchestration: public sector involvement not merely as financier or guarantor but as coordinator and facilitator of ecosystem development.

Why orchestration may be necessary
The coordination failures identified in Section 2 are not self-correcting. Contractors do not invest in MFH capabilities because demand is uncertain; owners do not demand MFH solutions because capable contractors are scarce. Breaking this cycle requires some actor to absorb coordination costs and early-stage risks that individual market participants will not bear.

Public entities may be positioned to play this role for several reasons. They typically have access to capital at lower cost than private actors. Their time horizons can extend beyond the short-term cycles that tend to constrain private firms, allowing them to absorb early losses in expectation of long-term benefits. They have convening authority – the ability to bring together fragmented actors, establish standards, and create platforms for coordination. And they may have legitimacy advantages: building owners may trust a public utility more than an unknown private contractor, reducing transaction costs.

Empirical patterns
The empirical evidence from Switzerland is consistent with this analysis. Research on energy contracting in the Swiss MFH sector finds that public-oriented organizations are essentially the only actors currently offering comprehensive contracting solutions for heat pumps in multi-family buildings. Private contractors generally lack the necessary combination of capital access, risk tolerance, technical capability, and administrative capacity to operate in this segment (Zapata et al., 2024). This has also been evidenced during the project in discussion with private construction

companies, whose loan requests were refused by banks on the grounds that the banks are not willing to carry the technical and financial risks inherent in such solutions.

This is not an indictment of private markets; it is a description of current market conditions. The question is whether to wait for private markets to develop organically – a process that may take many years and may never fully occur – or to use public orchestration to accelerate the process. The answer depends on how urgent policy objectives are and how confident one is that public orchestration can be designed and implemented effectively.

The politically agreed targets for fast decarbonization of the economy, and the inherent inertia of the complex energy system that permits only gradual changes without risks for major disruptions, suggests waiting is an overly costly option, leading to a loss of time for the deep, iterative and gradual adjustments required in so many interconnected energy system elements. This suggests that, in the presence of strong coordination failures and urgent decarbonization targets, relatively strong forms of market intervention may be justified as a second-best option.

While this suggests there may be a central role for public utilities in implementing a large building decarbonization acceleration agenda, it is worth noting regarding capital sources for the investments required, that public utilities like SIG typically require higher rates of return on their investments than institutional investors such as pension funds.[15] This differential suggests that the goal of public intervention need not be for public entities to finance everything directly. If pension funds can be induced to provide capital – through guarantees or other risk-mitigation mechanisms – the cost of capital for building energy infrastructure could actually be lower than under direct public utility financing. Public orchestration, on this view, aims to create conditions under which lower-cost institutional capital can flow into the sector, rather than to substitute public for private finance indefinitely.

Forms public orchestration can take

Public orchestration is not a single model but a family of approaches that can be configured differently depending on context. At one end of the spectrum, the public actor operates as contractor: directly offering energy supply contracting, taking responsibility for the entire value chain from design through operation, and retaining ownership of installed systems. This model provides comprehensive service to building owners and allows the public actor to accumulate experience and develop standardized processes, but it places substantial risk and responsibility on the public entity.

At the other end, the public actor operates as facilitator: providing guarantees that enable private contractors to access capital, certifying qualified contractors, offering standardized contract templates, and creating information platforms – but leaving the actual contracting activity to private parties. This model preserves a larger role for private initiative but may be less effective if private contractors remain unwilling or unable to operate in the segment.

Intermediate configurations are possible and may have advantages. A public entity might serve as delegated project manager/coordinator (maître d'ouvrage délégué): coordinating projects, providing performance guarantees to building owners, but subcontracting actual installation and maintenance to private firms under competitive tender. This approach combines public coordination with private execution, potentially capturing benefits of both while managing risks of each.

[15] This somewhat higher internal rate of return requirement for investments by public utilities may be considered a feature, not a bug, of the system, as it may help prevent an arbitrary expansion of public utilities into private market domains only tangentially connected to the utility's core business – a risk that is not unheard of in some other regions of Switzerland.

4.5 Designing for Market Maturation: Sunset Clauses and Accountability

If public orchestration is justified by market immaturity, the justification weakens as the market matures. Intervention design should in this case incorporate mechanisms for transition – ensuring that public involvement catalyzes private market development rather than permanently displacing it.

The principle of time-limited support
In addition to the preference for lightweight measures discussed in 4.2, the Subsidies Act reflects a clear preference for time-limited support: where possible, start-up, adjustment, or bridging assistance (Aufbau-, Anpassungs- oder Überbrückungshilfen) should be provided rather than permanent subsidies (see also Bezzola-Büchler, unpublished working paper). This principle applies in particular to market-development interventions. If the goal is to develop an ecosystem that can eventually function without public support, the intervention should be explicitly designed with an endpoint in mind.

Sunset clauses – provisions that terminate or phase down public support after a defined period or upon achievement of specified milestones – can help ensure that temporary interventions do not become permanent. Periodic review mechanisms can assess whether the conditions justifying intervention still obtain. Escalating private co-financing requirements can gradually shift risk from public to private actors as the market matures.

Learning effects and the case for patience
Evidence from pilot projects suggests that performance improves substantially with experience and optimization. In an extreme case, SIG-éco21's monitoring of early pilot sites revealed that systematic adjustments – avoiding unnecessary pump operation, optimizing control sequences, ensuring proper implementation of heating curves – led to a doubling of the coefficient of performance (COP) between successive heating seasons at one site (SIG-éco21, Chaleur Renouvelable program documentation). This improvement came not from new technology but from learning: identifying suboptimal configurations and correcting them.

Such learning effects have implications for intervention design. Early projects will likely perform worse than later ones as experience accumulates. If public programs are evaluated solely on early results, they may be judged failures before the learning curve has been climbed. Conversely, the existence of learning effects strengthens the case for public involvement in early-stage market development: the knowledge generated by pilot projects benefits the entire ecosystem, not just the entity that funded them. A public actor may internalize these spillovers in a way that private actors, who cannot capture the full value of learning they generate, cannot.

Risks of entrenchment
As noted earlier, the risk of entrenchment is real. In the context of market maturation, public entities that have invested in building capabilities, hiring staff, and establishing market positions may resist withdrawal even when their role is no longer necessary. Political constituencies may form around continued public provision. Private actors who might otherwise enter the market may be deterred by public competition. These dynamics can transform what was intended as temporary market development into permanent public sector expansion.

Mitigating this risk requires deliberate design. Clear articulation of objectives and success criteria at the outset makes it harder to redefine the mission later. Governance structures that include independent oversight can provide accountability. Transparency requirements – publishing performance data, costs, and outcomes – allow external assessment of whether continued intervention is justified.

Accountability and transparency mechanisms

Several mechanisms can enhance accountability for public entities operating in this space. Performance reporting against defined KPIs – installation volumes, costs per unit, system performance, customer satisfaction – allows comparison over time and across entities. Benchmarking against comparable activities elsewhere provides external reference points. Competitive tendering for specific activities, even within a publicly orchestrated framework, can introduce market discipline.

One option that merits consideration is systematic transparency about individual projects: making public the technical specifications, costs, and performance outcomes of installations facilitated by public programs. Such transparency serves multiple purposes: it enables learning across projects and actors, creates reputational incentives for quality, and allows independent assessment of whether public resources are being used effectively. It provides data for research and continuous improvement. Some such mechanism – whether organized as a public registry, an evaluation platform, or simply mandatory disclosure requirements – could strengthen accountability while simultaneously contributing to ecosystem development by reducing information asymmetries.

The risks from lacking strong public accountability are tangible. One may consider, for instance, that technological development may over time yield substantially more cost-effective solutions than those initially adopted. Without competitive pressure and transparent cost reporting, a publicly orchestrated entity may have weak incentives to switch suppliers or adopt innovations that would reduce costs – particularly if established relationships, familiarity, or internal preferences favor continuation with incumbent providers. Private markets, by contrast, tend to adopt cost-reducing innovations more rapidly because competitive pressure punishes those who do not. Strong accountability mechanisms without loopholes – including transparent disclosure of procurement choices and their rationale – can help ensure that public orchestration does not inadvertently lock in suboptimal solutions.

More generally, mechanisms that facilitate systematic exchange of experience, cost information, and technical solutions across jurisdictions can support learning and reduce coordination failures during the market maturation phase (see also the inter-cantonal exchange practice example in Section 6).

Balancing effectiveness and exit

There is tension between designing for effectiveness in the short term and designing for exit in the long term. An intervention that is maximally effective at accelerating market development may also be one that creates deep public involvement and strong path dependencies. An intervention designed primarily for easy exit may be too limited to overcome the barriers that justify intervention in the first place.

Managing this tension requires judgment about context-specific factors: how severe are the barriers, how urgent the policy objectives, what institutional capacities are available, what is the realistic potential for private market development? There is no formula that resolves these questions; they require deliberation and, inevitably, some degree of experimentation and learning.

Looking ahead

The framework developed in this section – risk typology, allocation principles, the role and limits of guarantees, the case for and design of public orchestration – provides the analytical background for assessing concrete intervention models. The following section applies this framework to examine the Geneva model in detail, assessing how its institutional design allocates risks and addresses the barriers identified in Section 2. Section 6 then considers how similar – or different – approaches might be adapted to other cantonal contexts.

5. The Geneva Model: A Detailed Case Study

The Geneva case does not represent a retrospectively selected or analytically neutral case study. Rather, it reflects an institutional approach that has been developed in close interaction between the Canton of Geneva and its public utility SIG in response to concrete policy and implementation challenges, while being examined and contextualized within the RENOWAVE research framework. SIG serves both as the main practice sponsor of the Innosuisse RENOWAVE program and as the official implementation partner of Subproject 3.2. This positioning is important for interpreting the case correctly: the Geneva model is presented not as a universally optimal solution, but as a living case embedded in an ongoing policy process. Geneva is therefore treated not merely as a descriptive case study, but as a policy laboratory in which institutional arrangements are actively being implemented, tested, and refined under real-world constraints.

Beyond this methodological positioning, the Geneva case merits detailed attention for several reasons. First, the canton has committed substantial public resources and institutional capacity to heat decarbonization already since more than a decade with the SIG-éco21 program, creating a natural laboratory for observing what works and what does not. Second, the model that has emerged and is currently pursued – centered on municipal foundations coordinated by the public utility SIG – represents a distinctive approach that differs from both pure market solutions and direct public provision, and therefore represents a direct practical implementation of what the present research finds to be a promising approach (see Section 4). Third, Geneva's institutional innovations are sufficiently developed so that they can be described in concrete terms, yet sufficiently recent that their long-term effectiveness remains to be demonstrated. This combination of specificity and uncertainty makes the case analytically interesting; the present research can benefit from implementation insights, and if successful, the analysis may provide further inputs to the evolution of the implementation, in addition to providing a useful live case study for any other regional government interested in a strong role of supporting its (large) building heat decarbonization.

The analysis proceeds as follows. Section 5.1 describes the Geneva context: why the canton faces particular challenges and opportunities in building heat decarbonization. Section 5.2 presents the municipal foundation model that has emerged as the primary institutional vehicle currently pursued. Section 5.3 examines SIG's role as orchestrator and technical guarantor. Section 5.4 analyzes the financing architecture, including the proposed cantonal financing central. Section 5.5 maps how the model allocates the specific risks identified in Section 4. Section 5.6 offers an assessment of what the model addresses well, what remains uncertain, and what lessons might transfer to other contexts.

