

# Energy building analysis considering different ownership types.

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# 1 Introduction

In Switzerland, the building sector accounts for around 40% of the country’s final energy consumption and contributes roughly one-third of CO<sub>2</sub> emissions, mainly from the use of fossil fuels for heating. (BFE, 2023). National strategies such as Energy Strategy 2050 and recent climate legislation set ambitious goals to reach net-zero CO<sub>2</sub> emissions in the building stock by 2050 (SFOE, 2024). To this end, deep renovations, the deployment of heat pumps, and the integration of renewable energy are promoted through financial incentives, such as subsidies and tax deductions (Berings et al., 2025).

Nevertheless, the number of buildings undergoing energetic renovation has been very low in recent years. This indicates that current policy initiatives are insufficient to encourage large-scale energy renovation.

Several authors (Amorocho et al., 2022; Azizi et al., 2019; De Tommasi et al., 2022; Mangold et al., 2018; März, 2018a) argue that renovation decisions are influenced by factors other than financial considerations, such as transaction costs and limited know-how. Furthermore, Azizi et al., (2019) and Mangold et al., (2018) highlight that current policies tend to consider building owners as a homogeneous group, neglecting the differences in their motivations and challenges, and call for a deeper understanding of the decision-making processes of each ownership type to enhance policy effectiveness.

Figure 1 illustrates the ownership structure in Switzerland. The statistics indicate that most Swiss buildings are owned by private individuals, followed by legal entities, while public buildings are excluded (BFS, 2025).

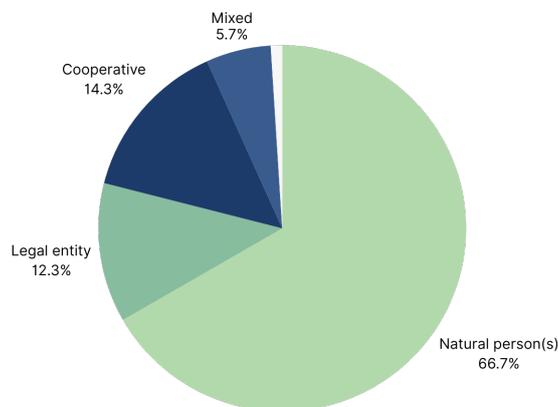


Figure 1 Swiss ownership structure (source: (BFS, 2025))

The aim of this report is to explore the opportunities that arise from differentiating ownership types in the planning of a Swiss municipality. In the following section, we describe the challenges and motivations for energy renovation faced by different types of owners, based on the literature. The report then outlines the process for obtaining ownership data in Switzerland, followed by an example application of ownership classifications for building benchmarking. Finally, it concludes with a discussion of how ownership data can be leveraged in future projects to inform and improve policy design and business model development.

## 2 Challenges and Motivations for Energy Renovation among Different Ownership Types

Today, institutional investors are responsible not only for financial returns but also for the environmental, social, and governance (ESG) factors that influence their investments (Thakkars et al., 2023). Several certificates and standards have therefore appeared on the market to measure and benchmark real estate properties in relation to ESG factors. Some of these reporting mechanisms have become mandatory for large companies (Archer-Svoboda, 2022), and according to Christensen et al., (2018), energy and sustainability tracking has therefore been adopted as a standard operating procedure by most institutional investors.

According to the 2020 PACTA report, buildings directly owned by institutional investors in Switzerland have lower CO<sub>2</sub> emissions than the rest of the building stock. Nevertheless, 70% of these buildings are still heated using oil. This indicates that even greater CO<sub>2</sub> emission reductions could be achieved by transitioning to a renewable heating system and performing energy-efficient retrofitting (Spuler et al., 2020).

Petkov et al., (2021) studied the decision-making process for retrofitting among institutional investors. They found that retrofitting decisions are often based on the idea of maximising building value. Schläpfer et al., (2020) show evidence that retrofitting buildings often leads to a considerable increase in property value.

However, Petkov et al., (2021) also notes that within the building portfolios of institutional investors, some properties are not economically viable to retrofit. In addition, institutional investors often apply rent increases to partially recover retrofitting costs. This is a highly sensitive measure that can lead to social issues and rent increases may therefore be regulated by the state.

As shown in Figure 1, 66% of buildings in Switzerland are owned by natural persons, including both rental and owner-occupied buildings. In the literature, split incentives are often identified as the most important barrier to the retrofitting of rental buildings (Broberg & Egüez, 2018; De Tommasi et al., 2022; Jimenez, 2025; Singhal et al., 2025). This situation arises when the party investing in the retrofit does not benefit from the resulting energy savings (Jimenez, 2025).

