E4S White Paper

Center for Risk Management Lausanne

Retrofitting the Future: The Costs, Timelines, and Strategies Shaping Swiss Real Estate

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Enterprise for Society (E4S) is a joint venture of the University of Lausanne through its Faculty of Business and Economics (UNIL-HEC), the Institute for Management Development (IMD) and the Ecole Polytechnique Fédérale de Lausanne (EPFL), under the stewardship of its College of Management of Technology, with the mission of spearheading the transition towards a more resilient, sustainable, and inclusive economy.

Executive Summary

Switzerland's buildings are a key part of the country's climate strategy, but understanding how the sector is progressing toward decarbonization can be challenging. Most available data are either backward looking or too general to reflect the current evolution.

This report offers a new perspective by using building permit data to measure the pace, cost, and type of renovations across Switzerland. We analyze over 45'000 permits to understand how renovations are happening, how long they take, and what they cost. While only a small share target energy efficiency, the data reveals important trends in building upgrades.

We then turn to Real Estate Investment Vehicles (REIVs) - key market actors with large, diversified portfolios and accessible data. This allows us to study how institutional investors are responding to sustainability targets. We introduce four strategic pathways REIVs can follow:

- Rebalancing - shifting portfolios by buying and selling assets,
- Renovation - upgrading existing buildings,
- Development - building new energy-efficient properties,
- Impact - acquiring and improving underperforming assets.

We present a simulated case study to show how REIVs could be classified by strategy, provided that richer renovation and transaction data becomes available. This offers a foundation for future research, investment comparisons, and policy design.

Finally, using permit data, we estimate renovation-driven emissions reductions, and project the capital needed to meet 2050 climate goals. On average, REIVs will need to invest around 13% of their net asset value - or CHF 28.3 billion - to stay on track, though some funds face a much heavier burden than others.

Résumé Exécutif

Les bâtiments suisses sont un levier essentiel de la stratégie climatique nationale, mais il reste difficile de suivre leurs progrès vers la décarbonation. La plupart des données disponibles sont rétrospectives ou trop générales pour refléter l'évolution actuelle.

Ce rapport propose une approche nouvelle en exploitant les données de permis de construire pour mesurer le rythme, le coût et le type de rénovations en Suisse. Nous analysons plus de 45 000 permis délivrés en 2024 afin de comprendre comment les rénovations se déroulent. Bien que peu d'entre elles ciblent directement l'efficacité énergétique, des tendances notables émergent dans l'amélioration du bâti.

Nous explorons ensuite le rôle des véhicules d'investissement immobilier (REIV), acteurs majeurs du marché avec des portefeuilles diversifiés. Cela permet d'observer leur réponse aux objectifs de durabilité via quatre stratégies :

- Rééquilibrage – ajuster les portefeuilles via achats/ventes,
- Rénovation – moderniser les bâtiments existants,
- Développement – construire des biens performants,
- Impact – valoriser des actifs sous-performants.

Une étude de cas simulée illustre comment classer les REIV selon leur stratégie, à condition de disposer de données plus riches. Cela ouvre la voie à de futures recherches et à un meilleur cadrage des politiques publiques.

Enfin, à partir des permis, nous estimons les réductions d'émissions possibles et les investissements requis pour atteindre les objectifs climatiques de 2050. En moyenne, les REIV devront mobiliser environ 13% de leur valeur nette – soit 28,3 milliards CHF – bien que certains devront faire des efforts bien plus importants.

Zusammenfassung

Die Gebäude der Schweiz spielen eine zentrale Rolle in der Klimastrategie, doch es ist schwierig, den Fortschritt bei der Dekarbonisierung genau zu erfassen. Verfügbare Daten sind meist rückblickend oder zu allgemein für aktuelle Entwicklungen.

Dieser Bericht nutzt Baubewilligungsdaten, um Tempo, Kosten und Art von Renovationen zu analysieren. Über 45’000 Bewilligungen zeigen, wie, wie lange und zu welchen Kosten renoviert wird. Nur ein kleiner Teil zielt auf Energieeffizienz ab, doch es lassen sich klare Trends bei Erneuerungen erkennen.

Wir untersuchen auch Real Estate Investment Vehicles (REIVs) – grosse, datenreiche Marktteilnehmer – und analysieren ihre Reaktion auf Nachhaltigkeitsziele. Vier Strategien werden identifiziert:

- Rebalancing – Portfolios durch Käufe und Verkäufe anpassen,
- Renovation – bestehende Gebäude verbessern,
- Development – energieeffiziente Neubauten erstellen,
- Impact – schwache Objekte übernehmen und aufwerten.

Eine Fallstudie zeigt, wie REIVs künftig strategisch klassifiziert werden könnten – sofern detailliertere Daten verfügbar sind.

Abschliessend schätzen wir Emissionsreduktionen durch Renovationen sowie den Investitionsbedarf bis 2050. Im Schnitt müssten REIVs etwa 13% ihres Nettovermögens – rund 28,3 Milliarden CHF – investieren, wobei einzelne Fonds stärker belastet sind.

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1 Introduction

Switzerland's real estate sector is undergoing a critical transformation, driven by ambitious decarbonization goals and the growing integration of environmental, social, and governance (ESG) criteria into investment decisions. Understanding the precise mechanisms of this transition has long been limited by a lack of granular and up-to-date data. This report introduces a novel approach to analyzing Swiss real estate market by leveraging building permit data, an underutilized yet insightful source of information. By doing so, we offer new insights into the scale, speed, and costs of real estate sustainability efforts—previously hard to access with traditional data.

Our analysis covers three key areas: *(1)* the types, duration, and cost structures of building permits, offering a new look into the actual investment dynamics of sustainable building transformations; *(2)* the strategic choices available to real estate investment vehicles (REIVs), captured through four transition strategies—*Rebalancing*, *Renovation*, *Development*, and *Impact*—which help investors and policymakers understand the trade-offs involved in achieving net-zero objectives; and *(3)* the financial burden of renovation efforts, providing cost estimates based on real market data to assess the scale of capital investments required to meet Switzerland's 2050 carbon neutrality target.

One of this report's key innovations is using building permit data to track renovation rates and projected emissions reductions at the REIV level. By merging the Federal Building and Housing Registry (RegBL) datasets on permits with Quanthome's data, we offer a comprehensive view of Swiss real estate renovations while also monitoring REIV portfolio changes.[1,2] Nationwide data coverage, available since 2023, allows us to track permits, costs, and project types. Complementing this, Quanthome's data provides insights into the composition of REIV portfolios and building characteristics, including market values. This integration helps assess how REIVs adjust their portfolios in response to sustainability goals, offering a more precise measurement of their impact beyond broad sector trends. Additionally, our cost analysis helps estimate retrofit costs for aging properties.

A key aspect of this transition is the decarbonization of existing buildings. Switzerland has set a net-zero emissions target for 2050, but achieving this goal will require extensive renovations, improved energy efficiency, and strategic investments across the sector. Many of the easiest decarbonization measures have already been implemented, meaning the remaining work will be more complex and expensive. While new energy-efficient buildings contribute to reducing emissions, large-scale renovations of older properties remain the primary challenge.

By analyzing building permit data, we can track these renovation efforts in detail. This dataset allows us to see where and how often renovations are happening, how long projects take, and what types of upgrades are being made. Importantly, it provides a real-world measure of sustainability progress, rather than relying on projections or policy commitments alone. While historical data remains limited, this topic holds such high potential and relevance that it already warrants dedi-

[1] The RegBL dataset contains unique identifiers for buildings and housing, along with key information such as addresses, construction years, floor counts, and heating systems. Managed by the Federal Statistical Office, RegBL plays a crucial role in population censuses and serves as the foundation for the country's building and housing statistics. See FSO (2022) for further details.

[2] Quanthome is a fintech company specializing in detailed real estate data across Switzerland, offering granular insights into building and investment vehicle characteristics. For more information, see `www.quanthome.com`.

cated attention.[3] This report aims to offer early insights and lay the groundwork for future research as more comprehensive data becomes available.

Beyond understanding renovation activity, this report also explores the financial dimension of decarbonization. Retrofitting buildings is a costly process, and these costs vary depending on factors such as building size, location, and the type of renovation being undertaken. We therefore estimate how factors like building size, age and location influence renovation costs.

At the core of this transition are REIVs, which must navigate a changing landscape of sustainability regulations, investor expectations, and financial trade-offs. REIVs are adapting to these challenges in different ways, with some prioritizing energy-efficient acquisitions, while others focus on renovations, new developments, or impact-driven investments. We identify four distinct strategies that REIVs can adopt: *(i)* Rebalancing, where investment portfolios shift toward greener assets through buying and selling, *(ii)* Renovation, where existing buildings undergo upgrades to improve energy performance, *(iii)* Development, where new energy-efficient buildings replace outdated properties, and *(iv)* Impact investing, where less energy-efficient buildings are acquired, renovated, and resold at a premium. Each of these strategies carries different risks, costs, and environmental benefits, shaping how the Swiss real estate sector will evolve in the coming years.

Our findings show both progress and major challenges. Using permit filings and project costs, we establish a benchmark for the financial effort required to reach net-zero. We then assess whether current renovation and investment trends are sufficient to meet national climate targets. While many REIVs are increasing their sustainability efforts, renovation rates remain too low to keep pace

[3] Figure A1 displays the annual count of building permits deposited in the database, indicating potential gaps in data coverage, particularly before 2020.

with Switzerland's climate commitments. Without accelerated action, a significant portion of real estate portfolios will continue to exceed emissions limits beyond 2026. Furthermore, the financial burden of achieving net-zero is unevenly distributed, raising important questions about funding mechanisms, regulatory incentives, and market-driven solutions.

This report provides essential data and strategic insights to help investors, policymakers, and industry leaders understand, plan, and accelerate the transition to a more sustainable real estate market. By combining granular building permit data with financial and strategic analysis, we offer a clearer picture of how the Swiss real estate sector is evolving - and what must happen next.

2 Switzerland Decarbonization Path

Switzerland has set ambitious decarbonization targets for its building sector, aiming for an 87% reduction in CO_2 emissions by 2040 and full decarbonation by 2050 in alignment with the Paris Agreement. Understanding the decarbonization path of the Swiss real estate sector requires an analysis of historical CO_2 emissions trends and the key factors driving these changes. Since 1990, greenhouse gas emissions from the building sector have decreased by 44%, making it the fastest-declining emissions sector in Switzerland (FOEN, 2024b). This reduction has been driven primarily by two key factors: the construction of new energy-efficient buildings and the gradual retrofitting of older properties. Both elements - new construction adhering to modern efficiency standards and targeted renovations - are essential to meeting climate targets, particularly given Switzerland's growing population and rising demand for housing.

An analysis of emissions data reveals two distinct phases in Swiss real estate emissions reductions.[4] In the initial phase from 1990 to 2004, the decline in relative emissions (Figure 1) appears driven primarily by the addition of new, lower-emission buildings, as total built area increased with relatively efficient structures. This trend is evident in Figure 2, where total emissions remained stable despite growth in real estate. The total built area data in Figure 3 further supports this interpretation, showing a steady increase over time.