5.1 The Geneva Context

Geneva presents a particular configuration of circumstances that shapes both the challenge and the response. As Switzerland's most urbanized canton, with a population density roughly five times the national average, Geneva faces constraints that may not apply to the same degree in other regions. Space for ground-source heat pumps is limited. Noise regulations in dense residential areas complicate air-source installations. The building stock includes substantial numbers of older multi-family buildings where heating system replacement involves genuine technical complexity.

At the same time, the canton, dominated by the City of Geneva as a favorable economic area, has institutional resources that other cantons may lack. SIG, as a cantonal public utility with responsibilities spanning large electricity, gas, water, and thermal networks, possesses technical capabilities, customer relationships, and financial capacity that smaller utilities or purely private actors would struggle to replicate. The canton has an established, ambitious framework of energy policy, including the Plan Directeur de l'Energie (PDE) and associated funding mechanisms, aiming to phase out direct carbon emissions in heating by 2030 (Geneva 2020). More generally, Geneva's political culture has historically been receptive to public sector involvement in infrastructure provision.

Beyond its technical and organizational capabilities, SIG operates under a specific public mandate that shapes both what it can and cannot do. As a cantonal public utility, SIG is not merely an energy service provider but is institutionally expected to contribute to the implementation of Geneva's energy and climate policy objectives, including the decarbonization of building heat supply. At the same time, it operates under regulatory, governance, and balance-sheet constraints that limit its ability to simply internalize all investment, operational, and performance risks on its own account. SIG cannot expand its balance sheet indefinitely, nor can it assume open-ended exposure to project-level risks without appropriate institutional backing. These constraints have been a central driver of the Geneva model's design: rather than positioning SIG as a fully integrated owner–operator for all decentralized heating assets, the model separates asset ownership, technical orchestration, and financing across municipal foundations, SIG, and the canton. The resulting structure reflects not a lack of willingness on SIG's part to act, but an attempt to reconcile an active public mandate with prudent risk management and institutional sustainability.

The strategic context is shaped by the canton's district heating plans. SIG has received a mandate to expand the reseau thermique structurant (RTS) – the backbone district heating network in the City of Geneva – from approximately 10% to 55% coverage of building heat demand by 2050. This expansion, estimated to require approximately CHF 1.5 billion on a first period of investment through 2030 (30% coverage of building heat), is proceeding under direct SIG responsibility. The public vote of February 2022 has confirmed a cantonal monopoly to deploy district heating solutions throughout the urban areas of the canton, , and the Grand Council approved the delegation of this monopoly to SIG, which will be responsible for ensuring the rollout of these structural thermal networks (Geneva 2024). That means that there will be about 40% of Geneva's overall buildings that will remain outside the district heating perimeter.

For these buildings – numbering over 4200 potential sites according to SIG's mapping – individual or small-scale collective solutions are required. Air-to-water heat pumps represent the most broadly applicable technology, given Geneva's limited access to other renewable heat sources apart from ambient air. SIG's Chaleur Renouvelable Bâtiment program has demonstrated technical feasibility through pilot projects, including installations serving buildings with up to 260 apartments and thermal capacities reaching 530 kW. These pilots have confirmed that the technology works, while also revealing the economic and organizational challenges discussed in Section 2.

Outside the RTS perimeter, the canton's strategy prioritizes solutions according to local conditions. Deep geothermal is being explored for two specific zones in the canton where favorable geological conditions exist. For all other areas, heat pumps represent the principal solution, and, where appropriate, small-scale local networks.

The target deployment rate – 50 to 100 building entrances per year at medium term – is ambitious relative to current market activity but modest relative to the total stock requiring transition. The gap between what the market delivers spontaneously and what climate objectives require has motivated the institutional innovations described in subsequent sections.

5.2 The Municipal Foundation Model "Fondation Communale"

The core institutional innovation in Geneva is the Fondation Communale – a municipal-level foundation structure designed to own and operate heating infrastructure for buildings outside the backbone district heating network (RTS). It envisages governing both types of solutions considered for the decarbonization outside this central district heating network:

- Individual large building heat-pump solutions
- Local district heating networks in the communes around central Geneva

The choice of municipal rather than cantonal scale reflects several considerations.

First, municipalities possess legitimacy with local property owners that more distant authorities lack. Experience with existing communal heating networks (chauffage à distance CAD communaux) has shown that municipal officials – both executive and legislative – maintain relationships of trust with residents that facilitate the 'before-sales and after-sales' aspects of heat contracting arrangements. Property owners are more willing to enter long-term contractual relationships with entities where they have voice and visibility.[16]

Second, municipal building stock often provides natural anchor customers. Administrative buildings, schools, and other communal facilities frequently occupy central village locations and can serve as initial connections that demonstrate the viability of collective solutions while providing baseline load for shared infrastructure.

Third, the municipal scale allows adaptation to local circumstances. Building density, available heat sources (ground-source options vary significantly across Geneva's 45 municipalities), existing infrastructure, and community preferences differ across locations. A single cantonal structure would either impose uniformity or require complex internal differentiation; municipal foundations can tailor their approach while operating within a common framework.

The municipal scale does impose constraints. With 45 municipalities potentially requiring separate foundations, the model demands a replicable organizational template. Substantial variation in foundation structures would generate administrative complexity and impede the standardization that reduces transaction costs. The model therefore envisions foundations sharing common governance principles and operational procedures while retaining municipal identity.

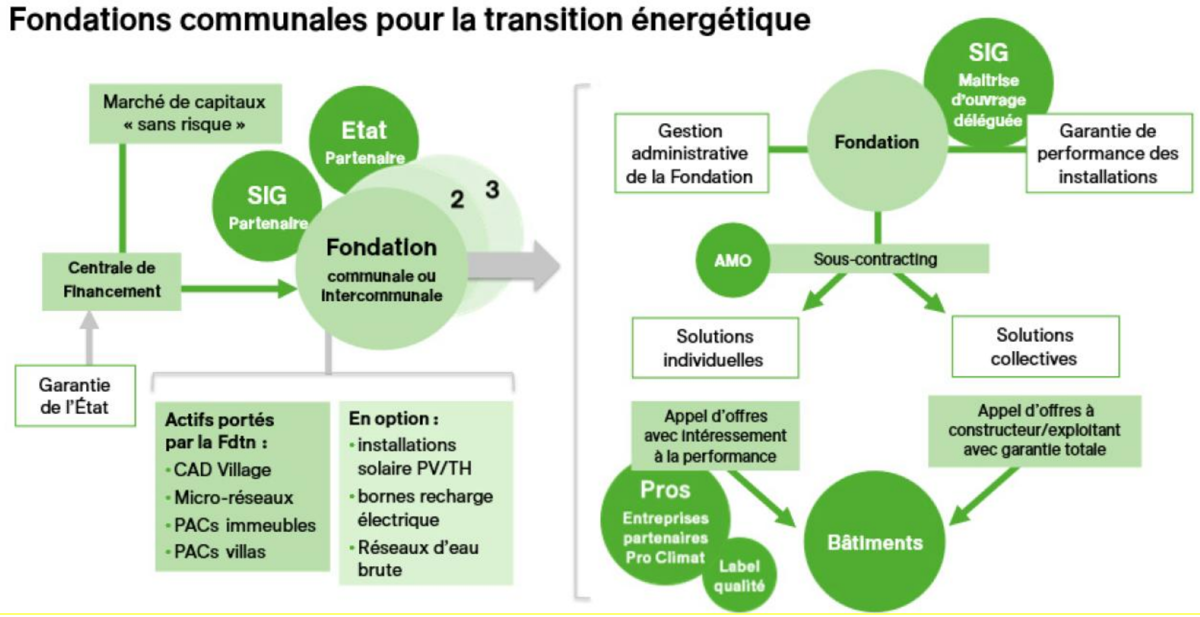
Governance Structure

The proposed governance structure operates at two levels. At the decision-making level, the foundation board includes representatives of the municipality, the canton, and SIG. This tripartite structure ensures that local interests, cantonal policy objectives, and technical-operational considerations all have voice in strategic decisions. At the consultative level, representatives of local stakeholders – including building owners participating in the contracting arrangements – provide input and oversight. This shared governance (*gouvernance partagée*) is considered essential to the model's legitimacy: the foundations operate as non-profit entities with open accounts, allowing building owners and the broader population to verify that the arrangement serves no private profit motive. This transparency is understood as central to building the trust required for long-term contracting relationships.

The legal form within which the Fondations Communales are implemented, remains under analysis. According to SIG's internal assessment (SIG 2024 Rapport Fondations Communales), the appropriate structure should be easy to replicate across municipalities while offering adequate legal security – criteria described as 'relativement simple à définir.' Two options are under consideration: public foundations (fondations publiques) or private foundations of public interest (fondations privées d'intérêt public). Legal analysis by SIG's direction DR was ongoing at the time of the report, with conclusions expected in 2026. The choice between these forms can be expected to depend on

[16] Rapport Fondations Communales (SIG 2024).

factors including governance flexibility, regulatory requirements, and compatibility with the proposed cantonal financing arrangements.



Source: M. Rüegg and A. Marcé (SIG), 2024

Figure 5 Municipal Foundations for the Energy Transition, with permission from M. Rüegg (SIG)

Operational Model

The foundations operate as asset-holding and contracting entities rather than as direct service providers. Building owners enter long-term contracts (typically 15-25 years) with the foundation, under which the foundation supplies heat at contractually defined prices. It seems expectable that these tariffs to be allowed to escalate during the contract period based on predefined indexes, although in the information so far received this is not clearly defined. The foundation owns the heating infrastructure – whether individual building heat pumps or small-scale thermal networks serving clusters of buildings.

Technical operations involve a two-tier tender structure rather than direct execution by the foundation. At the strategic level, SIG performs territorial energy planning (*planification énergétique territoriale*), analyzing the building stock across the canton and providing public information about which types of solutions are most appropriate for different zones. This yields a general picture of recommended approaches but does not yet account for the specifics of each individual building.

At the project level, SIG selects through a first competitive tender engineering firms to serve as orchestrators (*assistants maîtres d'ouvrage*, AMO). SIG delegates coordination to these AMOs while remaining present in the process. This first-tier selection serves three purposes: to guarantee full transparency in project development, to ensure that optimal solutions can be defined in collaboration with the relevant stakeholders, and to enable effective oversight of subcontractor performance. The AMOs are responsible for validating technical feasibility, designing solutions in detail for specific buildings, and subsequently defining and managing the second-tier procurement processes.

The second tier involves selection of the firms that will execute and operate the installations: installer-operators for individual building solutions, and constructor-operators for collective solutions (small-scale local networks). SIG maintains lists of accredited subcontractors meeting minimum quality requirements – building on existing accreditation mechanisms developed within the éco21 program – but the detailed specifications and tender management occur at the AMO level. This two-tier structure preserves market orientation: SIG shapes the strategic context and selects the coordinating engineers, while allowing the market to organize execution through the AMO layer.

We may refer to the AMO as "orchestrators", or as co-orchestrators together with SIG, as there is an important interactive element with by-way exchange and learning between these two layers.