Nevertheless, März, (2018) mentions that small private landlords face additional challenges when retrofitting, including high investment costs, limited knowledge of technical solutions, and an uncertain regulatory environment.

Owner-occupied properties face similar challenges when it comes to renovation decisions (Matschoss et al., 2013). Although owners benefit directly from the resulting energy savings and improved living comfort (Ruokamo et al., 2025), the complexity and cost of renovation projects still delay decision-making (Agorocho et al., 2022).

In the case of multifamily buildings with multiple owners, the situation becomes even more complex, as agreement among owners is required to carry out renovations (Agorocho et al., 2022; Matschoss et al., 2013). However, the investment costs are shared among multiple actors, which can be an advantage (Singhal et al., 2025). A case study of a Swiss neighbourhood conducted by Woggon, (2022) showed that, to reduce complexity, multifamily buildings with multiple owners often rely on technically competent advisors, who strongly influence homeowners' willingness to undertake renovations.

Similarly, housing cooperatives also face organizational challenges when considering renovations, they are often subject to collective and fragmented decision-making processes that can be time-consuming. (Hauge et al., 2014; Lukkarinen et al., 2022).

To meet overarching decarbonization objectives, increasingly stringent EU regulations are placing greater pressure on the energy renovation of publicly owned buildings. For example, the European Energy Efficiency Directive obliges national and local authorities to renovate 3% of the total floor area of public buildings annually, with the aim of transforming them into zero-emission buildings by 2040. Responsibility for implementing these renovations often lies with municipalities, which face significant financial, administrative, and technical challenges (Konstantinopoulou et al., 2025).

Figure 2 summarizes the primary motivations and challenges for energy renovation across different ownership types.



Figure 2: Motivations and challenges for energy renovation of buildings for different ownership types

## 2.1 Business models and policy recommendations

As demonstrated in the previous section, motivations and challenges for energy renovations vary based on ownership. Consequently, several authors (Azizi et al., 2019; Mangold et al., 2018; März, 2018a; Petkov et al., 2021) advocate for tailored policies and business models.

März (2018) claims that larger funding and support are needed for small private landlords and that financial subsidies should be tailored to align with the investment decision-making process, which favors incremental over comprehensive approaches renovations.

De Tommasi et al., (2022) acknowledge that green leasing is an important tool to address the split incentives problem. There are several variations of leasing agreements, typically involving the building owner signing a contract with a service provider who assumes the financial risk and supplies services like heat to tenants (Zapata Riveros et al., 2024).

Further studies focus on the importance of one-stop shops to facilitate the energy renovation of building associations and publicly owned properties. This business model offers the advantage of a single point of contact for technical, financing, and administrative solutions (Elgendy et al., 2024; Konstantinopoulou et al., 2025).

### 3 Data accessibility on ownership type

Despite the large importance of considering ownership types in the appropriated design of policies and regulations there are still some limitations to access of these data.

In Switzerland, the land register (Grundbuch / land registry) serves as the official record of property rights and ownership, determining who owns each plot. It is managed at the cantonal level (Grundbuchamt / land registry office) according to the legal framework of the Swiss Civil Code and its regulations (BJ, o. J.).

Some land-register information is publicly accessible, such as the plot designation, owner name and ownership type, easements, and acquisition date. However, access and detail levels are regulated by Art. 970 ZGB (ZGB, 2023) and related rules. Cantonal practices differ regarding online searchability and which information can be freely accessed without explicitly expressing interest.

Regarding publicly owned buildings, some cities publish open data on the properties they own (municipal portfolios, building stock, and energy-related attributes for municipal buildings). For instance, the city of Zurich provides a list of properties owned by the city and their related metadata on its open data platform (Stadt Zürich, o. J.).

### 4 Benchmark of buildings by ownership

More and more municipalities and cities (e.g., Baden<sup>1</sup>) are using the **SEP Energy Portal** of geoimpact to inform and sensitize the population on the topic of renewable heating. The energy portal is integrated directly into the city's website. This allows homeowners to inform themselves online—for example, about replacing a heating system or installing a photovoltaic system. Via the energy portal, they can select their building or enter the desired address and receive extensive personalized information after entry.

The portal also displays a legend for annual solar radiation, which is shown in colour on an interactive map according to the suitability of different roof surfaces. Below this is the core of the energy portal—users receive a **recommendation for the new heating system at their respective location**, based on the priorities of the city's energy planning.

This explains how linking data can help in decision-making (in this case, connecting to a renewable thermal network). Finally, the energy portal also provides additional knowledge for even better decision-making.