Around 2004, a second phase begins, marked by an uptick in investment in both transformations and new buildings. This period is characterized by a decline in both relative and absolute emissions, as seen in Figures 1 and 2. This shift suggests that the Swiss real estate sector has increasingly embraced a pathway toward full transition. Figure 4 provides additional support for this interpretation, illustrating a consistent rise in transformation-related investments since 2004.[5]

While the real estate sector is Switzerland's strongest sector in terms of decarbonization and shows clear signs of transition, it must accelerate its efforts or at least sustain the current pace to meet climate targets. A key challenge is that much of the progress so far might have focused on the easier-to-decarbonize segments, while the next phases will likely become increasingly complex and demanding.

[4] Emissions data are sourced from FOEN (2024a), and information on building investments is drawn from FSO (2024).

[5] It is important to note that here transformations include all types of building modifications, not just energy retrofits. This broader categorization adds complexity to assessing the climate-specific impacts of these investments.

Figure 1: Swiss Real Estate Carbon Relative Emissions Path ($kgCO_2e/m^2$)

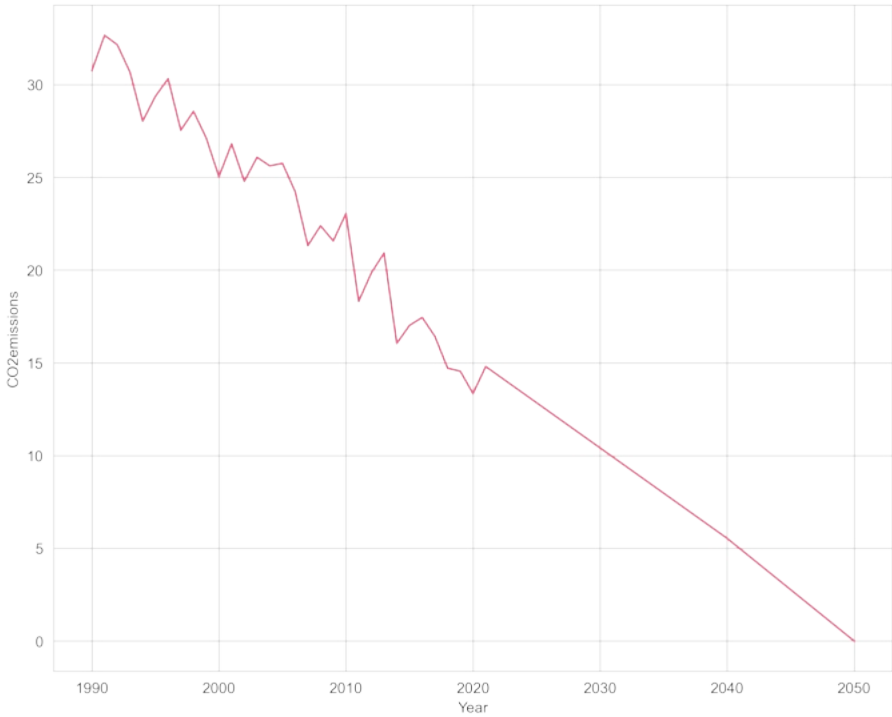


Figure 2: Swiss Real Estate Carbon Absolute Emissions Path (tCO_2)

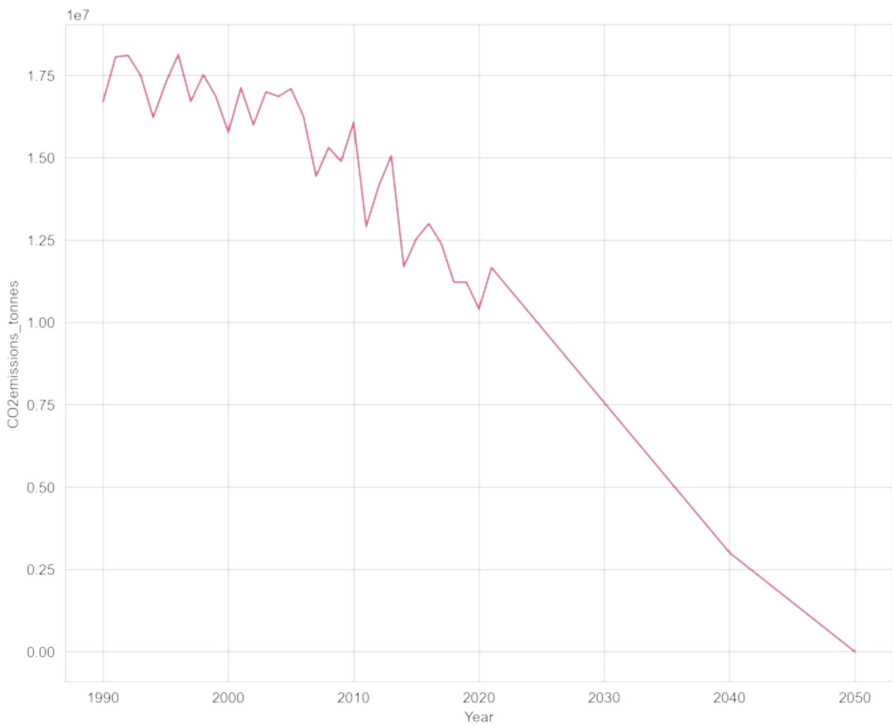


Figure 3: Swiss Total Built Area in m^2

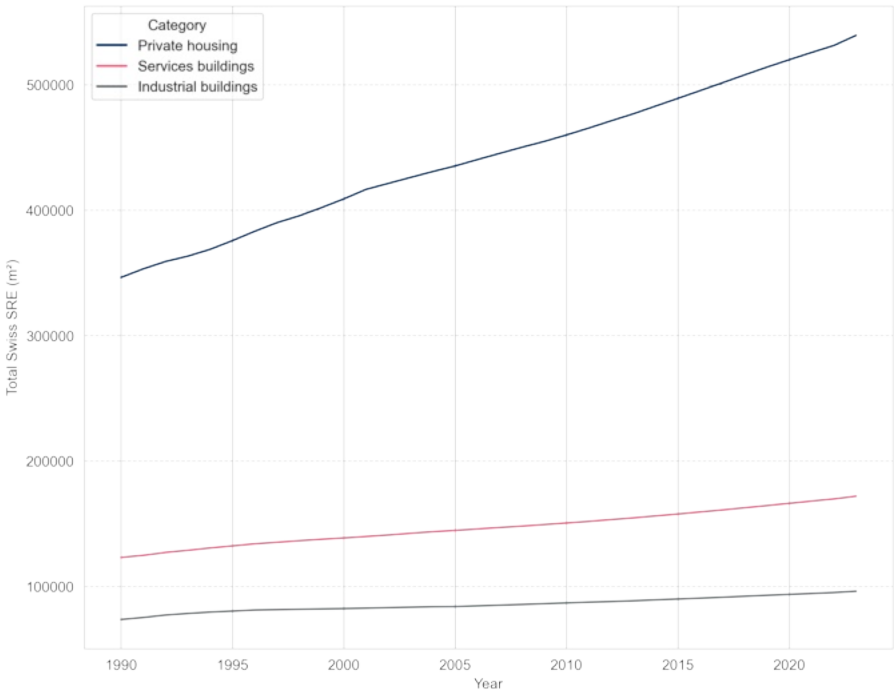
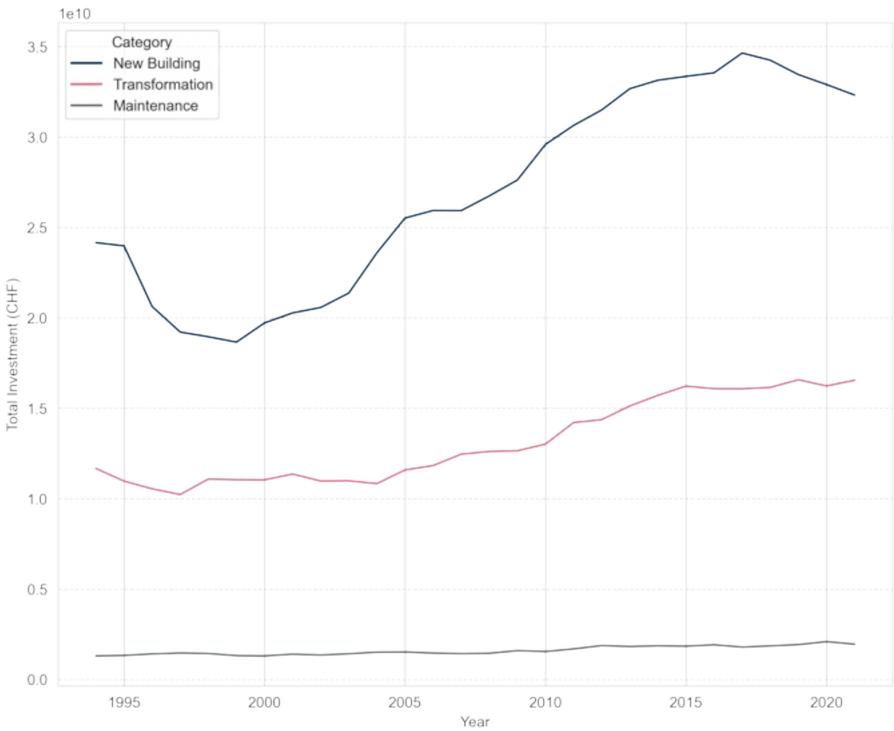


Figure 4: Swiss Total Investments in Real Estate



3 Building Permits

As the focus is on a gradual and ongoing transition, it becomes more and more important to understand how this change is actually happening. In this context, building permits are a useful tool, as they show real actions being taken to improve building efficiency and reduce emissions.

This section examines the role of building permits in understanding the pace and scope of sustainability transformations within the Swiss real estate market. It is organized into two key dimensions. First, it examines building permit types—transformations, new constructions, and demolitions—focusing on specific upgrades like energy retrofits and heating system replacements. This provides a clear picture of the types of actions to enhance building performance. Second, the evaluation of the duration of permitted projects, offering insights into the logistical challenges involved in the transitions. This step highlights the timescale and planning required to meet decarbonization objectives.

In 2024, we observe 45′546 building permits, representing approximately 2% of all Swiss buildings (see Figure A1). However, as outlined below, only a small fraction of these permits relate to energy-efficient renovations.

The building permit dataset offers valuable insights into construction and renovation activity across the country. Each record includes important information such as the start and end dates, the estimated cost of the work, a short description of the planned project, the approval status, and unique building identifiers. These identifiers make it possible to connect the permits with other national datasets. While the permit data is part of the RegBL database, access is limited and available only for research purposes.

Despite its value, the dataset comes with some limitations. Many of the non-essential fields—like detailed project descriptions—are often missing or incomplete. In contrast, key variables such as permit dates and cost estimates are more consistently reported and form the core of our analysis. Some level of inconsistency or noise is also present, likely because the data is compiled from hundreds of Swiss municipalities, each with its own reporting standards. These issues should be kept in mind when interpreting the results.