Administrative functions are distributed between SIG and local entities. SIG handles billing, second-level customer service, and technical support. First-level customer contact may be provided locally, potentially through municipal offices or local commercial partners, maintaining the accessibility that the municipal scale is intended to provide.

5.3 SIG's Role: Orchestrator and Technical Guarantor

SIG's role in the Geneva model extends beyond that of a conventional utility or contractor. In line with the ecosystem framework developed in companion research (Zapata et al., 2024), SIG functions as a co-orchestrator alongside the AMO firms it selects – shaping the market context and coordinating at the strategic level, while allowing substantial autonomy in project-level execution. This reflects a deliberate design principle: SIG orients the market but lets it organize itself.

Coordination Functions
As orchestrator, the utility performs several coordination functions that address the ecosystem gaps identified in Section 2. First, SIG aggregates demand. Individual building owners face high search costs in identifying qualified contractors and high transaction costs in negotiating bespoke arrangements. By consolidating procurement across multiple foundations and projects, SIG creates sufficient volume to attract contractor interest and justify investment in specialized capabilities.

Second, SIG develops and maintains technical standards. The absence of standardized hydraulic schemes for multi-family heat pump installations was identified as a key barrier. SIG's participation in research projects (including the AirBiVal project on hydraulic configurations) and its accumulation of operational experience across pilot sites, over more than a decade by now, allows it to specify requirements that contractors can reliably meet. This standardization reduces design risk for individual projects while building the knowledge base that enables the broader market to develop.

Third, SIG provides training and capability development. The SIG-éco21 program includes training components for engineers and heating technicians, addressing the knowledge gaps that interview evidence identified as significant barriers. By investing in workforce development, SIG addresses a coordination failure that no individual contractor has incentive to resolve: training workers who might subsequently move to competitors.

Fourth, SIG manages procurement at scale. Coordinating equipment purchases at the cantonal level – for example, bulk procurement of heat pumps – can ensure availability (of customized solutions) and reduce unit costs. In recent years, during supply chain disruptions such as those experienced during the COVID-19 pandemic and the energy crisis following the Ukraine invasion, coordinated procurement proved beneficial for maintaining project timelines.

Performance Guarantee
A distinctive feature – undoubtedly part of the most essential core of the entire setup - of the Geneva model is SIG's provision of a performance guarantee within the Municipal Foundations. Under this arrangement, SIG assumes responsibility for ensuring that installed systems deliver the contracted energy services at specified efficiency levels. If systems underperform – whether due to design deficiencies, installation errors, or operational problems – SIG bears the cost of remediation rather than the foundation or the end customer.

Beyond performance, a second element is considered essential to the Geneva model's viability: transparency through shared governance. The Municipal Foundations are intended to operate as non-profit structures with open accounts, allowing building owners and the broader public to verify that the arrangement serves no private profit motive. This transparency is not merely a governance nicety but a precondition for the trust required to sustain long-term contracting relationships – particularly given that building owners are asked to enter 15-25 year commitments with entities they do not control.

The guarantee also creates incentives for SIG to maintain quality throughout the value chain. A guarantor who bears performance risk has strong incentive to establish rigorous specifications, select capable contractors, monitor installation quality, and ensure effective ongoing operations. This alignment of incentives with capabilities represents a core design principle of efficient risk allocation.

This guarantee addresses a fundamental asymmetric information problem. Building owners cannot readily assess whether a proposed heat pump system is appropriately designed for their building, whether the selected contractor has the capability to install it correctly, or whether observed performance reflects inherent limitations versus correctable deficiencies. By interposing a creditworthy guarantor with technical expertise, the model shifts these risks away from parties who cannot evaluate them toward a party that can.

An important corollary is that SIG intends to transfer substantial performance responsibility to the subcontractors who actually perform the work. The Pro Climat partner program establishes expectations that participating contractors move from an obligation of means ('I installed a heat pump') to an obligation of results ('I operate an efficient thermal supply system'). However, this transfer is conceived as a gradual process. Initially, subcontractors – particularly those without established track records in MFH installations – will not be accustomed to assuming performance risk. The approach therefore introduces step-by-step increases in performance responsibility, developed through collaboration with the AMO engineering firms, applicable to both individual and collective solutions. This gradual transfer is facilitated by monitoring systems that provide transparency on actual performance, enabling both accountability and continuous improvement.

5.4 Financing Architecture

The financing challenge for Geneva's heat transition outside the district heating network is substantial. With over 4200 potential sites requiring individual or small-scale collective solutions, and investment costs running to several thousand francs per kilowatt of thermal capacity, the total capital requirement through 2040 could approach CHF 1 billion. Mobilizing this capital at costs that keep delivered heat prices competitive is essential to the model's viability.

The Centrale de Financement
The Rapport Fondations Communales (SIG 2024) proposes a centralized financing structure – a "Centrale de Financement" – as the mechanism for channeling capital to municipal foundations. The rationale rests on two observations. First, capital markets for low-risk instruments are typically active only for issuances exceeding CHF 100 million; individual municipal foundations would fall far below this threshold. Second, administrative costs for bond issuance are substantial and should be borne once centrally rather than replicated across dozens of separate foundations.

Under the proposed structure, the Centrale would be put in place by the cantonal Direction Générale des Finances and be managed by a financial operator to be selected through competitive tender. It would pool financing requests from individual foundations and, once aggregated volumes reach appropriate thresholds, issue bonds that can be listed on exchanges. The Centrale could also manage construction credits during the build-up phase, avoiding the need for each foundation to handle its own treasury operations.

The critical enabling condition is a cantonal guarantee. The Rapport Fondations Communales envisions non-profit structures benefiting from public guarantees that enable access to "risk-free" capital markets. The canton already provides analogous guarantees to other public entities, including Transports Publics Genevois and Rentes Genevoises, establishing precedent for this type of arrangement.

Investor Appetite: The Ethos Assessment
To test whether this financing concept would attract institutional capital, SIG commissioned the foundation Ethos to survey pension funds, insurers, and asset managers. As discussed in Section 2.2, the findings confirmed that a cantonal guarantee transforms the investor landscape: with a guarantee, investors require only modest spreads above cantonal bond yields; without one, the majority have no interest at all. The guarantee functions less as a marginal cost reducer than as a market-access enabler.

Ethos also assessed alternative financing structures – including decentralized approaches where each foundation raises capital independently, and a pooled investment fund managed by a professional asset manager. Their analysis concluded that centralized issuance through a cantonal vehicle, as SIG had proposed, offered the most promising path, avoiding the fragmentation problems of decentralized approaches and the governance complexities of managed funds.

Outstanding Questions
Several aspects require clarification before implementation. The legal basis for cantonal involvement in this type of financing coordination requires verification. Governance arrangements – including any discretionary authority of the Centrale over project selection – need specification. The mechanics of fund allocation from the Centrale to individual foundations, and the accountability structures accompanying such flows, remain to be elaborated. The Rapport Fondations Communales noted that legal analysis was ongoing, with conclusions expected in 2026. Political alignment among the canton, municipalities, and SIG on these details is a prerequisite for proceeding.

5.5 Risk Allocation in Practice

Section 4 identified the principal risks facing different actors in MFH heating system transitions and articulated principles for efficient allocation. How does the Geneva model allocate these risks in practice?

Risks to Building Owners
Building owners in the Geneva model face substantially reduced risk compared to conventional approaches. Design and technical feasibility risk is shifted to SIG through the performance guarantee: if the system does not perform as specified, remediation is SIG's responsibility. Contractor capability risk is mitigated by SIG's role in qualifying and monitoring contractors through the Pro Climat program. Construction and integration risk remains present but is bounded by contractual arrangements that cap owner exposure to agreed prices.

Cost risk is partially addressed through the contracting model itself: owners pay for heat delivered rather than bearing the full uncertainty of capital costs, operating costs, and system performance. However, owners do face some sort of tariff-related risk over the contract duration – if energy costs or other factors change substantially, contracted tariffs may prove more or less favorable than alternatives that might have been available.

Operator continuity risk – the concern that the contractor might fail or withdraw over a multi-decade contract – is substantially mitigated by SIG's involvement. A large public utility with diversified activities is far more likely to remain operational over 20+ years than a small private contractor, and the municipal foundation structure provides additional institutional continuity.

Risks to Contractors
Private contractors in the Geneva model operate as subcontractors rather than principals, fundamentally changing their risk profile. Tariff estimation risk – identified in interviews as the dominant concern for contractors contemplating independent contracting – is transferred to the foundation and ultimately to SIG. Contractors bid on defined scopes of work with specifications established by SIG, rather than bearing full project risk.

Capital access constraints are resolved by the foundation's access to financing through the cantonal central. Contractors need not finance installations themselves; they receive payment for work performed according to normal commercial terms.

The trade-off is reduced autonomy and potentially reduced margins. Contractors operating within the SIG-orchestrated framework accept standardized approaches, quality monitoring, and performance accountability that independent operators might avoid. For contractors who possess or are willing to develop appropriate capabilities, this represents access to a substantial and growing market; for those preferring less structured arrangements, it may be unattractive.

Risks to the Public Sector
The Geneva model deliberately concentrates certain risks in the public sector. SIG bears performance risk through its guarantee to foundations. The canton bears credit risk through its guarantee to bondholders. This concentration reflects the judgment that these public entities are better positioned to bear these specific risks than the private parties who would otherwise hold them.

The fiscal exposure involved is real but bounded. SIG's performance guarantee is backed by its balance sheet and supported by its ability to monitor and enforce quality throughout the value chain. The canton's credit guarantee is contingent – a liability only if the underlying projects fail to generate sufficient revenue to service debt. Given the essential nature of heating services (customers have strong incentive to continue paying for heat) and the long-term nature of contracts, systemic default appears unlikely, though not impossible.

The model also creates entrenchment risk for the public sector: what begins as market development support may prove difficult to withdraw as constituencies develop around continued intervention (see above). The design addresses this partially through the use of private contractors for execution – SIG orchestrates but does not build internal capacity that would be difficult to wind down – but the fundamental tension between temporary support and permanent presence remains.

5.6 Assessment and Limitations: From Pilot to Pending Roll-out

Before assessing strengths and limitations, the current implementation status deserves explicit acknowledgment. At the time of writing, the Municipal Foundation model as described here has not yet been implemented. The institutional design has been elaborated, and political discussions are underway, but the foundations themselves have not yet been established. Practical implementation is expected to begin in the course of 2026. In parallel, SIG's éco21 program has accumulated substantial operational experience with MFH heat pump installations through individual projects organized under that program – experience that informs the Municipal Foundation concept, even if those projects operated under a different institutional framework. The assessment that follows therefore rests on this prior operational experience and on the coherence of the institutional design, rather than on observed performance of the Municipal Foundation model – or the model of "Sociétés portant d'actifs" how they might alternatively be called – itself.

What the Model Addresses Well

The model addresses the coordination failure problem directly. By positioning SIG as a delegated project owner and then having a first competitive tender to select orchestrators, it creates a focal point for ecosystem development – aggregating demand, setting standards, building capabilities, and coordinating among actors who would otherwise struggle to align. This orchestration function is perhaps the model's most distinctive contribution.