#### Key Component: SEP Energy Portal

- **Download of Electricity Tariff Sheets** Local grid operators' electricity tariff sheets can now be downloaded at the touch of a button. This facilitates access to important tariff information at a national level and saves valuable time. Users can select the appropriate grid operator directly in the Electricity Panel and download the tariff sheet, enabling a fast and efficient market analysis.

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<sup>1</sup> <https://www.baden.ch/de/leben-wohnen/energie-mobilitaet/energie/energieportal.html/1046>

- **Building-Specific Electricity Grid Areas** SEP MarketSense now offers the possibility to query grid operators for different grid levels (**NE3, NE5, NE7**) directly at the building level. This function helps to identify specific market potentials for battery storage or other energy management measures. The benefit lies particularly in performing efficient profitability calculations and recognizing targeted potentials.
- **Integration of External Services in SEP MarketSense** SEP MarketSense enables the integration of external data services, allowing one's own business logic to be used in combination with SEP data. This opens up a multitude of possibilities, such as combining building-specific data from SEP with data from customer systems like CRM or GIS to calculate connection costs for district heating. Additionally, SEP MarketSense offers the possibility for live visualization of results from customer-specific data analyses, such as connection costs or expansion potentials, which supports fast and precise decision-making.
- **Interactive Visualization of Geoinformation** With the new function for interactive visualization, users can explore geoinformation in detail. A practical example is exploring individual sub-roof areas or facades, which is particularly useful for PV planning.

For this project we collaborated with the City of St. Gallen and geoimpact to generate a dataset which could also be integrated into the SEP services. To be able to carry out this analysis, we collected the data basis and the following specifications: Format: .csv

Identifiers:

- EGID (Federal Building Identifier) or EWID (Federal Dwelling Identifier)
- If applicable, parcel numbers or similar

Profiling:

- Indication of whether the owner is institutional (with further distinctions) or private
- If applicable, further information (e.g., via ZEFIX), where available, to enable more differentiated profiling

Other relevant data:

- Year of construction
- Energy consumption
- Energy Reference Area (ERA)
- Number of floors
- Number of apartments
- Subsidies received for renovations

The following categories were used for the types of ownership:

- Legal entities (AG, GmbH)
- Private individuals
- Condominium ownership (Stockwerkeigentümerschaften)

- Cooperatives
- Political municipality (City)

This data was provided for all buildings, including schools, office buildings, commercial properties, etc., as well as residential buildings.

For buildings for which no consumption measurements are available (mostly oil-heated buildings), the space heating demand was modelled (building category, demand type, year of construction, ERA). For hot water consumption, a calculation was used (1.1 MWh/year per person).

Furthermore, it was noted whether and in which year a thermal insulation measure was implemented. Regarding the "Gebäudeprogramm" (Building Program), this means: the measure was subsidized through the national Building Program (Energy Agency) and not through our local energy fund. For those marked with "Sanierungskonzept"(renovation concept), a consultation report titled "Building Renovation with a Concept" was prepared (Energy Agency).

Note on terminology:

- EGID/EWID: These are standard Swiss federal identifiers for buildings and dwellings.
- ZEFIX: Refers to the Central Business Name Index in Switzerland.
- EBF/ERA: We translated *Energiebezugsfläche* as Energy Reference Area, which is the standard technical term in building efficiency.

The energy indicators were enriched with data from geoimpact in particular EBF and energy consumption data. Geoimpact developed a method to get the energy indicators in a more reliable way (Weber, 2022).

In addition, data on installed PV systems was added to the database.

The dataset was cleaned and analysed using Microsoft Power BI. Ownership categories were consolidated, resulting in four distinct ownership types: Company, Private, Public, and Foundations and Cooperatives.

## 4.1 Non-Residential buildings

Figure 3 shows the number of buildings categorised by construction period. It indicates that companies are the largest owners of non-residential buildings, accounting for 47% of buildings, followed by private owners with 26%, public owners with 21%, and owners from foundations and cooperatives with just 4%.

The largest part of the building (46%) was constructed between 1900 and 1945. Only 5% were built in the last 20 years, and most of these belong to companies.