3.1 Categories of Building Permits

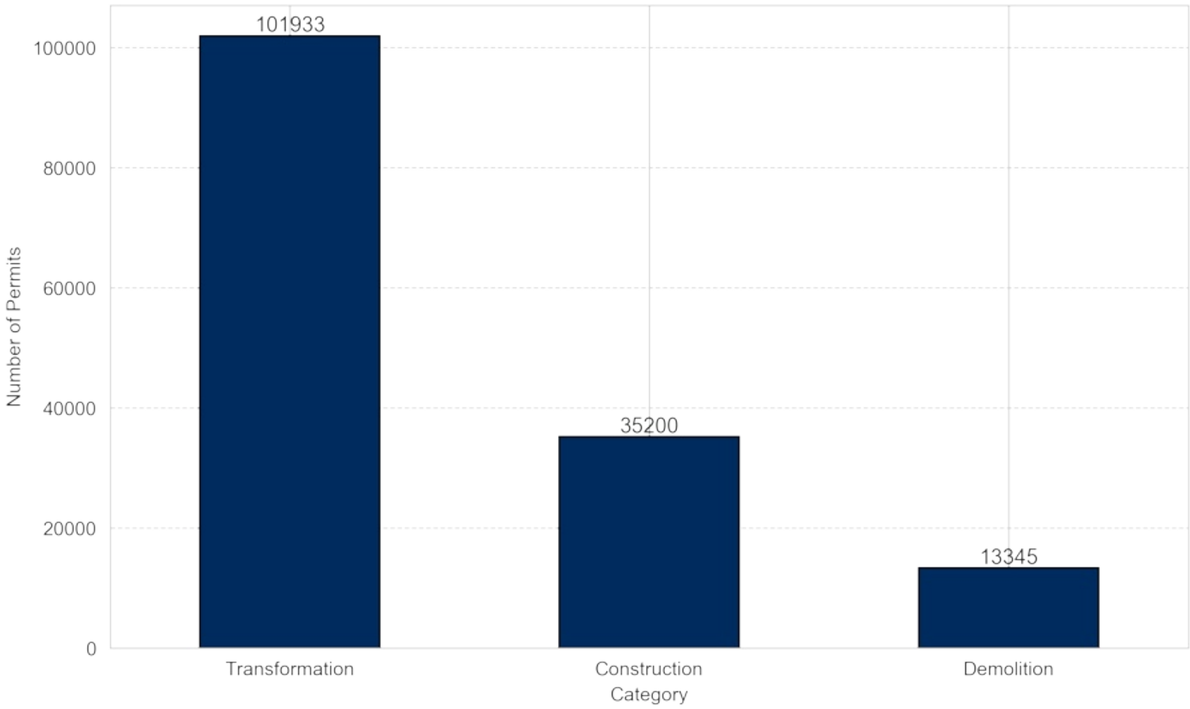
Swiss building permits fall into three main categories: transformations, new constructions, and demolitions. The majority are issued for transformations (Figure 5), reflecting a strong emphasis on upgrading existing buildings rather than expanding the real estate stock.

The transformation category is broad, covering several items from major energy retrofits to minor modifications like installing advertising panels. Nearly 50% of permits in this category fall under "other" modifications (Figure 6), while heating system upgrades account for 17.3% and energy retrofits for 9.1%. As a single permit can include multiple types of transformations, these figures are not mutually exclusive.

Figure 7 details the share of permits involving energy retrofits where specific components can be identified. Envelope retrofits are the most common (20%), followed by facade (16.7%) and roof renovations (12.9%). Window replacements are mentioned in 11% of cases. However, these numbers likely underestimate the actual extent of such renovations, as they only account for modifications explicitly stated in permit documentation.

Figure 8 illustrates the distribution of renewable heating systems in permits specifying heating system replacements. As not all permits identify the new system, the totals do not sum to 100%. Among identified installations, heat pumps are, by far, the most frequently adopted, followed by district heating and wood-

Figure 5: Type of Building Permits



based systems, signaling a shift away from fossil fuel heating.

Figure 6: Type of Transformations

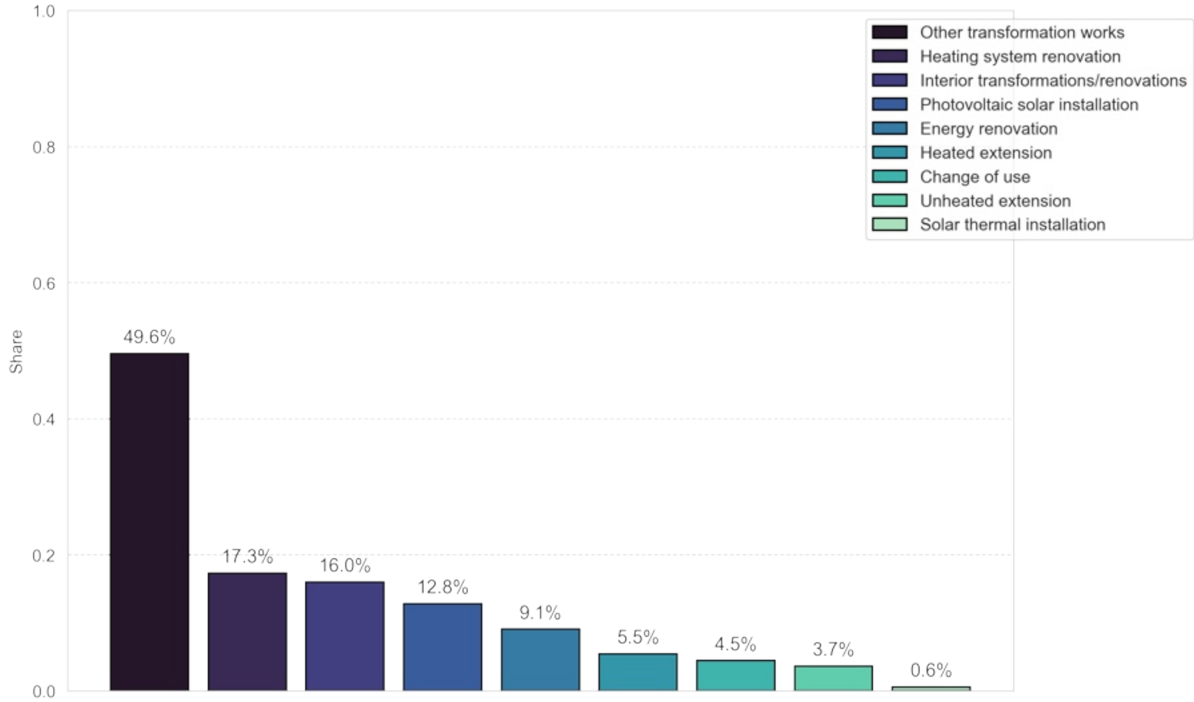


Figure 7: Type of Energy Transformations

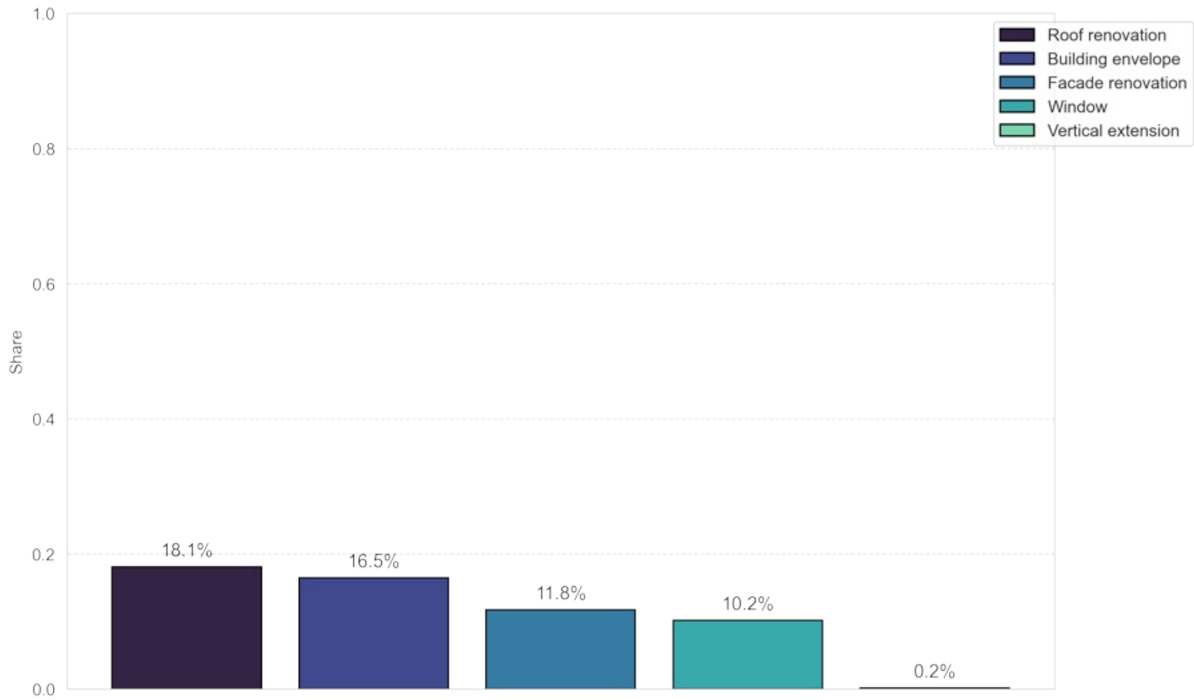
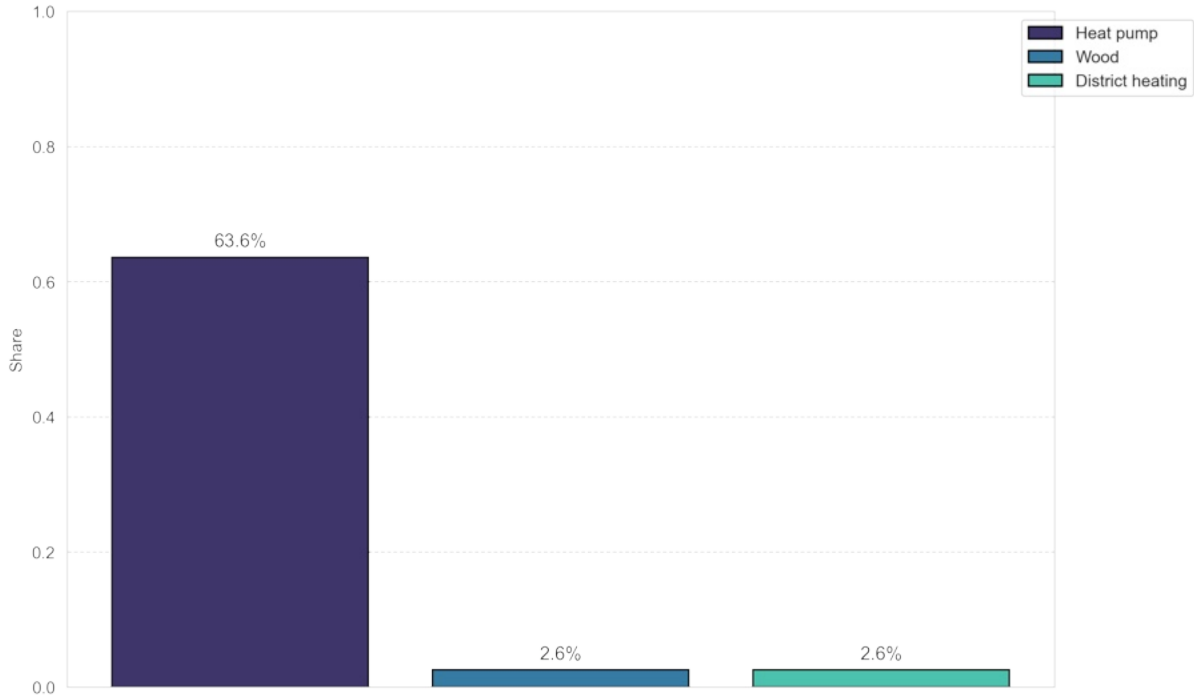


Figure 8: Type of Renewable Heating Transformations



3.2 Duration

The analysis of building permit durations provides insights into the timelines for construction and renovation projects. Durations are measured from the permit deposit to the reported project completion, offering a conservative estimate as they exclude preparatory work that can take several months or even years.