The model addresses information asymmetry through SIG's performance guarantee. Building owners need not assess contractor capability or system appropriateness themselves; they can rely on a creditworthy guarantor with technical expertise to ensure delivered performance. This represents a substantial simplification of the decision problem facing building owners. The model equally addresses the problem of a lack of efficient, centralized, by having SIG tightly involved in the technical solutions.

The model addresses financing constraints through the combination of public guarantee and centralized issuance. By transforming the credit profile of project financing, it enables access to institutional capital at costs that would otherwise be unavailable. The market study confirmed that this access – not marginal cost reduction – is the primary value of the guarantee.

The model preserves private sector involvement through the subcontracting structure. Contractors perform design, installation, and operations; SIG orchestrates rather than executes. This preserves competitive discipline and private sector capabilities while addressing barriers that private actors alone cannot overcome.

What Remains Uncertain or Unresolved

Several significant uncertainties remain. First, the model has not yet been implemented at scale. Pilot projects and institutional design are not the same as operational reality across dozens of foundations serving thousands of buildings. Unforeseen complications may emerge as the model moves from planning to execution.

Second, the tariff levels required to make the contracting model economically viable remain subject to uncertainty. Heat pump installations in multi-family buildings are capital-intensive, and achieving tariffs competitive with fossil alternatives depends on installation costs (which should decline with standardization and scale), electricity prices (which involve substantial long-term uncertainty, as discussed in Section 3), and the level of subsidies and support available. If delivered heat proves substantially more expensive than alternatives, customer uptake may disappoint regardless of institutional arrangements.

Third, the model depends heavily on SIG's capacity and willingness to serve as orchestrator over extended periods. Institutional priorities can shift; key personnel move on; political and regulatory contexts evolve. The durability of SIG's commitment to this role – which requires sustained investment without immediate financial return – cannot be assumed.

Fourth, the broader ecosystem development that the model aims to catalyze may or may not materialize. The theory is that SIG's orchestration activities will build contractor capabilities, establish standards, and create market conditions that eventually enable private actors to operate more independently. Whether this development actually occurs – or whether the ecosystem remains dependent on public orchestration indefinitely – is an empirical question that cannot be answered in advance.

Critical Implementation Details

Four implementation details merit particular attention, as they may prove as important for long-term program sustainability as the broader institutional architecture.

First, the mechanism for transferring performance risk to contractors requires careful elaboration. The Rapport Fondations Communales (SIG 2024) articulates the intended direction clearly: professionals should shift from an "obligation of means" to an "obligation of results", with remuneration tied to delivered performance rather than margins on equipment. The report also notes that contracts may include performance penalties if agreed energy efficiency targets are not met. However, the specific contractual structures – liability limits, penalty thresholds, monitoring protocols, and dispute resolution mechanisms – remain to be specified. How performance risk is ultimately shared between SIG (as guarantor to the foundations) and contractors (as executing parties) will significantly influence contractor incentives, pricing strategies, and willingness to participate. A tiered approach, in which contractors bear routine or manageable performance deviations while public guarantees absorb more extreme or systemic risks, would seem ideal, as it may offer a workable balance between accountability and market participation. More generally, effective risk allocation will depend on aligning responsibility with both the degree of control actors have over specific risk factors and their respective capacity to absorb potential losses. Translating this principle into practice requires detailed, domain-specific understanding of the technical risk profiles involved – an area in which SIG's accumulated operational experience is likely to be particularly valuable.

Second, tariff indexation deserves attention. With contracts spanning 20 or more years, it is unlikely that a fully fixed tariff trajectory over the full duration of the heat supply contract is adequate. Hence, tariff escalation rules should be fixed, similar to what is usually the case for other larger scale PPP infrastructure projects. The formula by which heat tariffs adjust over time will substantially affect the distribution of risk between foundations and customers. A purely fixed tariff exposes foundations (and ultimately the public guarantor) to input and financing cost volatility; a purely pass-through formula shifts all risk to customers, potentially undermining the value proposition of stable, predictable heating costs. Appropriate indexation – ideally reflecting electricity prices, general inflation, labor costs, and perhaps interest rates – can allocate cost risk to parties best positioned to bear it while preserving the predictability that makes contracting attractive. Neither the Rapport Fondations Communales nor other available documentation specifies how this will be handled.

Third, transparency and information disclosure are critical. The long-term credibility and legitimacy of the model depend on systematic transparency regarding costs, performance, and decision criteria. This includes transparent heat tariff structures and indexation formulas, clear disclosure of performance metrics used to assess contractors, and visibility into procurement and subcontracting decisions, including, ideally, KPIs such as capex costs for core elements (such as the heat pumps) of solutions implemented. Without such transparency, it becomes difficult for building owners, contractors, and external observers to assess whether risks are being allocated as intended and whether efficiency gains from orchestration are being realized. Over time, insufficient transparency risks undermining trust, weakening contestability, and blunting learning effects that are central to market maturation. The importance of these points should not be understated and may override concerns about (slight) economic disadvantages when insisting on publishing, for example, certain core capex or services costs.

Fourth, procurement governance and the scope of objectives matter. The Geneva case highlights a broader governance challenge that is likely to arise in similar public–private arrangements: public orchestration of complex infrastructures inevitably raises questions about how far procurement and contracting should be used to pursue objectives beyond narrowly defined technical performance and cost efficiency. For example, requirements imposed on contracted firms – such as training or apprenticeship commitments of the kind discussed above – may be viewed, depending on perspective, either as legitimate expressions of broader social objectives or as an illiberal mixing of unrelated policy goals into technical procurement. If not carefully calibrated, such conditions risk introducing arbitrariness, reducing effective competition, and increasing administrative overhead, thereby undermining some of the efficiency gains that the centralized orchestration model seeks to achieve. The Geneva case illustrates the importance of striking a careful balance: leveraging public procurement to support ecosystem development without overburdening it with secondary objectives that could compromise transparency, contestability, and long-term cost discipline. As a general design principle, there is therefore a strong case for erring toward the integration of conditions that are directly linked to the core market failures the model is intended to address, while incorporating additional objectives only where they plausibly and demonstrably contribute to resolving those failures or are indispensable enabling elements. Reservations for unrelated aims should be avoided within the scheme.

Transferability to Other Contexts

These governance considerations also shape how far, and in what form, the Geneva model can be transferred to other contexts.

The Geneva model should be understood less as a blueprint and more as a reference architecture or “illustration”. Its value for other cantons lies not in replication but in demonstrating how certain design principles – public guarantee enabling institutional capital, separation of orchestration from execution, municipal-scale legitimacy combined with cantonal-scale financing – can be combined into a coherent whole.

The Geneva model reflects Geneva's particular circumstances: a large and capable public utility, an urbanized canton with substantial multi-family building stock, a political culture receptive to public sector involvement, and established institutional relationships among cantonal, municipal, and utility actors. Not all of these conditions obtain elsewhere.

Cantons with smaller or less capable utilities may struggle to replicate SIG's orchestrator role. Rural cantons with dispersed single-family housing face different challenges than Geneva's urban multi-family context. Political preferences regarding public sector involvement vary substantially across Switzerland.

Nevertheless, certain elements of the Geneva model may transfer more readily than the complete package. The principle of public guarantee enabling access to institutional capital applies wherever such capital is needed and public creditworthiness is available. The orchestrator function might be performed by entities other than utilities – cantonal energy agencies, for example, or purpose-built public-private partnerships. The municipal foundation structure might be adapted to inter-municipal or regional scales where individual municipalities lack sufficient volume.

Section 6 takes up the question of generalization more systematically, developing a decision framework that cantons and cities can use to assess which elements of the Geneva model might be applicable in their specific circumstances.

6. Generalization: Adapting the Approach for Other Cantons

The Geneva case illustrates one possible way of organizing public intervention to accelerate the decarbonization of heating in multi-family buildings. It does not constitute a universally applicable blueprint. The purpose of this chapter is therefore not to promote replication of the Geneva model as such, but to distil from it transferable principles and a decision logic that can guide other cantons and cities in choosing context-appropriate approaches. Generalization in this sense concerns mechanisms, sequencing, and roles, not institutional form.

The chapter is intended to support decision-making by public authorities operating under heterogeneous local conditions. Rather than asking whether a given canton should adopt a specific model, the relevant question is which public role is economically coherent under prevailing market, institutional, and political constraints.

The Geneva model did not emerge from a research design exercise, nor was it conceived as a template for replication. It evolved within an ongoing cantonal policy process, driven primarily by the strategic and operational work of the local public utility and public authorities. The role of Renowave 3.2 has been to analyze, accompany, and reflect on this evolution through close interaction with implementation partners, drawing out the economic logic underlying observed institutional choices.

The analytical value of the Geneva case lies not in its originality, but in the fact that it renders otherwise latent coordination, risk-allocation, and governance problems visible under real-world conditions. In particular, it shows how fragmented private incentives, project-specific risks, and missing market standards interact to suppress investment, even where technologies are becoming technically more mature and socially desirable. The case is therefore best understood as an observed instance of public orchestration in practice, from which the reasoning linking specific market failures to corresponding public roles and instruments can be generalized.

What Is Geneva-Specific – and Why It Matters

Several elements of the Geneva context are not easily replicable elsewhere and must be made explicit to avoid overgeneralization.

First, Geneva benefits from the presence of a large, technically sophisticated, and politically embedded public utility with long-standing operational experience in the heat sector. This utility enjoys a high degree of public legitimacy and is accustomed to acting as a system integrator across planning, construction, and operation. Second, the canton has the capacity to mobilize balance-sheet resources and public guarantees at a scale that materially affects risk allocation. Third, the dense urban building stock, combined with a clear political mandate for rapid decarbonization, creates both pressure and opportunities for coordinated solutions.

These conditions matter because institutional solutions that rely on active public risk participation and central coordination presuppose administrative capacity, technical expertise, and political accountability. Transposing such arrangements into contexts lacking these prerequisites risks inefficient use of public resources, excessive exposure to poorly understood risks, or implementation failure. Recognizing what is Geneva-specific is therefore a precondition for meaningful generalization.

Transferable Principles Across Cantons

Drawing on the risk-allocation principles developed in Section 4, several design principles emerging from the Geneva experience are broadly transferable across cantons.

First, public intervention is most effective when it targets coordination and risk-allocation failures rather than treating each project as an isolated financing problem. In the context of large-building heat retrofits, private actors often face risks that are difficult to price, diversify, or insure, leading to systematic underinvestment even when capital is in principle available.

Second, risks should be allocated to actors best able to manage and diversify them. This frequently implies shifting development, performance, and long-term operational risks away from individual building owners, who typically lack both the expertise and the portfolio scale to bear them efficiently.

Third, and particularly relevant in the context of multi-family buildings, ownership, project development, and operation need not coincide. Separating these functions allows each to be assigned to the actor with the appropriate capabilities: asset ownership can remain local or public-interest oriented, project development can be concentrated in specialized entities, and operation can be delegated to actors with technical and organizational expertise. While this separation is well known in infrastructure finance, it remains underutilized in building-level heat decarbonization.

Finally, contingent instruments such as guarantees, backstops, or performance assurances can often achieve more leverage than direct grants when the dominant barrier is downside risk rather than absolute cost. These principles can be implemented through a variety of legal and organizational forms, ranging from utility-led models to facilitation platforms or mixed public–private vehicles.