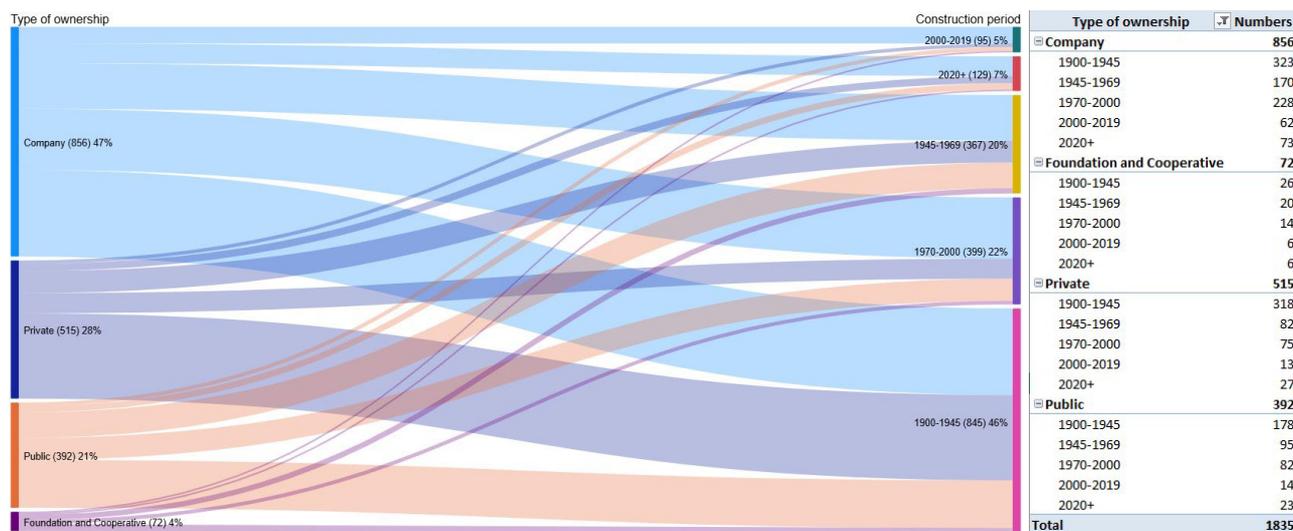


Figure 3 Number of buildings spread over construction period

Additionally, Figure 4 categorises ownership type by construction period and heating source type. It is clear from the figure that the majority of buildings, especially those constructed between 1900 and 1945, use gas as the main heating fuel. The next most common heating systems are district heating and oil, at 20% and 18% respectively, followed by geothermal at 10%.

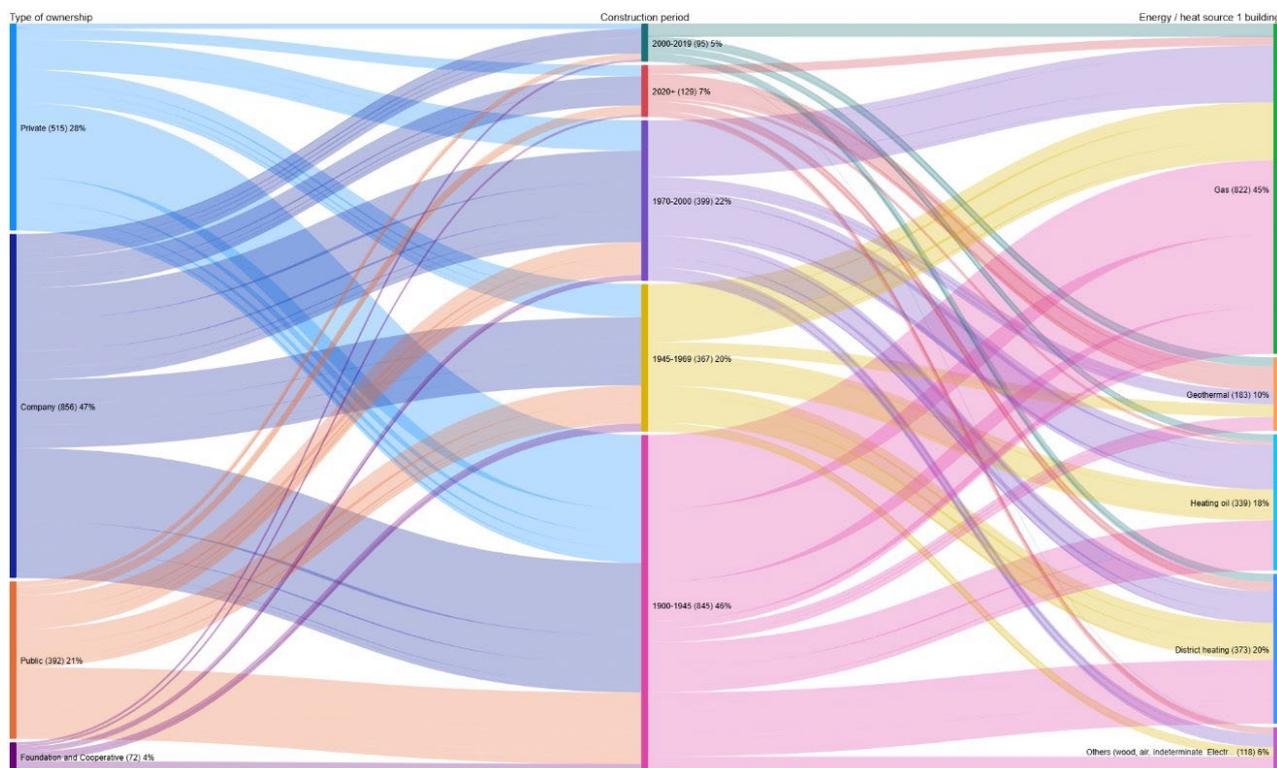


Figure 4 Ownership type broken down by construction period and energy/heat source