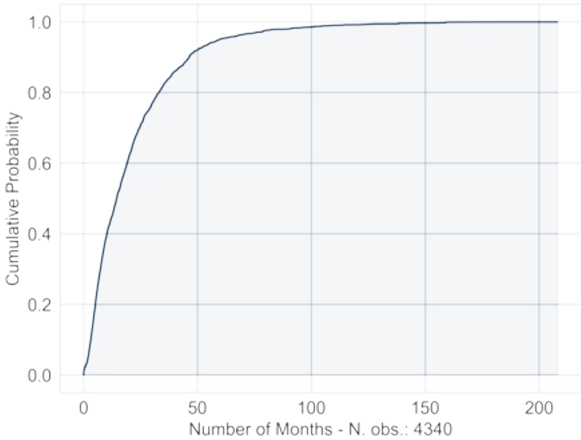
The cumulative distribution of durations for all types of work, shown in Figure 9a, spans a wide range. Most permits take 10 to 20 months to complete, with less than 2% extending above 90 months. This variability likely reflects differences in project scope as well as regulatory and logistical factors.

Focusing on transformation permits (Figure 9b), durations are shorter, typically finishing in less than 30 months. These projects often involve building upgrades or minor modifications, which require less time. Transformations involving energy and heating system upgrades (Figure 9c) typically fall within a 5 to 25-month range, providing a practical timeline for real estate owners targeting sustainability goals through manageable projects.

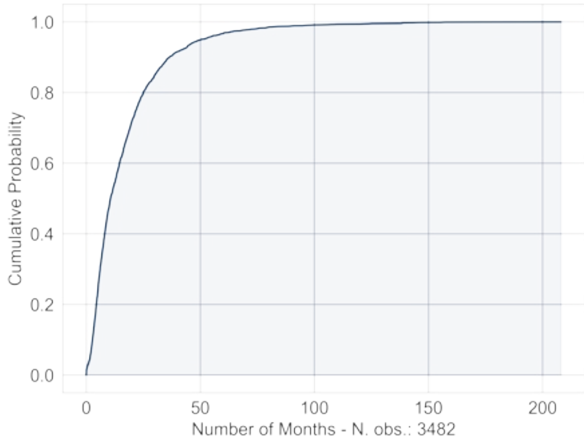
Demolition and new construction permits display different timelines (Figures 9d and 9e). Most of demolition permits reach term in less than 60 months. New construction projects, meanwhile, typically span 20 to 80 months, indicating greater scope and complexity.

These duration patterns provide valuable insights into the timelines real estate owners can expect for various project types, supporting strategic planning, particularly for real estate funds prioritizing sustainability and building transformation initiatives. However, two main limitations should be noted. First, some duration estimates rely on small samples due to missing data, which may limit their representativeness. Second, the database does not support dynamic analysis. According to Statistique Vaud (2023), while the time required to obtain a

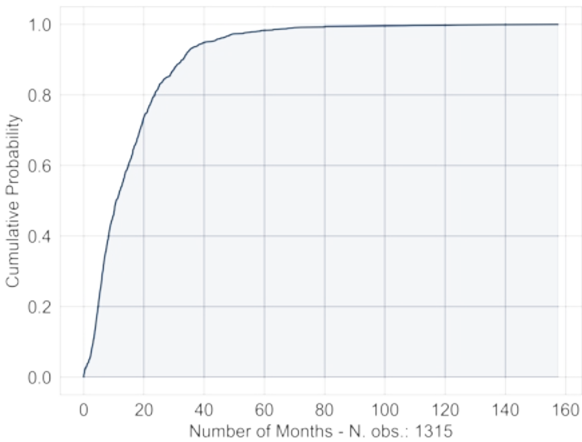
Figure 9: Cumulative Distribution of Building Permits Duration



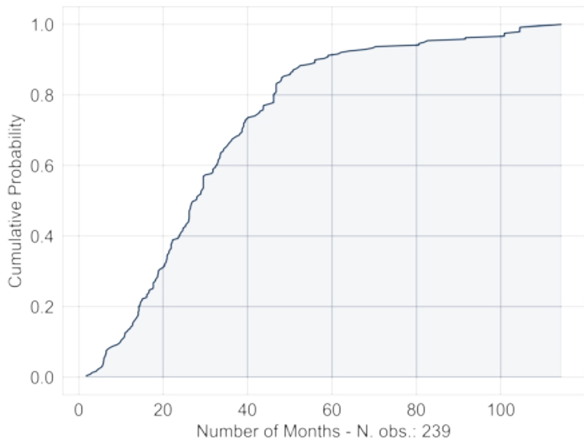
(a) All Building Permits



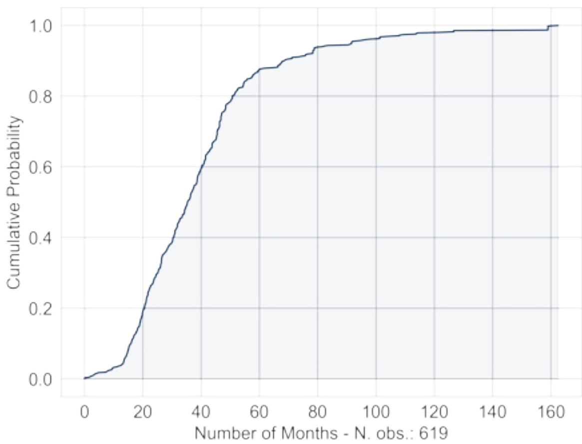
(b) Transformations



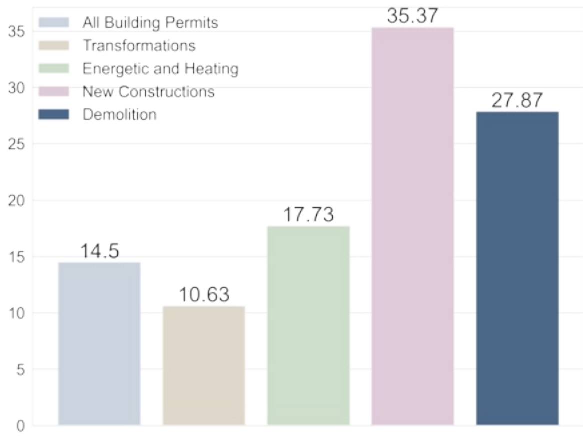
(c) Energetic and Heating System Retrofits



(d) Demolitions



(e) New Constructions



(f) Median duration in months

building permit remains relatively stable, the overall construction timeline is increasing. This rise is attributed to delays between permit issuance and the start of construction, as well as longer construction periods.[6] It may also reflect bottlenecks due to the lack of people specialized into new activities (PV panel installers, retrofit specialists) or to the lack of materials (wood, etc.). However, further research and data are needed to determine whether this trend applies nationwide.

4 Cost Analysis

4.1 Statistics on Costs

Table 1 provides summary statistics on the total costs of all Swiss building permits, offering insights into the expenses associated with various building projects.[7]

The average cost for transformations involving both heating system upgrades and energy retrofits is CHF 1'013 per m^2. These costs vary widely depending on the scope of work and whether insulation and heating systems are upgraded simultaneously. The significant cost variation might also reflect differences in project scale and material quality.[8]

For building permits reporting only energy retrofits, the average cost is CHF 1'714 per m^2. However, this figure should be interpreted with caution. It is based

[6] Note that the longer duration during this period may also be due to opposition after permit approval. However, Statistique Vaud (2023) cannot disentangle the impact of increased opposition from other contributing factors.

[7] These data have three main limitations. First, due to the structure of the building permit database, it is unclear which specific aspects of the permit contribute to the overall cost. Second, since these prices are reported as totals, there is no information on the quality of the work—whether it was performed at a premium or budget level, which could affect cost estimates. Third, the lack of historical data limits the sample size for certain categories, such as elevations.

[8] Note that extreme outliers above CHF 40'000 per m^2 have been removed from the sample. These outliers are assumed to be unreliable, likely resulting from misreporting, typographical errors in prices, or inaccurate estimates of building surfaces in the RegBL.

on a smaller sample and shows high variability, with an interquartile range from CHF 241 to CHF 1'786. The average is skewed by a small number of very large values. Projects in this category typically include insulation improvements, window replacements, and roof refurbishments to reduce heat loss.

In cases where only heating systems are updated, the average cost is CHF 449.58 per m^2, with a smaller standard deviation than energy retrofits, indicating less variation. More than 75% of Observed costs for standalone heating system upgrades do not exceed CHF 300 per m^2.

We also report the average cost per square meter for photovoltaic installations, which is CHF 867.62 per m^2. Due to data limitations, this cost is scaled to the overall building size rather than the area of installed photovoltaic panels. This category shows relatively low price variability in the building permits reviewed.

Finally, given that REIVs increasingly use building elevation to enhance the returns on property transformations, we report the average cost for permits involving elevation. The average cost is CHF 5'169.95 per m^2, calculated based on the building's total surface area. When well-executed, building elevation appears to be an effective strategy to boost property value while improving its sustainability profile (BCV, 2024).

Table 1: Prices of Transformations per Types in CHF / m^2

Variable	Average	Standard Deviation	25%	Median	75%	Number of Observations
All energetic or heating System Transformations	1'014	2'322	131	250	830	34'775
Only Energetic Transformations	1'714	3'177	241	657	1'786	3'942
Only Heating Transformations	450	1'263	105	181	293	15'036
Only Photovoltaic Installations	868	5'949	78	145	381	14'090
Transformations with Elevations	5'170	6'059	1'425	2'957	5'862	96

4.2 Cost Determinants

In this section, we examine the factors that influence the costs of heating system and energy retrofits based on the type of building (residential or commercial), its size, its construction period, and its regional location.

The sample incorporates all available building permits across Switzerland for which the cost is reported, so some data are missing. The analysis includes 11'999 building permits from 2023 and 2024, as older data are less representative in terms of frequency compared to the past two years. To keep the analysis focused on buildings suitable for investment purposes, we consider property types typically included in REIV portfolios, such as multi-apartment residential buildings, industrial properties, offices, and hotels.

Two main caveats apply. First, many factors affecting prices are not captured in this dataset, so the results offer an initial snapshot rather than a comprehensive view. Second, these are general estimates and should not be interpreted as precise market values, particularly since the characteristics of each individual building heavily influence renovation costs.