6.1 A Decision Framework for Cantonal Approaches

To support context-sensitive policy design, the Geneva experience can be translated into a structured decision framework. This framework is not intended as a mechanical checklist, but as an analytical aid linking observable conditions to economically coherent public roles.

A first question is whether low-carbon heating solutions are socially desirable but privately unattractive. If fossil-based alternatives remain cheaper due to insufficient price internalization, institutional solutions alone will not suffice; price-based instruments, regulatory standards, or phase-out mandates are then indispensable preconditions.

If the problem is not primarily price but uptake, the next step is to identify the dominant barrier. If liquidity constraints dominate and risks are well understood, targeted loans or credit facilitation may be the first measure to put in place. Where risk allocation and coordination failures dominate – as is typical for large-building retrofits – finance-only instruments are insufficient, as they leave the underlying uncertainty unresolved.

A further decision concerns whether private actors can reasonably bear the relevant risks. If risks are highly project-specific, asymmetric, or only partially controllable by contractors, expecting private actors to carry them will rationally suppress market entry. In such cases, partial public risk participation, for example through performance guarantees or structured backstops, can be economically justified.

Finally, institutional capacity matters. Where a capable public coordinator exists – such as a utility, public agency, or dedicated foundation – more integrated models become feasible. Where such capacity is lacking, lighter-touch instruments, facilitation roles, or cooperative solutions across jurisdictions may be preferable.

Towards a concrete political decision framework

The preceding discussion identifies which public roles and instruments are economically coherent under different configurations of market failures, risks, and institutional capacity.

In practice, cantonal and municipal authorities operate under binding political, fiscal, and administrative constraints. Not all economically coherent options are politically or institutionally feasible at a given point in time.

The Geneva experience therefore suggests a complementary feasibility-first decision sequence. Rather than starting from an abstract diagnosis of barriers alone, this sequence asks which public levers can be credibly and sustainably deployed under prevailing conditions, and then selects the strongest available intervention accordingly. The logic is intentionally hierarchical: where more powerful instruments are feasible, they should generally be preferred; where they are not, progressively lighter but still active forms of public intervention remain available.

Box: Feasibility-first decision sequence within the cantonal decision framework

Step 0 – Fix framework conditions and reduce strategic uncertainty (precondition)
As early as possible, and as credibly as possible, public authorities should fix the ultimate direction of travel for building heating systems. **Clear and stable timelines for fossil phase-outs, replacement obligations**, and (where relevant) the **duration and end dates of support schemes** reduce uncertainty, lower the option value of waiting, and allow building owners to integrate decarbonization into normal investment cycles. This step is a precondition for all subsequent instruments and applies irrespective of the chosen pathway. The more long-term and authoritative commitments can be made, the better for all actors within the entire concerned ecosystem.

Step 1 – Are additional regional heating-energy or fuel surcharges politically conceivable?
If regionally differentiated heating-energy or fuel surcharges are politically feasible, they constitute a first-best instrument to directly incentivize the fuel switch by internalizing the social and system costs of fossil heating. By increasing the relative operating cost of fossil systems, such surcharges reduce the attractiveness of continued fossil use and lower the need for compensatory downstream interventions.
Where politically acceptable, a (partial) earmarking of the resulting revenues can further support the transition, for example by financing complementary measures such as targeted subsidies, guarantees, or market-development capacity. This revenue use is secondary to the primary function of the surcharge as an incentive instrument and does not remove the need to decide how decarbonization is operationally delivered; rather, it expands the fiscal and policy space for subsequent steps.

Step 2 – Is the canton or city (possibly via a public utility) able and willing to provide public loans and system-level performance guarantees for large-building renovations?
This requires sufficient scale, balance-sheet capacity, technical expertise, and governance structures, as well as the willingness to assume and manage long-term performance risk.
If **yes**, integrated public-orchestrator models become feasible (e.g. utility- or foundation-led solutions with bundled project development, financing, and performance responsibility; see Illustrative Case A). *This corresponds closest to the Geneva solution.*
If **no**, proceed to Step 3.

Step 3 – Is there willingness to finance a strong but strictly time-limited subsidy program for large buildings?
If capital-intensive public risk participation is not feasible, a reinforced subsidy scheme may still be deployed, provided it is strong enough to shift decisions for most rational owners and clearly time-

bound to avoid permanent dependency and excessive waiting behavior. Hard deadlines are essential for effectiveness.
If **yes**, a subsidy-driven pathway with finite duration is viable. *This may be seen as corresponding to the current approach of Vaud, where the main instrument includes subsidies (combined with administrative simplifications such as removal of requirements for construction permits, likely most relevant for SFH rather than for the more complex MFH case).*[17]
If **no**, proceed to Step 4.

Step 4 – Is there willingness to invest in active, hands-on informational and logistical support?
Where neither public risk-bearing nor strong subsidies are feasible, authorities can still pursue an active facilitation pathway. This goes beyond passive information campaigns and entails local or interregional support structures that:

- engage directly with building owners,
- assess building-specific situations,
- allow fully flexible solution searches (rather than narrow protocols),
- publicly document and review advice, and
- actively follow up with owners to prevent inertia.

The minimum objective is to avoid delays beyond legally mandated replacement deadlines; the ideal objective is to accelerate improvements beyond the minimum. This pathway corresponds to a lean coordination and facilitation role (Illustration Case C), but remains more interventionist than simple information provision.

6.2 Hierarchy of Instrument Choice Within a Feasible Pathway

Once a feasible intervention pathway has been identified using the decision logic above, public instruments should be deployed in an ordered sequence that reflects the residual barriers that remain. Public intervention should escalate only to the extent necessary to address those barriers, rather than deploying multiple instruments in parallel without a clear ordering.

Across all pathways, priority should be given – where politically and legally feasible – to instruments that internalize the social and system costs of fossil heating rather than compensating for them ex post. Cost-reflective pricing of heating fuels or energy aligns private operating decisions with societal objectives and reduces the need for downstream support. The hierarchy of instruments discussed below should therefore be read in light of the degree of cost internalization already achieved.

Instruments should be deployed in an order that reflects fiscal efficiency and administrative proportionality. Measures addressing information asymmetries and coordination failures are typically least intrusive and can substantially reduce transaction costs. Where such measures are insufficient, contingent instruments such as guarantees, backstops, or performance assurances can address downside risks that private actors are unable or unwilling to bear. Loans may follow where liquidity constraints remain binding but risks are sufficiently understood. Non-repayable grants are best used as targeted gap-closers, i.e. to bridge residual cost gaps in projects that remain socially desirable but privately marginal even after risk reallocation and coordination mechanisms are in place, particularly where cost internalization remains incomplete.

[17] See e.g. e4s 2025 *Heat pumps and the energy transition in Switzerland: key perspectives from Vaud & Geneva*.

The hierarchy applies within each feasible pathway identified in Section 6.1. In integrated models with strong public capacity (Case A below), guarantees and long-term contracting arrangements may form the backbone of intervention, with grants playing a subsidiary role. In facilitator models (Case B below), credit enhancement, standardization, and advisory services are typically combined, while direct subsidies are used selectively. In lean coordination pathways (Case C below), information, predictability, and inter-regional cooperation dominate, and financial instruments remain limited.

In this sense, the hierarchy is dynamic rather than static: it guides both the initial choice of instruments and their adjustment over time as coordination improves, risks become better understood, and price signals increasingly carry the burden of alignment.

6.3 Complementary and Enabling Measures

Institutional and financial arrangements reach their full effectiveness when combined with complementary measures that support learning, credibility, and market development over time.

6.3.1 Transparency and predictability

Transparency plays a particularly important role. Systematic disclosure of publicly supported large-building renovation projects – including basic project characteristics, cost ranges, chosen technical solutions, and ex post performance indicators – reduces information asymmetries and accelerates learning across actors. Such information can be organized in a shared, publicly accessible inventory that allows practitioners, building owners, and authorities to compare solutions and outcomes. Over time, this type of transparency supports standardization, reputational discipline, and evidence-based policy adjustment.

Predictable policy timelines are equally important, emphasized as Step 0 in the decision logic Box. Clear and credible phase-out dates for fossil heating systems reduce the option value of waiting and discourage strategic delay by building owners. Given the long investment cycles in the building sector, early and stable communication of future requirements allows owners, planners, and financiers to integrate decarbonization into normal renewal cycles rather than treating it as an exceptional intervention.

Where relevant and feasible, alignment with federal frameworks and greater consistency in how existing rules and support structures are interpreted and applied can further lower transaction costs. In the context of large-building heat renovations, this does not refer to the existence of a single national standard or harmonized institutional model, which does not currently exist. Rather, it concerns a set of partially overlapping and still evolving elements, such as technical and regulatory boundary conditions (e.g. grid connection rules, acoustic constraints, planning requirements), eligibility criteria and procedural logic of subsidy programs, and the way (publicly supported) advisory and support services accompany building owners through complex renovation decisions.

These elements are today defined at different levels (federal, cantonal, municipal) and often implemented in heterogeneous ways. Greater consistency – without requiring full uniformity – can reduce complexity for building owners, planners, and contractors by making requirements more predictable and learning effects transferable across projects and regions. In this sense, the development of a more coherent framework emerges primarily through practice, pilot projects, and inter-cantonal exchange, rather than through the top-down introduction of new formal standards. Supporting this learning and coordination process can therefore be as important as the financial instruments themselves. Concretely, this points to a small number of pragmatic next steps that can be pursued incrementally and without requiring new formal competencies or national standard-setting:

First, cantons and utilities can systematically document and publish a minimum common set of information for publicly supported large-building renovation projects (e.g. building type, chosen technical solution, investment cost ranges, applied subsidy instruments, and selected ex post performance indicators). Even partial comparability across regions already creates learning effects.

Second, existing regulatory and procedural reference points – such as MuKEn-based cantonal rules, SIA norms, and building program eligibility criteria – can be explicitly cross-referenced in guidance documents and advisory processes, making implicit assumptions more transparent to project developers and building owners.

Third, advisory and support services (such as Impulsberatung / conseil incitatif, cantonal energy advisory services, or utility-led owner support) can be better linked to implementation feedback, for example by feeding recurring technical or procedural bottlenecks back into program design and guidance.

Fourth, inter-cantonal practitioner exchange formats can be used deliberately to compare how similar rules or standards are interpreted in practice, helping to identify low-cost opportunities for greater consistency without requiring formal harmonization.

6.3.1 Inter-Cantonal Cooperation and Scale Effects

Inter-cantonal cooperation is particularly relevant for smaller cantons that lack scale, specialized expertise, or sufficient project volume to develop and operate complex instruments on their own. However, it is also desirable for larger and more capable cantons, including Geneva. Many of the benefits of transparency, benchmarking, and institutional learning only materialize when data and experience are comparable across regions.

Concrete forms of cooperation include shared data infrastructures for renovation projects, peer review or benchmarking of program outcomes, and practitioner exchange formats among utilities, administrations, and technical experts. One concrete example from an adjacent field that illustrates that such cooperation can be implemented at relatively low cost while yielding tangible benefits, is the emerging inter-regional exchange around the electrification of construction sites (see above), where pilot projects in different cities are accompanied by a shared online platform that enables the pooling of experience, access to specialized equipment, and exchange between public clients, planners, and contractors. Such platforms reduce coordination failures, lower entry barriers for smaller actors, and support learning across regions – functions that are directly relevant for large-building renovation and heat decarbonization as well.