The specific space heating requirement, as detailed by the owner and the type of fuel, is depicted in Figure 5. The data presented herein demonstrate that most proprietors who primarily utilise gas for heating purposes are found in the categories of Foundations and Cooperatives (71%) and Private Individuals (50%). Despite the fact that the percentage of gas used by public and company owners is lower, it nevertheless remains significant, with the respective figures standing at 44% and 40%.

District heating represents the second most prevalent heating system, with companies (30%) and private households (20%) being its primary users.

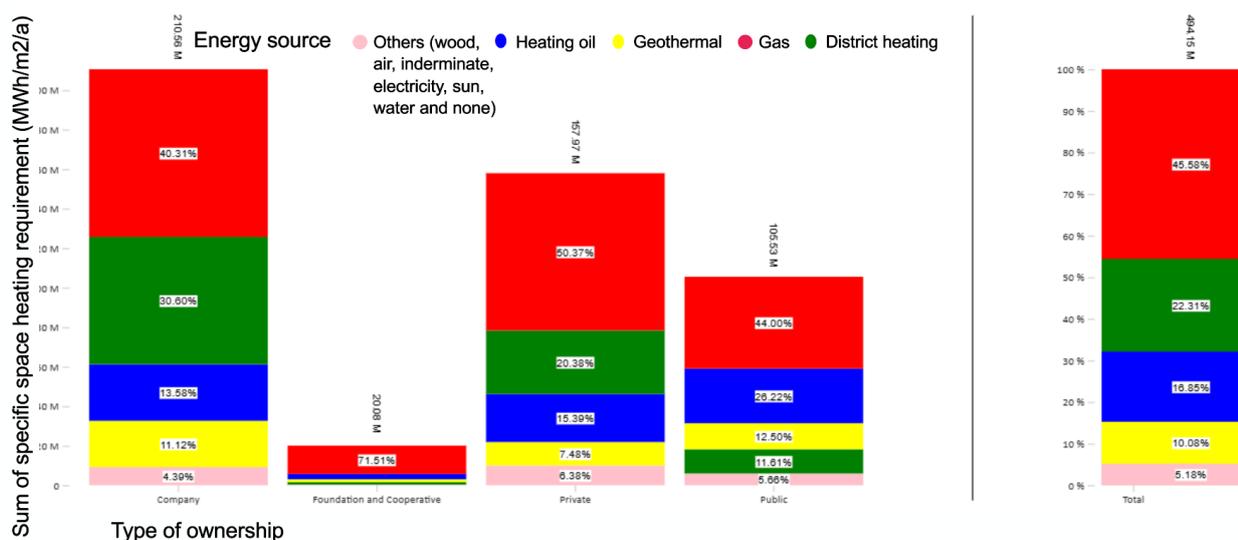


Figure 5 Specific space heating requirement specified by the owner and fuel shares (as a percentage of the total)

Figure 6 presents the distribution of specific energy demand by ownership type. While the medians are very similar across all ownership categories, privately owned buildings exhibit a substantially larger interquartile range, indicating greater variability. In particular, a large share of private buildings falls within the second and third quartiles, corresponding to specific energy demands between 87 and 191 kWh/m<sup>2</sup>. Company-owned buildings display a generally lower median and the smallest dispersion, with 95% of observations remaining below the third quartile threshold of 95 kWh/m<sup>2</sup>. Publicly owned buildings show intermediate characteristics, with a first quartile (Q1) of 61 kWh/m<sup>2</sup>, a median of 87 kWh/m<sup>2</sup>, and a third quartile (Q3) of 120 kWh/m<sup>2</sup>.