The regression results in Table 2 use a log-linear model, where each coefficient approximates the percentage change in cost associated with a given variable.[9,10] To simplify the interpretation of the results, Figure 10 shows how size, age categories, and retrofit types impact prices.

In this analysis, a heating retrofit on a small residential building in Zurich built after 2000 serves as the baseline scenario.[11] The constant term (5.56) represents the log-cost per square meter for this reference group (or CHF 259.82 per square meter), and each coefficient reflects the percentage difference from this baseline.

The type of retrofit has a major influence on costs. Energy retrofits alone are associated with a 148% increase in costs per square meter compared to heating retrofits. When both energy and heating upgrades are undertaken together, costs rise by an additional 110%, reflecting the high expense associated with

[9] The regression model estimates log cost per square meter of building b using dummy variables for energy and heating retrofits, building type, size, construction year, and region, with interaction effects and a residual error term. It is specified as:

$$\log\left(\frac{\text{Cost}}{\text{m}^2}\right)_b = \alpha + \beta_1 \cdot \text{Energy Retrofit}_b + \beta_2 \cdot \text{Energy Retrofit}_b \cdot \text{Heating Retrofit}_b + \beta_3 \cdot \text{Commercial Building}_b + \sum_{i=4}^{5} \beta_i \cdot \text{Size}_{b,i} + \sum_{j=7}^{9} \beta_j \cdot \text{Construction Period}_{b,j} + \sum_{k=10}^{15} \beta_k \cdot \text{Regions}_{b,k} + \epsilon_b$$

[10] In this type of model, coefficients are often interpreted as approximate percentage changes in cost per square meter, which helps make the results easier to understand. For example, a coefficient of 0.91 for energy retrofits suggests that renovation costs are about 91% higher for energy retrofits relative to the baseline case. If the baseline cost is CHF 260 per m^2, this would correspond to an estimated total of around CHF 495 per m^2. In fact, β parameters are semi-elasticity and we use the full regression formula: *cost = exp(regression equation)*. In this case, using the constant term (5.56) and the energy retrofit coefficient (0.91), the result is: exp(5.56 + 0.91) $\approx$ CHF 645.48 per m^2, or an increase by 1484%.

[11] The size variable is defined based on terciles of the distribution. Small buildings are those with an area below 398 m^2, while large buildings exceed 806 m^2.

comprehensive energy efficiency improvements. However, we do not observe any significant price differences between commercial and residential buildings.

Table 2: Log-Linear Regression of Retrofit Cost Determinants

Dependent variable: Log of cost per m^2		
Constant	5.56***	(0.05)
Energy Retrofit	0.91***	(0.04)
Energy × Heating Retrofit	0.74***	(0.05)
Commercial Building	0.04	(0.07)
Size		
Medium Building	-0.28***	(0.04)
Large Building	-0.58***	(0.04)
Construction Year		
Before 1950	0.17***	(0.05)
Between 1950 and 1975	0.34***	(0.05)
Between 1975 and 2000	-0.03	(0.06)
Regions		
Lemanic	0.39***	(0.07)
Mittelland	0.25***	(0.05)
North west	-0.20***	(0.06)
Eastern	-0.18***	(0.06)
Central	-0.28***	(0.06)
Ticino	-0.22***	(0.06)
R^2	0.13	
R^2 Adjusted	0.13	
Number of observations	11'999	

Notes: The baseline case is a heating retrofit on a small residential building in Zurich with a year of construction after 2000. The variable *Energy Retrofit* is a dummy variable set to 1 if the building has an energy intensity above 60 kWh/m^2. The variable *Energy × Heating Retrofit* captures the interaction between the need for both heating and energy retrofits. All remaining variables are dummy indicators for the specific characteristics they represent. Standard errors clustered are reported in parentheses. *, ** and *** respectively denote statistical significance at 5%, 1% and 0.1%.

Building size also affects costs, with medium-sized buildings reducing costs per square meter by 32% compared to smaller buildings, and large buildings seeing a 79% cost reduction. These findings suggest that larger buildings benefit from economies of scale, lowering the per-unit cost of retrofits.[12]

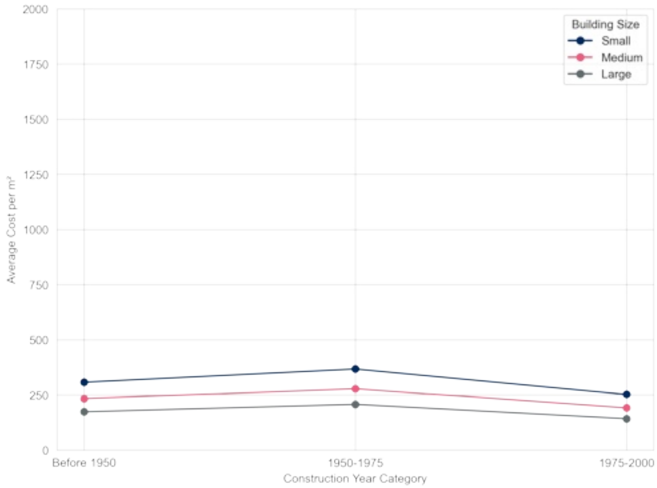
The construction year significantly impacts costs, with older buildings generally incurring higher expenses. Buildings constructed before 1950 see a 19% increase in per-square-meter costs. The steepest increase (40%) is observed for buildings from 1950 to 1975, indicating that mid-20th-century buildings pose substantial retrofit costs.

Regional differences further influence costs, with some regions showing lower expenses than Zurich. For example, Eastern Switzerland sees a 20% reduction in costs per square meter, while the Ticino region experiences a 25% reduction. In contrast, the Mittelland region experiences a 28% increase and the Lemanic region exhibits a 48% increase relative to Zurich. These variations likely reflect differences in local labor and material costs, as well as regional policies affecting affordability.

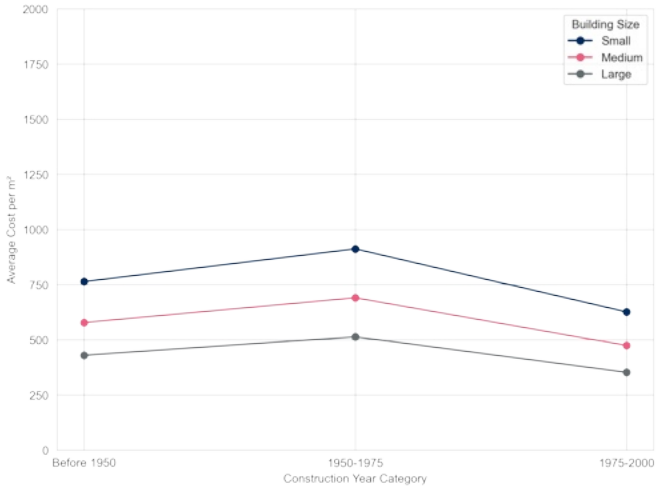
In summary, the analysis indicates that energy-focused retrofits and upgrades for older or smaller buildings lead to higher costs, while large buildings and properties in certain regions benefit from lower retrofit expenses. These findings emphasize the importance of building characteristics, construction history, and geographic location in shaping retrofit costs, providing useful insights for budgeting and strategic planning in energy efficiency initiatives across REIVs portfolios.

[12] In A1, we present an additional regression model that includes an interaction between retrofit type and building size categories. The results indicate that economies of scale are less pronounced for energy retrofits, which aligns with the fact that larger buildings require more extensive work, such as improved insulation, to achieve energy efficiency gains.

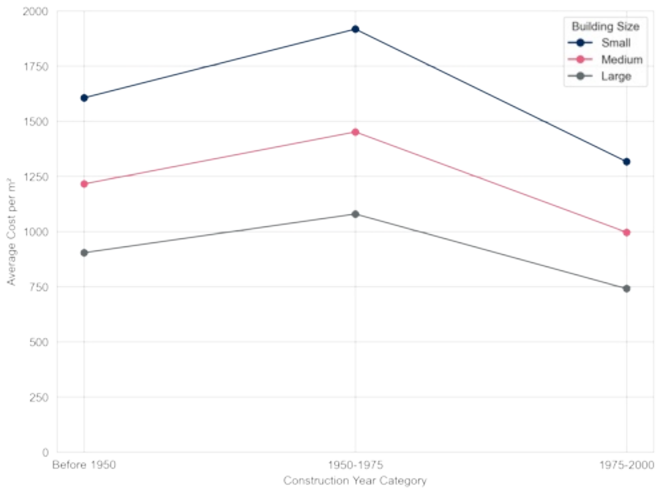
Figure 10: Average Estimated Retrofit Costs Per Categories



(a) Only Heating retrofit



(b) Only Energy Retrofit



(c) Heating and Energy Retrofit

5 REIVs Transition Strategies

REIVs are a central focus of this analysis because they are among the few actors in the Swiss real estate market with portfolios that are both large and diversified enough to support structured transition strategies. They also represent a rare case where reliable, asset-level and portfolio-level data is accessible, allowing for a detailed examination of how investment decisions align with climate objectives.

In this section, we outline four conceptual strategies - *rebalancing*, *renovation*, *development*, and *impact* - to illustrate the diverse approaches REIVs employ to navigate the transition. This strategic analysis provides critical insights into how various pathways align with regulatory requirements, investment priorities, housing needs and sustainability objectives. We then present a case study using simulated data to illustrate how REIV transition strategies can be identified and classified. Additionally, we evaluate the broader implications of building permit trends by analyzing REIV renovation efforts, including their renovation rates and the capital allocated to retrofitting their portfolios. These efforts are compared to overall Swiss decarbonization trends to assess their contribution to national climate goals. However, these estimates may be conservative, as some retrofits might not require building permits.

REIVs building stock represents around 4% of the total stock of residential buildings. For other large institutions owners, such as pension funds, as the list of buildings is not available, we cannot proceed with the same analysis.

By focusing on REIVs building permits, this section delivers a detailed view of REIVs' sustainability transformations, identifying areas where additional investments could maximize impact. The findings equip stakeholders with actionable insights to inform strategic planning and advance a more sustainable and resilient real estate market.

5.1 The Four Transition Strategies

Each transition strategy carries unique implications for Switzerland's climate targets and housing needs, offering portfolio managers, investors, and other stakeholders tailored approaches to meet national objectives. Although we present these strategies individually, most REIVs are likely to employ a combination. Table 3 summarizes the strategies and their potential impacts.

1. Rebalancing

The first strategy, *rebalancing*, focuses on achieving net-zero emissions through portfolio turnover rather than through direct property transformations or new developments. Here, REIVs sell brown (higher-emission) assets and acquire green (lower-emission) assets, theoretically creating a net-zero portfolio without the costs, delays, and risks associated with renovations or new projects. If the green value and brown discount are currently underpriced, REIVs will benefit from this strategy in terms of Net Asset Value (NAV). However, this strategy carries long-term risks, as market correction of mispriced brown discounts or green premiums could reduce the REIV's NAV. Moreover, rebalancing has minimal positive externalities, as it relies on financial adjustments rather than reducing CO_2 emissions or expanding housing supply.

2. Renovation

The second strategy, *renovation*, focuses on upgrading assets within a REIV's portfolio and holding them. By targeting heating system upgrades and energy retrofits, this approach seeks to reach net-zero emissions across the portfolio.[13] While this strategy is effective in lowering emissions, it requires significant plan-

[13] It is worth noting that demolishing a building to construct a more energy-efficient one also aligns with this strategy.