The ideal outcome of generalization is therefore a process in which cantons learn from each other's successes and failures, rather than as a series of isolated replications of a single model.

6.4 Limits of Generalization and Outlook

The above implies that no single institutional arrangement will suit all cantons. Differences in building stock, administrative capacity, political preferences, and fiscal space imply that solutions must remain context sensitive. For example, cantons with limited utility capacity may prioritize facilitation and advisory roles over direct contracting, while those with constrained fiscal space may rely more heavily on guarantees than on upfront subsidies.

In addition, broader system constraints – such as long-term electricity market evolution and grid impacts – remain sources of uncertainty that can affect the relative attractiveness of different heating solutions. These uncertainties reinforce the need for adaptable policy frameworks rather than fixed institutional blueprints.

The aim of this chapter is therefore not to prescribe a model, but to clarify when and why certain public roles and instruments are warranted. By making the underlying decision logic explicit, the Geneva case supports transparent, context-sensitive, and adaptable policymaking across diverse cantonal settings.

6.5 Illustrative Stylized Implementation Pathways: Cases A – C

To make the preceding decision logic more tangible, this section presents three stylized implementation pathways for regions facing different institutional, financial, and organizational conditions. These cases are not intended to be exhaustive, nor do they correspond one-to-one to specific cantons. Rather, they represent analytically distinct archetypes derived from the decision framework above. Their purpose is to illustrate how the same underlying principles can translate into materially different institutional solutions.

While the underlying market failures are broadly similar across contexts, the pathways differ in which barriers are most binding and which can realistically be addressed through public intervention under prevailing institutional and political conditions.

Case A: High-Capacity Canton with a Strong Public Utility (Geneva-like Pathway)

Typical conditions. This pathway is relevant for cantons or cities with a large, technically capable public utility or a comparable public entity that already plays a central role in the heat sector. Such regions typically have a clear political mandate for active climate policy, sufficient administrative capacity, and the ability to mobilize balance-sheet resources or public guarantees at meaningful scale.

Dominant and addressable barriers. In this context, the main obstacles to large-building heat decarbonization are less related to access to capital as such than to coordination failures, performance and development risks, and high transaction costs for individual building owners. Private actors may be technically capable but reluctant to assume long-term, project-specific risks.

Public role. The public sector takes on an active orchestration role. A public or quasi-public entity acts as system integrator, explicitly assuming those risks that private actors cannot efficiently bear, while structuring projects in a way that remains attractive to private contractors.

Concrete institutional setup. In practice, this can take the form of a utility- or foundation-led model in which a dedicated entity:

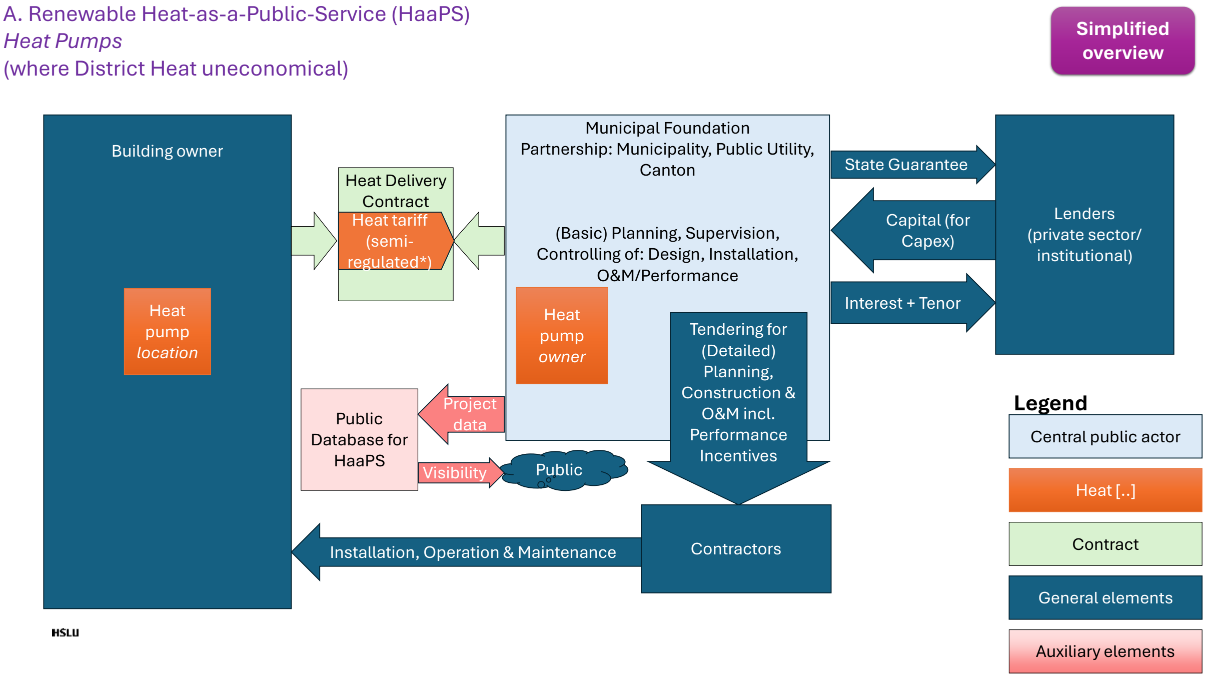
- aggregates projects and develops them to investment-ready stage,
- contracts private firms for construction and operation under performance-based arrangements,
- holds assets directly or through dedicated vehicles (e.g. foundations or SPVs), and
- serves as the contractual counterparty for building owners via long-term heat supply or energy-as-a-service contracts.

Instruments. Guarantees, performance backstops, and long-term contracting arrangements form the backbone of this pathway. Direct subsidies play a secondary role and are used selectively to close residual gaps rather than to replace risk reallocation.

Key risks and governance challenges. A central risk of this pathway is that the strong public or quasi-public entity evolves into a de facto monopoly with its own internal dynamics. Over time, there is a danger of organizational self-expansion, increasing procedural requirements, or preference for bespoke solutions that are no longer cost-efficient. Maintaining a clear mandate, strong performance monitoring, and external benchmarking is therefore crucial to keep the entity focused on efficient implementation rather than institutional growth.

As an implementation of the transparency suggestion in Section 5.6, strong 'no-excuses' transparency requirements and a "Projects Facebook" detailing each project's framework conditions, technical implementation, and performance follow-ups, potentially also including a public commenting function, could therefore be part of an ideal solution. Figure 6 illustrates this solution, in two levels of abstraction: First somewhat simplified, then in more detail. *Note, elements shown are opportunistically chosen to best illustrate the setup: some (more obvious) relations (flows/contracts) are omitted, reducing complexity.*

For additional descriptions of this case, see the presentation *Renewable Heat-as-a-Public-Service (HaaPS)* (Habermacher 2026).



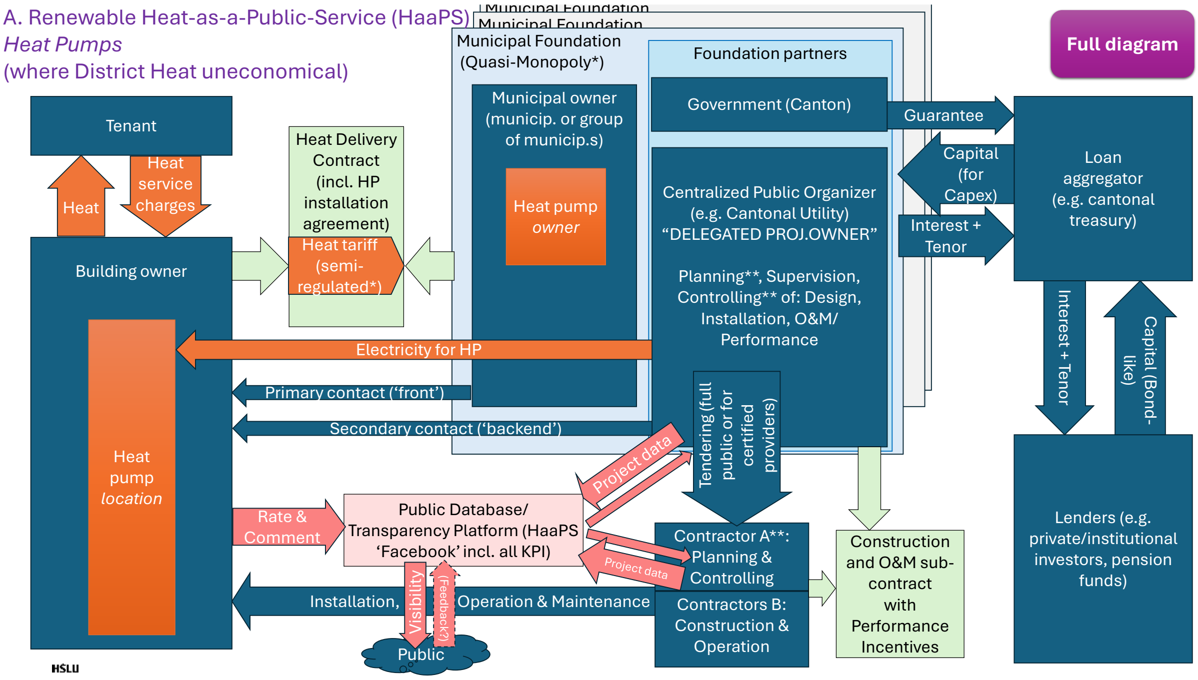


Figure notes:
* Heat-Pump-as-a-Public-Service will not an obligate monopoly (in contrast to District-Heating-as-a-Public-Service). But concentration of expertise & contacts in the Communal Foundation is expected to result in market dominance.
→ Regulation of tariff as prerequisite, given (i) the strong market power, (ii) obligation for clients to undergo the transformation, (iii) the Communal Foundation’s autonomy in designing, constructing, operating the solution.
→ Political decision to be made as to which degree regulated tariff allows (i) project-specific cost pass through, *i.e. more complex buildings have «1:1» higher cost; potentially with a cap*, vs. (ii) cost-socialization, *i.e. standard tariffs for all buildings or per building type, adjusting over time to actual average costs.*
** Split between Centralized Public Entity and Planning Contractor to be defined in line with available skills & requirements

Figure 6 Illustration Cantonal Case A: High-Capacity Canton with a Strong Public Utility (Geneva-like Pathway)

Case B: Medium-Capacity Canton without a Dominant System Integrator (Facilitator Pathway)

Typical conditions. This pathway applies to cantons with moderate administrative capacity but without a single dominant public utility capable of acting as system integrator. Utilities may be fragmented, municipally organized, or focused on other core activities. Fiscal space for direct risk absorption may be limited.

Dominant and addressable barriers. In this context, perceived risk and lack of standardization are particularly binding. Private actors are present and willing in principle, but face uncertainty regarding technical performance, contractual complexity, and financing conditions. Individual projects remain too bespoke to scale easily.

Public role. The public sector acts primarily as facilitator rather than implementer. Its role is to reduce uncertainty, improve coordination, and make projects legible and bankable for private actors, without itself becoming a long-term asset holder.