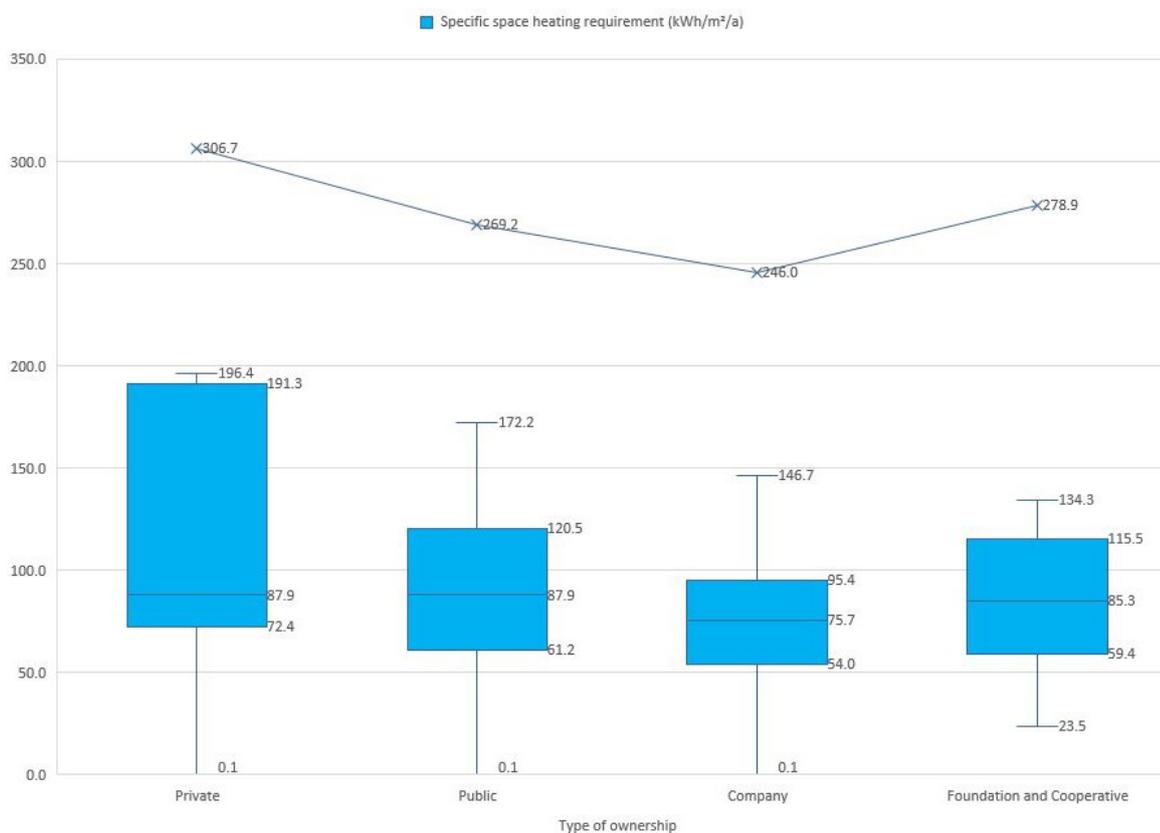


Figure 6 Box plot specific energy demand (kWh/m<sup>2</sup>/a) per ownership

Figure 7 demonstrates the installed PV capacity by ownership category. According to this figure, company-owned buildings have the largest installed PV capacity, accounting for around 74% of the total, followed by public buildings (11%) and private buildings (10%).