Table 3: Summary of REIVs Transition Strategies

Strategy	**Objective**	**Approach**	**Risks**	**Positive Externalities**
Rebalancing	Achieve net-zero without physical transformations	Sell "brown" assets and acquire "green" assets	Market risk: potential mispricing of brown discounts or green premiums that may not be reflected in REIV's NAV, impacting portfolio value	Minimal. Primarily financial transactions, with limited impact on Swiss real estate CO_2 emissions or housing supply
Renovation	Reach net-zero by upgrading existing assets	Retain portfolio and implement energy retrofits and heating system upgrades	Transition risks, such as increasing renovation costs and project delays, which can impact returns if not carefully managed	Directly reduces both relative and absolute Swiss real estate emissions, positioning REIVs as leaders in sustainable transformation efforts
Development	Approach net-zero through new construction	Construct and retain new energy-efficient buildings	Risks tied to new developments, including extensive planning, possible delays, and opposition to projects	Addresses housing demand while reducing relative CO_2 emissions
Impact	Transform brown assets to green for resale	Acquire brown assets, renovate, then sell to capture transformation premium	High liquidity risk; requires optimizing renovations to secure significant sale premiums	Potentially greatest positive impact on Swiss emissions by continuously turning over and upgrading a larger number of buildings

ning and exposes REIVs to transition risks, such as rising renovation costs, which may affect returns if not carefully budgeted. Despite these challenges, the positive externalities of the renovation strategy directly supports Switzerland's climate goals by reducing both relative and absolute CO_2 emissions.

3. Development

The third strategy, *development*, centers on constructing new energy-efficient buildings and retaining them in the portfolio. For REIVs that employ only this strategy, achieving net-zero is possible if the portfolio consists solely of new, highly efficient properties. The risks associated with development mirror those of general real estate development, including extensive planning requirements, potential delays, and opposition to new projects. However, development positively contributes to housing demand while reducing Swiss CO_2 relative emissions.[14]

4. Impact

The fourth strategy, *impact*, focuses on acquiring brown assets, upgrading them to green standards, and then selling them to capture a transformation premium. This approach is the most complex, as it involves high liquidity risk and requires efficient, targeted renovations to achieve substantial premiums upon resale. Nevertheless, it holds the greatest potential for positive externalities in terms of reducing Swiss emissions, as it reaches a broader range of properties through continuous turnover than the *renovation* strategy alone.[15]

To the best of our knowledge, the impact strategy remains largely underutilized in the current Swiss real estate market. This gap can present an opportunity for new market participants to emerge, contributing to the broader real estate

[14] For an overall environmental perspective, this strategy would also increase the land use, which could negatively affect biodiversity objectives.

[15] A fifth potential strategy, *impact-development*, involves constructing new buildings and selling them upon completion. Although outside our scope due to the absence of rental income, this strategy could generate similar positive externalities as the *development* approach, potentially at a faster rate.

transition and addressing the sector's sustainability challenges.

Classifying these strategies enables REIV managers, investors, and other stakeholders to better define their focus and identify the positive externalities they wish to prioritize. Due to limited historical data, categorizing all REIVs by strategy remains challenging at present. However, in the medium term, it should become feasible to assign each REIV to a primary strategy or at least estimate the share of each strategy used in their approach to meet 2050 climate goals.

5.2 Transition Strategies Simulation

To strengthen the theoretical framework introduced in this report, we present a simulated classification of REIV transition strategies. This simulation provides a visual representation of how different REIVs may align with various strategic approaches based on two key metrics: the portfolio turnover rate and the Development Renovation Difference (DRD).

The turnover rate helps distinguish between REIVs that tend to hold onto assets and those that frequently buy and sell properties. In the simulated dataset, this metric is plotted on the Y-axis of Figure 11. A turnover rate of 0 means the REIV has neither bought nor sold assets over the observation period, while a turnover rate of 1 indicates a complete turnover, where all assets were either acquired or sold within the period.

The DRD provides insight into whether a REIV's portfolio growth comes primarily from renovating existing properties or developing new buildings. It is defined as follows:

$$DRD_{p,t} = \frac{Development\ NAV_{p,t}}{Total\ NAV_{p,t}} - \frac{Renovation\ NAV_{p,t}}{Total\ NAV_{p,t}} \tag{1}$$

where all variables depend on the REIV's portfolio p and the observation period *t*. The *Total NAV* represents the total value of all properties held in the portfolio. The *Renovation NAV* refers to the value of properties that have undergone an energy retrofit, while the *Development NAV* corresponds to the value of constructed buildings, both during the observation period.[16]

The logic behind the DRD is straightforward: if an REIV renovates his whole portfolio over the observation period, it would have an DRD of -1, whereas an REIV that develops his whole portfolio over the observation period would have an DRD of 1. A value close to zero would indicate a balance between the two approaches.[17]

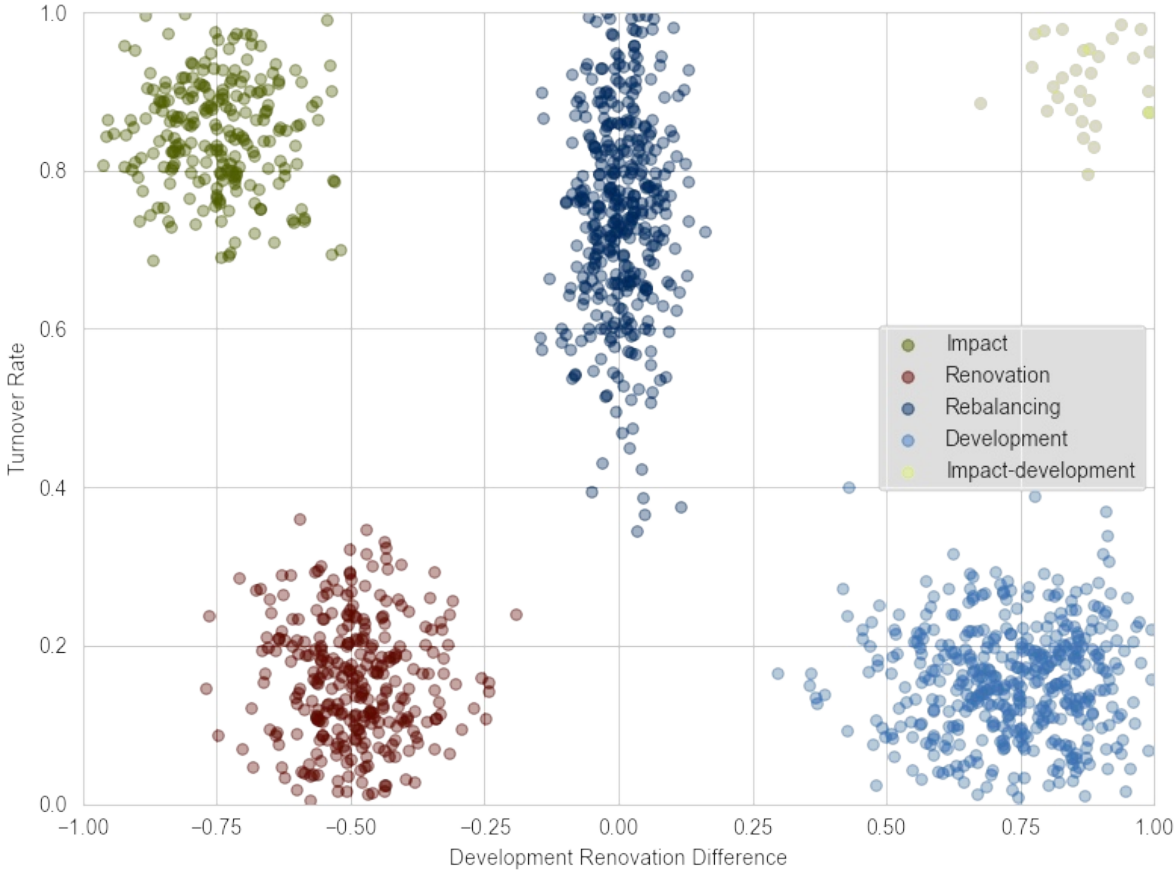
To illustrate how REIVs could be classified using this approach, we simulate a dataset and display the results in Figure 11. The data is generated using a bivariate normal distribution, with clusters centered around the key transition strategies. The goal is to provide a clear representation of how these classifications might look in practice, though in reality, the boundaries between strategies may be more fluid, and REIVs may have a mix of different approaches.

The figure highlights five distinct clusters: the four transition strategies outlined earlier—*Rebalancing*, *Renovation*, *Development*, and *Impact*—as well as a separate impact-development category. While impact-development naturally fit within this representation, they are not considered part of the transition strategies, as their primary activity is to develop new buildings and sell them directly, rather than manage a long-term portfolio. The other four clusters corresponds to a different strategic approach.

[16] An alternative approach, if NAV data is not readily available, could be to use the developed and renovated heated square meters as a proportion of the total heated square meters instead. This method would provide a similar classification, capturing the relative emphasis on renovation versus development.

[17] A potential limitation of the DRD is that an REIV that renovates and develops properties in equal measure may appear in the center of the graph, indistinguishable from an REIV that remains largely inactive. If, when applied to real data, we find excessive clustering around zero, a third variable—such as the intensity of actions—could be introduced to provide additional clarity, using color or dot size to represent the scale of each REIV's activity.

Figure 11: Simulation of REIVs Transition Strategies Classification



The Impact strategy, represented in the top left, is characterized by high turnover and a strong focus on renovation. In extreme cases, an REIV fully dedicated to this strategy could reach a turnover rate of 1 and an DRD of -1 over a long enough period.

The Renovation strategy, positioned in the bottom left, involves low turnover and a negative DRD, reflecting a focus on upgrading existing properties while maintaining a stable portfolio.

The Rebalancing strategy, located near the top center, is marked by a high turnover rate but an DRD close to zero, indicating frequent buying and selling without a strong emphasis on either renovation or development.

The Development strategy, found in the bottom right, is characterized by low turnover and a positive DRD, as REIVs pursuing this approach prefer to construct new buildings and hold onto them.[18]

At present, the lack of historical building permit data and REIV transaction records prevents us from applying this classification system to real Swiss REIVs. However, with improved access to these datasets, it would be possible to assign real estate funds to specific strategic categories, analyze market trends, and identify areas where new investment opportunities might emerge. This classification could provide valuable insights into which strategies are most commonly used and where gaps in the market exist for future entrants.