Concrete institutional setup. A canton or inter-cantonal body may:

- provide partial guarantees or credit enhancements for qualifying projects, which can be of both forms, ESCO (ESCO owns the installations) or more basic EPC (Engineering, Procurement and Construction, whereby the building owners becomes owner of the installation)
- develop standardized contractual templates and guidance documents,

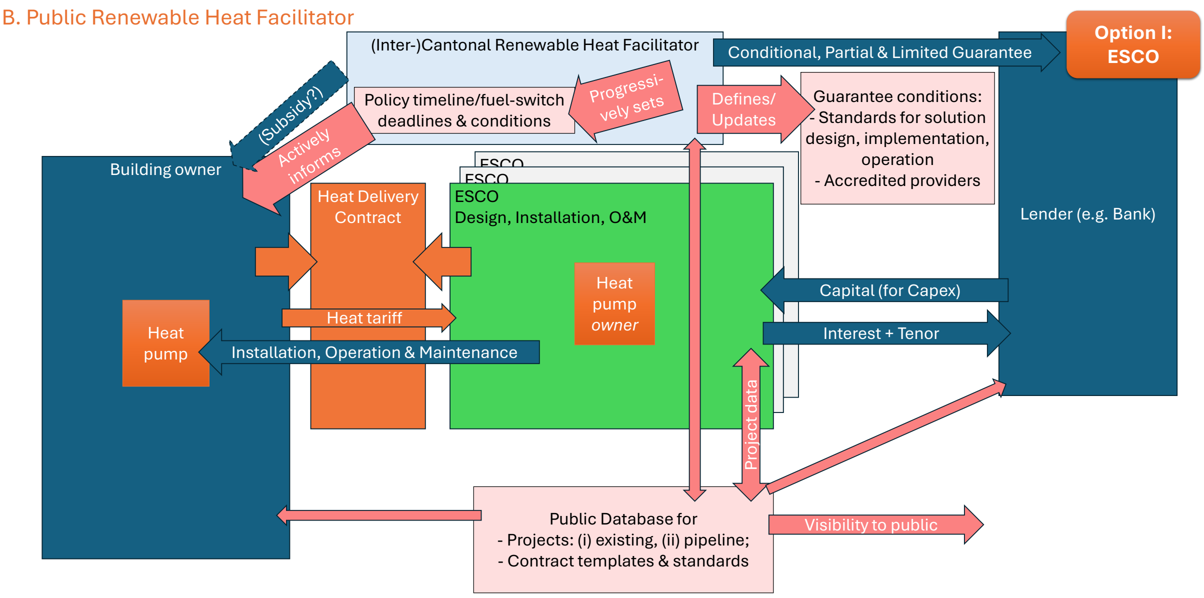
- maintain a visible project pipeline to support aggregation and learning,
- link advisory services closely to implementation and financing processes.

Project development and operation remain largely private, but occur within a clearer and more predictable framework.

Instruments. Credit guarantees, aggregation mechanisms, advisory services tied to implementation, and targeted subsidies are combined. Public exposure is limited and primarily contingent, while private actors retain operational responsibility.

Key risks and governance challenges. The critical challenge in this pathway lies in maintaining the tightrope between meaningful risk reduction and excessive public involvement. Guarantees that are too weak may fail to mobilize private investment, while overly generous or poorly conditioned guarantees risk recreating implicit public liability without corresponding influence, control, or learning. Clear eligibility criteria, transparent risk-sharing rules, and periodic reassessment of public exposure are therefore essential.

Figure 7 illustrates this setup, for both an ESCO and an EPC case, and the presentation *Renewable Heat-as-a-Public-Service (HaaPS)* (Habermacher 2026) provides additional description of the case.



B. Public Renewable Heat Facilitator

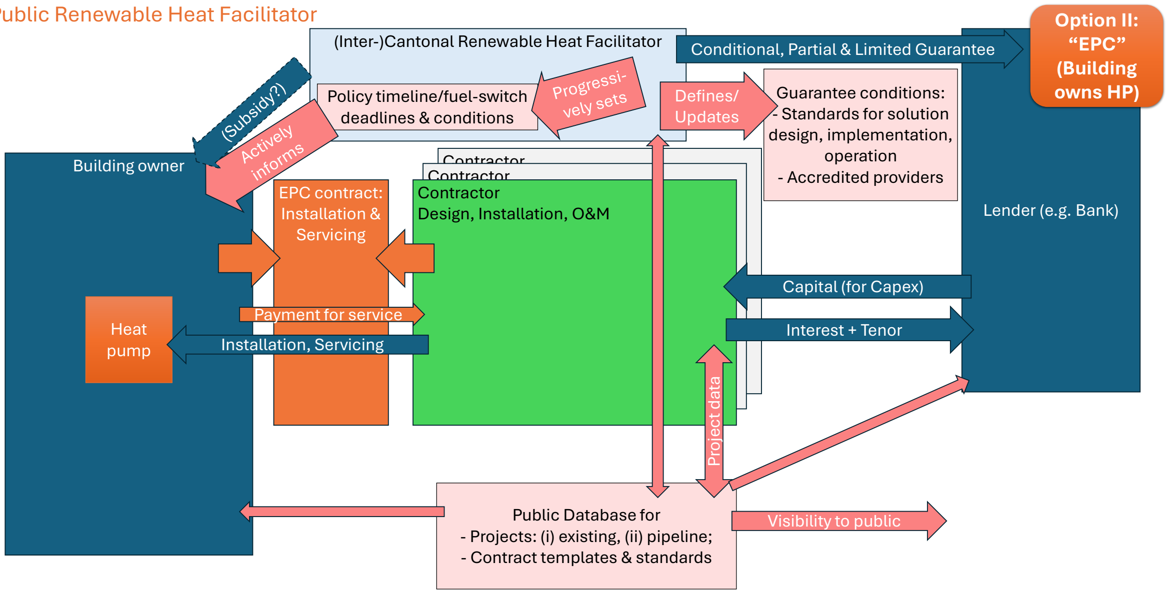


Figure 7 Illustration Cantonal Case B: Medium-Capacity Canton without a Dominant System Integrator (Facilitator Pathway)

Case C: Small Canton or Region with Limited Capacity (Lean Coordination Pathway)

Typical conditions. This pathway is relevant for small cantons or regions with low project volume, limited administrative capacity, and no realistic prospect of developing dedicated implementation entities. Transaction costs per project are high relative to potential scale.

Dominant and addressable barriers. In this context, lack of scale and localized expertise becomes the binding constraint. Even well-designed instruments may be inefficient if applied in isolation, as fixed costs overwhelm learning effects.

Public role. The public sector focuses on enabling access rather than direct intervention. Its primary function is to connect local actors to external expertise, shared platforms, and predictable rules.

Concrete institutional setup. In practice, this may involve:

- participation in inter-cantonal advisory, data, or guarantee platforms,
- reliance on external utilities, ESCOs, or regional service providers for project execution,
- clear and early communication of regulatory timelines and expectations,
- minimal in-house project development.

Instruments. Basic subsidies, participation in shared guarantee schemes, and strong emphasis on information, coordination, and predictability dominate. The objective is not to internalize complexity locally, but to lower barriers to external solutions.

Key risks and governance challenges. In this pathway, the main risk is that limited local experience remains fragmented or captured by individual private actors. If learning from early projects is not systematically shared, knowledge about technical solutions, cost drivers, and pitfalls may remain proprietary, slowing broader uptake and reinforcing information asymmetries. Even modest regions therefore benefit from actively publishing and sharing project experiences, ideally through inter-cantonal platforms, to support cumulative learning and informed decision-making.

Figure 8 illustrates this setup (for an ESCO situation), and the presentation *Renewable Heat-as-a-Public-Service (HaaPS)* (Habermacher 2026) provides additional description of the case.

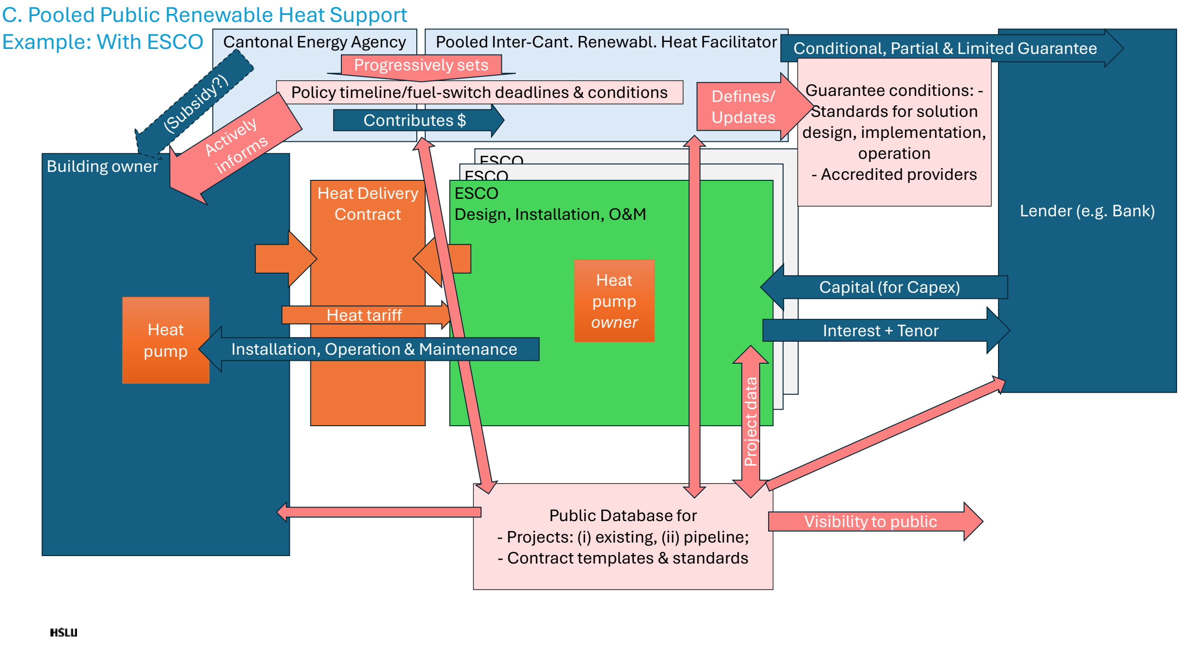


Figure 8 Illustration Cantonal Case C: Small Canton or Region with Limited Capacity (Lean Coordination Pathway)

Synthesis

Taken together, these stylized cases illustrate that there is no single optimal institutional solution. The appropriate pathway depends on local capacity, scale, and risk-bearing ability. What unites the cases is not a common organizational form, but a shared logic: public intervention should be aligned with the specific barriers present; assume only those risks that cannot be efficiently managed privately; share information aggressively as much of the market shortfall can be explained as an information problem; and evolve incrementally as learning accumulates.

7. Renewable Heat-as-a-Public-Service (HaaPS): An Interpretative Lens

The preceding chapters have examined market failures, risk allocation, institutional design, and context-specific intervention pathways for accelerating the decarbonization of heating in multi-family buildings. This chapter introduces **Renewable Heat-as-a-Public-Service (HaaPS)** as an *interpretative lens* for understanding a subset of these interventions. It does not propose an additional implementation model, nor does it alter the decision framework developed in Chapter 6. Rather, it offers a coherent way of interpreting why, under certain political and economic conditions, public actors may rationally assume roles that resemble public service provision in substance, even if not always in legal form.