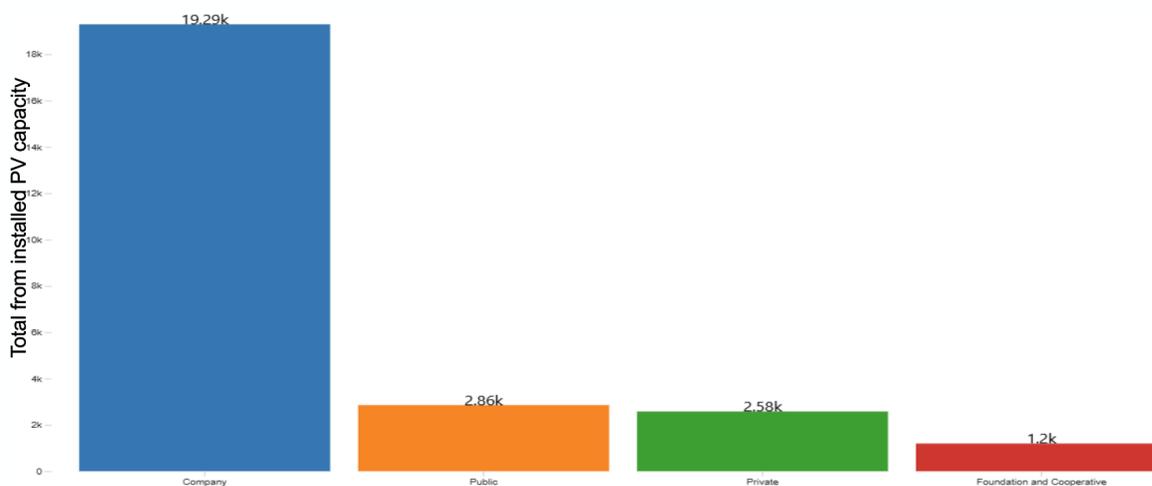


Figure 7 Installed PV capacity (kW) per ownership

## 4.2 Residential buildings

Figure 8 shows the number of buildings distributed across a range of construction periods and ownership types. The finding that private-owned buildings account for 66% of the total buildings analysed is noteworthy. This is followed by company-owned buildings, which account for 22%, and buildings belonging to founding and cooperative entities, which account for 10%.

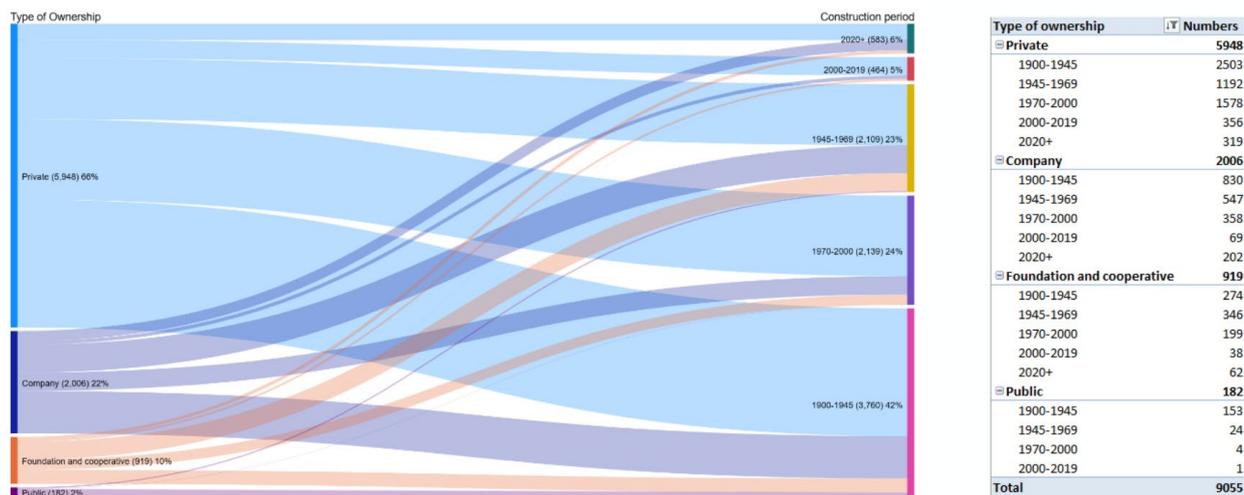


Figure 8 Number of buildings spread over construction period.

As with non-residential buildings, gas is the most prevalent heating source in residential buildings (38%), with the majority of these buildings having been constructed during the period between 1900 and 1945 (see Figure 9). Heating oil (23%) and District heating (16%) represent the next significant fuels in terms of their utilisation. Geothermal, in turn, constitutes a further 16% of total heating demand, which is a larger percentage than in non-residential buildings.