5.3 Focus on REIVs Renovation Rates, Projected Emissions, and Costs

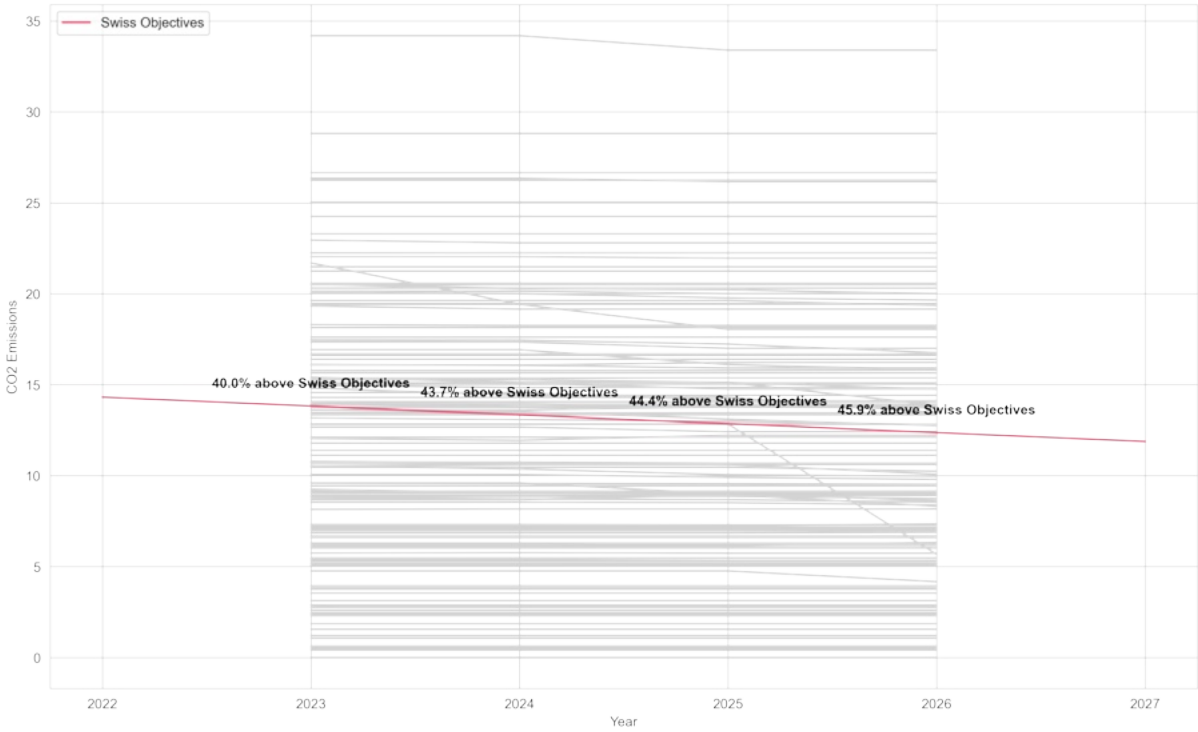
This subsection projects the emissions pathways of REIVs using building permit data, historical emissions, and anticipated upgrade timelines. It then estimates the financial burden of renovations relative to the NAV of REIVs. The analysis aims to provide forward-looking indicators of REIVs' progress toward the 2050 decarbonization targets, focusing primarily on emissions reductions driven by renovations—making these projections particularly relevant for REIVs following *renovation* or *impact* strategies.

Given the range of strategies that REIVs can employ, this analysis has certain limitations. The current projections primarily reflect emissions reductions from renovation activities and therefore do not fully capture the broader strategies REIVs might use to meet 2050 targets. Access to more comprehensive historical

[18] The area near the bottom center could be occupied by REIVs with mixed strategies. These funds might favor holding onto assets while balancing renovation and development, rather than committing entirely to one approach.

data on individual REIV strategies would enable a more nuanced assessment of how each approach contributes to emissions reduction and the overall feasibility of meeting climate goals.

Figure 12: Projected CO_2 Emissions per REIVs for the period 2023 to 2026



To evaluate REIVs' progress on Swiss decarbonization goals, we combine building permit data, historical emissions, and projected renovation timelines to model emissions pathways. Due to limitations in the RegBL database and restricted historical data, our analysis focuses on renovation rates projected for the 2023–2026 period.

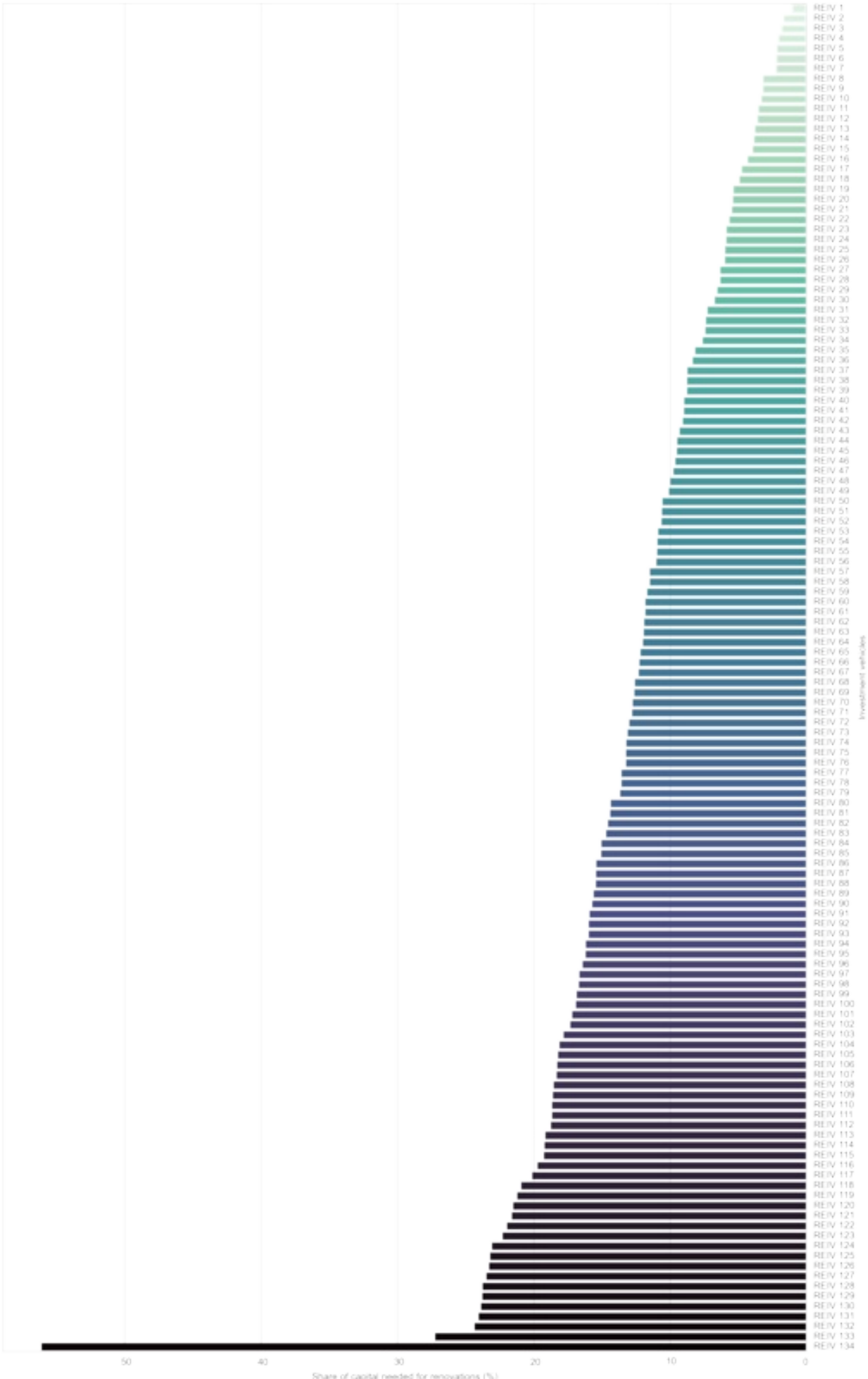
Each REIV's projected emissions trajectory is based on building permits filed between 2020 and 2024, providing a forward-looking indicator even for projects still underway. For permits involving heating system or energy efficiency upgrades, we use the median completion time to estimate likely end dates. While this approach provides an initial estimate of expected emissions reductions, it remains conservative due to data limitations. Moreover, since the analysis only includes retrofits requiring a building permit, it may underestimate the full extent of renovation efforts.

Figure 12 illustrates REIVs' projected emissions rates from 2023 to 2026, based on permits targeting energy efficiency and heating system upgrades. For buildings scheduled for these renovations, we assume an energy performance of 40 kWh/m^2 and adjust CO_2 emissions based on the upgraded heating systems (e.g., heat pumps, pellet systems, or district heating). Each grey line in Figure 2 represents an individual REIV's projected emissions trajectory, while the red line shows Swiss linear decarbonization target. In 2023, 40% of REIVs are projected to exceed the Swiss decarbonization target, with this proportion rising to 45.9% by 2026. In terms of share of AuM, this represents between 21.3% and 25.2% of the market. This suggests that the dynamic primarily affects REIVs of relatively smaller size. This trend suggests an increasing gap between current renovation efforts and climate objectives, underscoring the need for accelerated renovations and faster adoption of low-carbon technologies.

To estimate the financial impact of meeting the 2050 decarbonization targets, we identified buildings within each REIV's portfolio likely to require significant retrofits. Buildings with energy intensities above 60 kWh/m^2 or those using fossil fuel heating systems were marked for renovation, with retrofit costs estimated based on prices estimated in our linear model for energy and heating system retrofits in section 4.2.

Figure 13 displays the portion of each REIV's NAV that would need to be allocated to transition costs if investment vehicles followed a straightforward decarbonization pathway. On average, Swiss REIVs would need to allocate approximately 12.93% of their NAV to cover the required retrofit costs to meet 2050 emissions targets, representing an estimated total sector-wide cost of CHF 28.3

Figure 13: Share of Renovation Cost per NAV of REIVs



billion. This translates to an annual investment of around 0.50% of NAV per fund to maintain the necessary renovation pace.[19]

However, REIVs are not equally exposed to these costs. Some funds, particularly those already holding energy-efficient or newer buildings, may not require additional investment to meet decarbonization goals. For other funds, the level of exposure varies: some may need to invest as little as 0.04% of NAV annually, while others might require up to 2.16%.[20] This variation reflects differences in portfolio preparedness and the intensity of renovations required.

These estimations remain conservative. They are based on current prices but could rise under specific economic conditions. An increase in the brown discount could reduce the market value of non-compliant buildings, increasing the relative burden of transition costs on NAV. Furthermore, if inflation in the construction and retrofit sectors outpaces general inflation, real renovation costs could escalate, requiring an even greater share of NAV to finance the necessary upgrades. Delays, due to labor bottlenecks, could also increase these costs.

6 Discussion and conclusion

Swiss real estate sector is at a turning point. Achieving net-zero emissions by 2050 will require accelerated renovations, strategic investment decisions, and a precise understanding of transition costs. This report brings a novel, data-driven approach to this challenge by leveraging building permit data to measure the pace, scale, and financial implications of sustainability efforts. By integrating RegBL permit records with Quanthome's investment data, we provide novel in-

[19] The average NAV allocation is calculated as the arithmetic mean of the renovation rates across all funds. The annual rate is then determined by dividing this result by the number of years remaining from the final data point until 2050, which is 26 years as of 2024.

[20] These evaluations are obtained by dividing the portion of the portfolio requiring renovation by the number of years remaining until 2050.

sights into how REIVs are adapting their portfolios to meet decarbonization goals.

One of the key contributions of this report is the ability to measure renovation activity based on building permit data. Unlike previous studies that relied on projections or broad market trends, this approach enables us to track actual projects, their scope, and their financial implications. By analyzing permit filings forms, we quantify how much REIVs need to invest in sustainability, what types of renovations are most common, and how long these projects take to complete.