7.1 What Is Meant by HaaPS – and What Is Not

HaaPS refers to a policy stance in which the public sector accepts partial responsibility for ensuring that eligible buildings are supplied with renewable heat under reasonable and predictable conditions, at least temporarily and under clearly specified constraints. The concept goes beyond conventional energy-contracting models by framing the fuel switch in large buildings not merely as a private investment decision, but as a **delivery problem** under binding collective targets.

Importantly, HaaPS **does not imply**:

- free or fully subsidized heat,

- uniform tariffs irrespective of cost,
- automatic or universal public ownership of heating assets,
- or permanent displacement of private provision.

Nor does it pre-empt political choices regarding compulsory connection, tariff regulation, or cost socialization. Instead, HaaPS highlights that when decarbonization timelines are politically fixed and individual decision space is materially constrained, society may also choose to assume part of the delivery and coordination risk rather than relying exclusively on private actors operating under incomplete price signals.

7.2 Why a Public-Service Framing Becomes Plausible in MFH Heat

The analytical results developed earlier in the report help explain why a public-service framing can become economically coherent in the specific context of MFH heat decarbonization.

First, **key preconditions for efficient private provisioning are weakened**. In many MFHs, owners have limited ability to influence system costs through behavior or technology choice; feasible technical solutions are often narrowly constrained (e.g. district heating where available, otherwise heat pumps); and fuel-switch deadlines are politically imposed rather than induced by price signals. Carbon pricing remains moderate relative to the ambition of the decarbonization targets, such that even economically “rational” private decisions may remain misaligned with collective objectives.

Second, **coordination and learning externalities dominate**. As shown in Chapters 2 and 4, transaction costs, risk-allocation problems, and missing ecosystem capabilities inhibit private market formation even where capital is in principle available. These barriers are not primarily financial in nature and cannot be resolved by marginal price adjustments alone.

Third, **the legacy nature of the building stock matters**. A large share of MFHs was constructed decades ago, often under ownership structures and regulatory conditions very different from those prevailing today. Current owners typically did not choose the original heating systems, nor could they reasonably have anticipated today’s climate targets or the speed at which decarbonization is now being pursued. As a result, many owners are confronted with the need to retrofit long-lived assets under externally imposed time constraints. This weakens the intuition that responsibility for delivery should rest exclusively with individual owners and strengthens the case for shared responsibility in managing the transition.

Finally, **heterogeneity and arbitrariness play a role**. Some buildings are eligible for district heating while others are not; heritage protection or structural constraints affect feasibility and costs of new heating solutions unevenly; and the distribution of costs and benefits across owners and tenants remains imperfectly aligned. From the perspective of affected owners, outcomes may therefore appear partly exogenous and administratively determined rather than market-driven.

Taken together, these conditions weaken the normative case for treating MFH heat provision purely as a private responsibility. A public-service framing becomes plausible not as a matter of moral entitlement, but as a response to **time consistency under binding political constraints**: if rapid and comprehensive decarbonization is non-negotiable, partial public responsibility for delivery risk can be an economically coherent complement.

7.3 Relation to Existing Intervention Designs

HaaPS is proposed as an interpretative layer, not as a separate pathway alongside those discussed in Chapter 6. In practice, the strongest approximation to a HaaPS logic corresponds to highly integrated, high-capacity arrangements in which a public or quasi-public actor assumes orchestration, aggregation, and performance responsibility for MFH heat solutions, **as illustrated by the Geneva case and by Case A in Chapter 6**. However, the relevance of the HaaPS lens does not depend on formal adoption of a “public service” label, nor does it require full public ownership or monopoly provision.

7.4 Implication: Tariff, Acceptance, Ambition

Tariff socialization, caps, or standardized components

The most tangible implications of the HaaPS lens may arise when considering tariff regulation for publicly supported heat in MFH. Due to variability of legacy building characteristics, regulatory constraints, and locational contingencies, strictly cost-reflective tariffs risk producing large and opaque dispersion in heat prices across otherwise comparable households. The observations supporting the HaaPS viewpoint can naturally be seen to suggest also utilizing tariff variants that include partial socialization, caps, or standardized components, at least where compliance with decarbonization mandates would otherwise imply heat costs that are significantly higher than prevailing alternatives and perceived as arbitrary or disproportionate. Such designs do not eliminate cost signals altogether but limit extreme outcomes that could undermine acceptance and political sustainability of the transition. Tariff design becomes a core element of institutional choice.

At the same time, adopting a HaaPS lens does not reduce the importance of cost discipline and transparency. Any degree of tariff smoothing or socialization increases the need for explicit tariff rules, transparent disclosure of underlying cost drivers, and periodic review. Without these safeguards, tariff regulation risks obscuring inefficiencies or shifting risks implicitly onto the public balance sheet.

Acceptance and Ambition under HaaPS

More broadly, the value of the HaaPS framing lies in making explicit what is already implicit in such arrangements: that the public sector is no longer merely correcting marginal market failures, but actively ensuring system delivery under constrained conditions. More limited or hybrid approaches may still exhibit partial HaaPS characteristics without adopting the framing explicitly.

Seen in this light, HaaPS provides a way of interpreting strong public involvement not as an unfortunate departure from market logic, but as a deliberate response to a delivery problem under constrained conditions. It reframes intervention as a means of ensuring reliable provision of a collectively mandated service while leaving open how far and for how long such arrangements should persist.

7.5 Limits and Political Choice

HaaPS is **not a general prescription**. The classification of an activity as a public service is inherently political and context-dependent. It reflects societal preferences, institutional capacity, and tolerance for public risk exposure, rather than any universal efficiency criterion.

Moreover, the logic underpinning HaaPS **does not imply permanent public service provision**. It can instead be understood as a transitional response to a phase in which markets, price signals, and coordination mechanisms are insufficiently developed to deliver rapid decarbonization on their own. As learning accumulates, standards emerge, and if private actors become able to price and manage risks more effectively, the rationale for public service–like arrangements can weaken accordingly. Depending on the political ambition to eventually converge towards a more standard market, designing credible exit options, maintaining transparency, and preventing institutional entrenchment can therefore remain essential, as discussed in Chapters 4 and 5.

A more detailed conceptual and illustrative discussion of HaaPS, including alternative implementation intensities and design variants, is provided in the accompanying presentation prepared within Renowave 3.2 (Habermacher 2026).

8. Conclusions and Research Outlook

This report has examined the economic, institutional, and practical conditions under which the fuel switch in multi-family buildings can be accelerated, with a particular focus on renewable heat solutions such as heat pumps and their integration into existing urban building stock. Rather than identifying new barriers, one of the report's main contribution lies in showing how well-known challenges can be addressed through specific institutional design, risk allocation, and financing mechanisms grounded in implementation experience. The analysis confirms that, while the technological feasibility of large-scale electrification of building heat is largely established, the decisive constraints today lie less in engineering than in market structure, risk allocation, and institutional capacity.

That said, even if not core topic of the report, it seems important to acknowledge that the fuel-switch in MFH is often rather costly and it cannot be presumed that it would be attractive for every building owner even in the absence of the above-mentioned subtler ecosystem issues.

A central conclusion is that, under current conditions, a purely competitive, decentralized market is unlikely to deliver the required pace and scale of transformation in the multi-family building segment. High upfront investment costs, complex project development processes, fragmented ownership structures, and substantial uncertainty regarding costs and performance create barriers that private actors alone are poorly positioned to overcome. As a result, some form of sustained public involvement appears unavoidable in the medium term.

At the same time, the analysis does not support a one-size-fits-all institutional solution. Different cantonal and municipal contexts imply different optimal roles for public actors. The analysis distinguishes between models in which public entities act directly as contractors and those in which they act primarily as facilitators, de-risking private investment through guarantees, coordination, and standard setting. Each approach involves trade-offs between speed of deployment, fiscal exposure, market development, and long-term competitive dynamics. The appropriate choice depends on local administrative capacity, market maturity, and political constraints.

The Geneva case illustrates how a public utility, operating in close coordination with cantonal and municipal authorities, can function as a pragmatic orchestrator of a nascent ecosystem. By assuming selected risks, standardizing processes, and accumulating operational knowledge, such an actor can lower transaction costs and enable deployment at scale, while still leaving room for private participation in engineering, construction, and operation. Importantly, the Geneva model should be understood not as a universally optimal blueprint, but as a context-specific institutional arrangement that continues to evolve through practical implementation.

From a system perspective, the study also finds no strong evidence that electrification of building heat is likely to become economically or technically untenable due to electricity system constraints alone, even in winter. While the analysis is of a somewhat tentative nature and to be refined in future, and while uncertainty remains regarding future electricity prices, grid costs, and marginal carbon intensity, preliminary modeling suggests that these factors do not, by themselves, invalidate the electrification pathway. This reinforces the case for proceeding with the fuel switch, while embedding flexibility, monitoring, and adaptive mechanisms into policy and business-model design.

Chapter 7 introduces HaaPS as an interpretative perspective on certain intervention designs, without altering the decision framework or policy conclusions of the report.

Overall, the analysis points to a transition logic in which public intervention is best understood as temporary but decisive: strong enough to overcome coordination failures and learning barriers in the current phase, yet designed to evolve as markets mature. Transparency, explicit risk allocation, and continuous feedback from real-world implementation emerge as key principles for maintaining legitimacy, limiting public exposure, and enabling gradual market development.

In this sense, the fuel switch in multi-family buildings is not only a technological challenge but an institutional one. Addressing it successfully requires moving beyond isolated instruments toward coherent, context-sensitive governance arrangements that combine public leadership with private execution. The frameworks and cases discussed in this report aim to contribute to such an approach and to provide a structured basis for further refinement as implementation progresses.

Limitations and Directions for Further Work

Electricity system and carbon assessment

- The electricity market modeling remains preliminary and should be completed with systematic robustness checks, in particular regarding grid costs, winter conditions, cross-border interactions, and the factors shaping renewables buildout constraints in the future.
- Further work is needed on marginal carbon intensity of electricity, reflecting European market integration rather than average emission factors. This is a largely unaddressed gap in nearly all (European) climate policy assessment work and if unaddressed in future, there is a risk for unwelcome surprises. This may become all the more relevant if recent hints at potential future softening of European climate policy (such as certain announcements of weakening the phase out of combustion engines) turn out to also reasons to expect dampening of ambitions in terms of speed and/or depth of electricity decarbonization.

Implementation monitoring

- The Geneva model should be followed as a live institutional experiment, with systematic monitoring of performance, transaction costs, risk allocation, and unintended effects.
- Such monitoring is essential to distinguish context-specific outcomes from more generalizable insights.

Transferability

- Application to other cantons or cities requires case-by-case analysis, given differences in administrative capacity, market maturity, legal frameworks, and political constraints.

Legal specificity

- Detailed cantonal legal feasibility analyses remain necessary, particularly regarding competences, procurement rules, guarantee structures, and long-term governance arrangements.

Dynamic conditions

- Institutional and policy choices should be periodically reassessed in light of evolving political conditions, climate economics (including expected global social cost of carbon as well as domestic WTP to reduce emissions), energy-system developments, grid constraints, and twofold technological change: technology for MFH heating infrastructure specifically, as well as AI progress potentially revolutionizing how efficient building heat systems designs, construction, operation, and/or evaluation look like.

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