Our cost analysis provides a benchmark for estimating retrofit expenses, helping investors and policymakers understand the financial burden of the transition to net-zero. The results highlight significant cost variations based on factors such as building size, location, and renovation type, offering a more detailed view of the economic feasibility of different decarbonization strategies. However, these estimations remains limited as they cannot take into account factors that are for instance at the microlevel of the building.

The report introduces a framework of four key strategies that REIVs can adopt to align their portfolios with Switzerland's climate goals: *Rebalancing*, *Renovation*, *Development*, and *Impact*. Each of these pathways comes with distinct financial risks and contributions to emissions reductions, providing investment managers with a clearer road-map for sustainability decision-making.

While some REIVs choose Rebalancing, which involves selling high-emission properties and acquiring energy-efficient ones, others are actively investing in renovations or new developments. Renovation and impact strategies—which focus on upgrading existing assets—provide the greatest environmental benefits, as they directly reduce emissions from buildings already in use. However, these strategies also involve higher financial risks, longer project timelines, and greater planning complexity. This underscores the need for careful investment planning and policy support to ensure that sustainability efforts remain both financially viable and environmentally effective. These are general strategic frameworks, and REIVs may combine elements from different approaches to build a sustainable portfolio.

To illustrate how these strategies could be identified and applied in practice, we also present a simulated case study. By using simple classification metrics, this exercise shows how REIVs might be positioned along the different strategic paths—provided the necessary transaction and renovation data are available. While the classification remains illustrative, it highlights the potential for future research to map strategic behavior more precisely as data availability improves.

Despite an increase in renovation activity, our findings suggest that current efforts are insufficient to meet Switzerland's decarbonization objectives. While many REIVs are making progress, the overall pace of renovations remains too slow to align with the country's 2050 net-zero targets.

Our projections indicate that by 2026, nearly half of REIVs will still exceed Switzerland's emissions limits, highlighting the urgent need for faster and more ambitious interventions. Without a significant acceleration in renovation rates and energy efficiency upgrades, the sector risks falling further behind, increasing the risk of regulatory penalties, asset devaluation, and financial instability in the future.

The transition to net-zero real estate will require substantial capital investment. Our analysis estimates that REIVs will need to allocate an average of 12.93% of their NAV to retrofit costs, representing a sector-wide investment of CHF 28.3 billion.

However, the financial burden is not evenly distributed. Some funds, particularly those that already own energy-efficient buildings, may require minimal additional investment. Others, with older or less efficient portfolios, could need to allocate up to 2.16% of their NAV per year to keep pace with decarbonization targets. These differences highlight unequal exposure to transition risks, emphasizing the importance of tailored investment strategies and potential policy incentives to support those facing the highest costs.

Overall, the findings of this report emphasize the critical need for proactive decision-making in the real estate sector. Investors must weigh financial trade-offs between different decarbonization strategies, balancing cost efficiency with long-term sustainability gains. Policymakers, in turn, must consider regulatory incentives and financial support mechanisms to ensure that market-driven renovation efforts keep pace with national climate commitments.

This report equips stakeholders with data to navigate the Swiss real estate transition effectively. By shedding light on real renovation activity, strategic choices, and financial constraints, we provide a foundation for better-informed investment and policy decisions. Moving forward, the ability to accelerate renovations, optimize investment strategies, and ensure regulatory alignment will be decisive in shaping a sustainable, low-carbon future for Swiss real estate.

Appendix

Figure A1: Count of Permit Deposited per Year

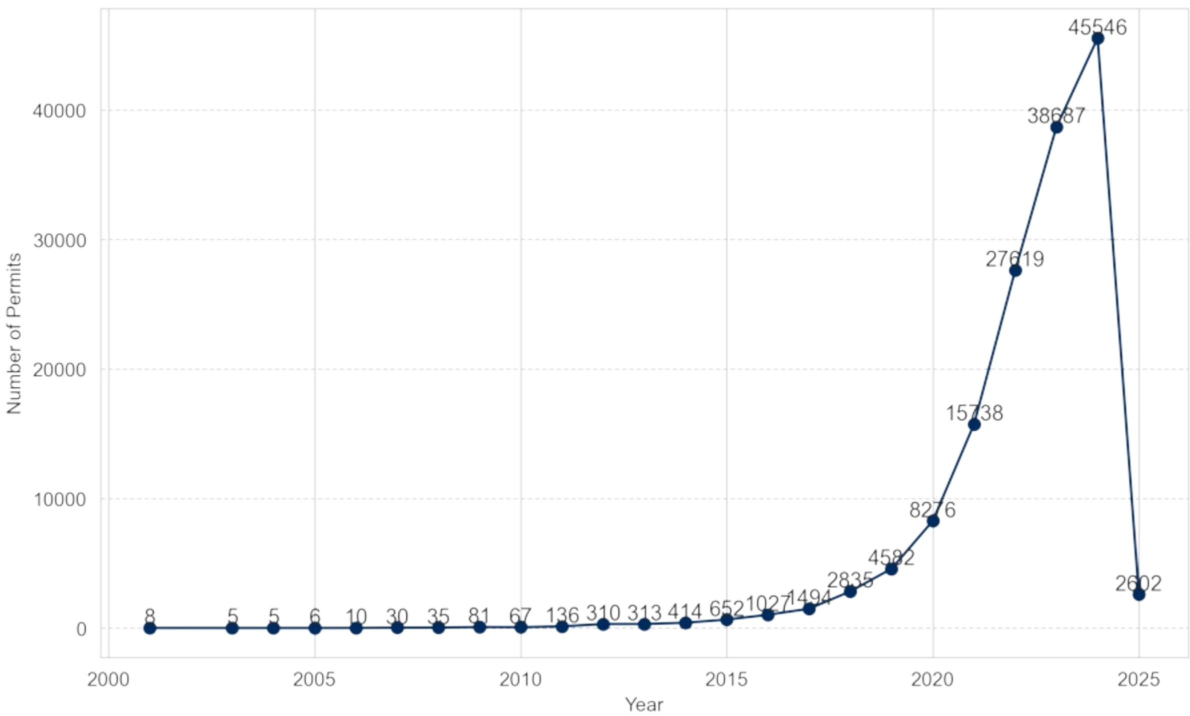
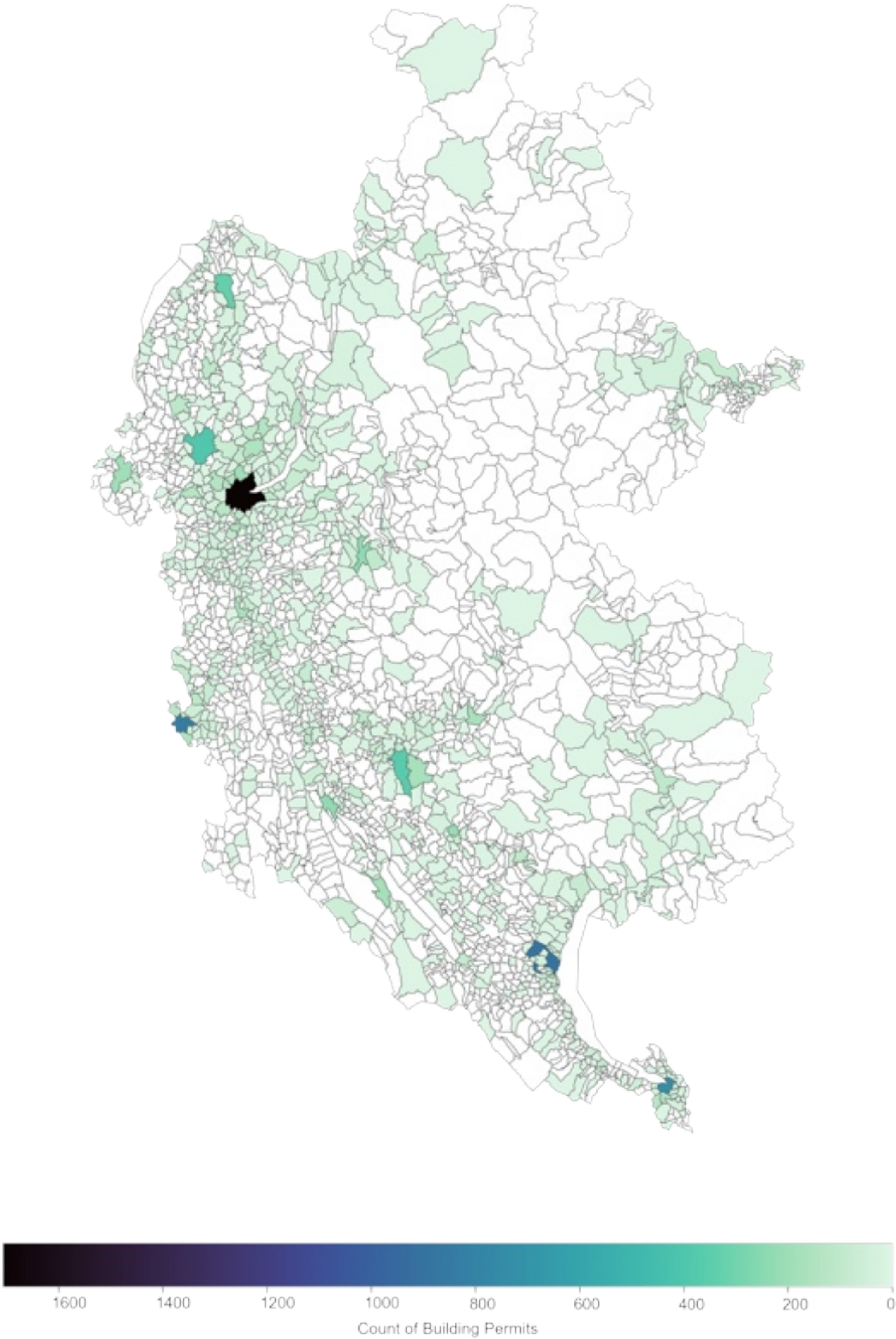


Table A1: Log-Linear Regression with Retrofit Interaction

Dependent variable: Log of cost per m²		
Constant	5.68***	(0.05)
Energy Retrofit	0.61***	(0.05)
Energy × Heating Retrofit	0.79***	(0.05)
Commercial Building	0.02	(0.08)
Size		
Medium Building	-0.39***	(0.05)
Large Building	-0.79***	(0.06)
Energy Retrofit × Medium Building	0.30***	(0.07)
Energy Retrofit × Large Building	0.55***	(0.08)
Construction Year		
Before 1950	0.16***	(0.05)
Between 1950 and 1975	0.33***	(0.05)
Between 1975 and 2000	-0.05	(0.06)
Regions		
Lemanic	0.39***	(0.07)
Mittelland	0.23***	(0.05)
North west	-0.21***	(0.06)
Eastern	-0.18***	(0.06)
Central	-0.29***	(0.06)
Ticino	-0.23***	(0.06)
R^2	0.14	
R^2 Adjusted	0.14	
Number of observations	11'999	

Notes: The baseline case is a heating retrofit on a small residential building in Zurich with a year of construction after 2000.

Figure A2: Count of Permit Deposited per Municipality



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