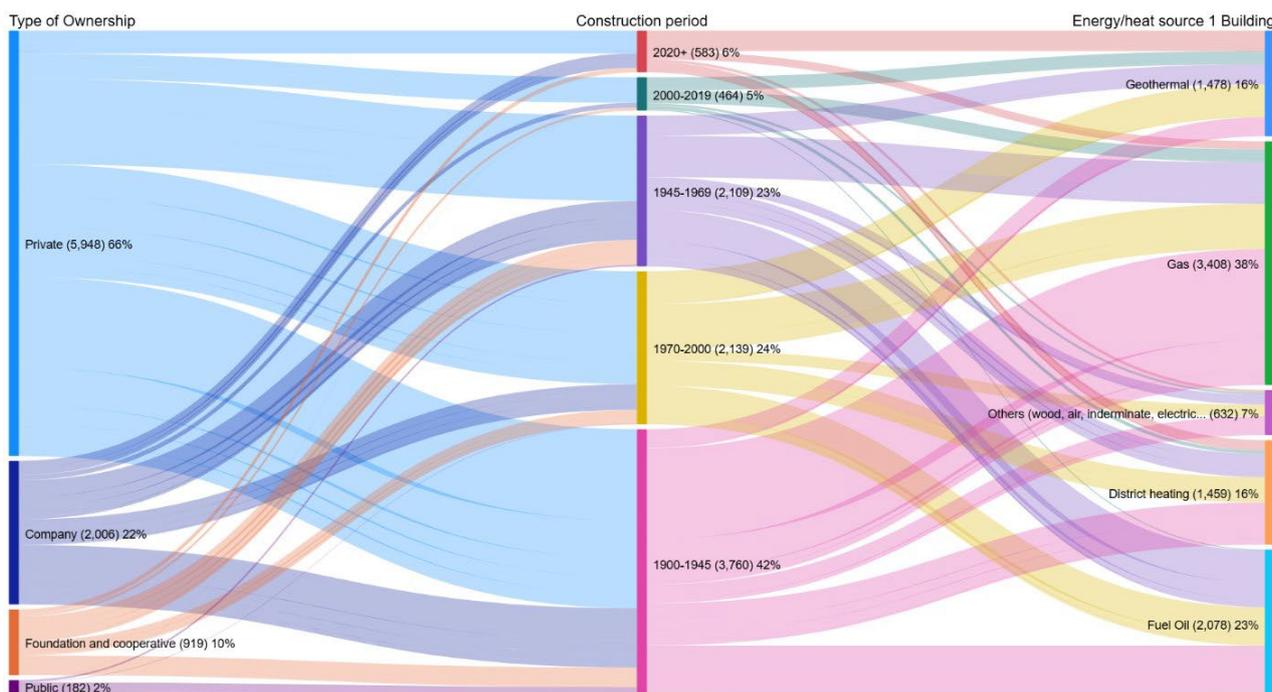


Figure 9 Ownership type broken down by construction period and energy/heat source

Figure 10 illustrates the specific space heating demand disaggregated by ownership type and heating fuel. The results indicate that gas-based heating accounts for approximately 38% of space heating demand across all ownership categories. District heating is the second most prevalent heating option, particularly among private owners (24%) and companies (28%). Geothermal heating plays a notable role for privately owned buildings, where its share is comparatively higher than in other ownership categories.

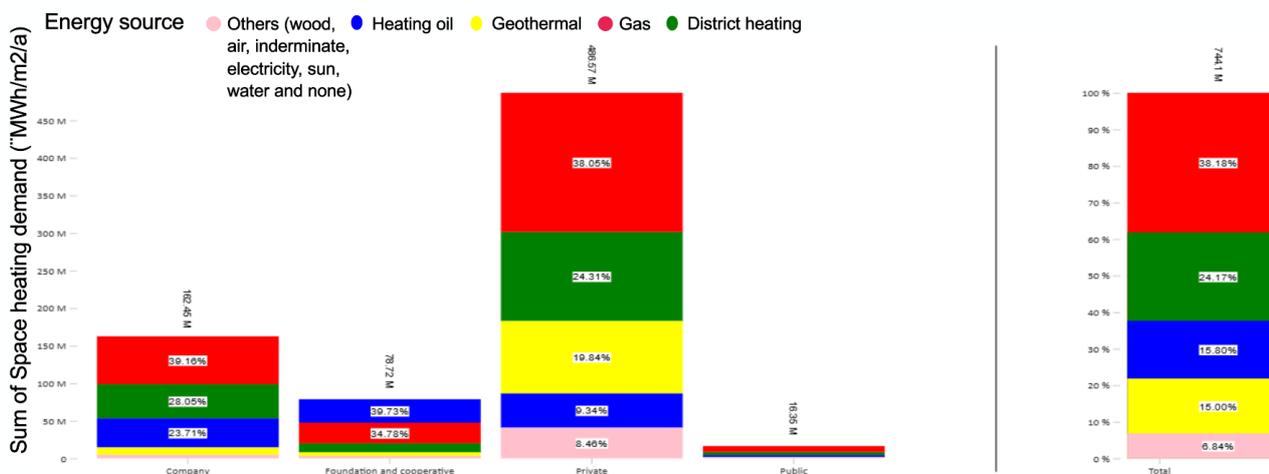


Figure 10 Specific space heating requirement specified by the owner and fuel shares (as a percentage of the total)

Figure 11 presents the distribution of specific energy demand (kWh/m<sup>2</sup>-a) by ownership category. Privately owned buildings exhibit the highest median value, at 84 kWh/m<sup>2</sup>-a. Public buildings show a lower median of

65 kWh/m<sup>2</sup>·a; however, a substantial proportion of observations lies between the second and third quartiles, spanning from 65 to 93 kWh/m<sup>2</sup>·a, indicating a concentration of buildings in this range. Company-owned buildings also display a wide dispersion, with a first quartile (Q1) of 42 kWh/m<sup>2</sup>·a, a mean of 50 kWh/m<sup>2</sup>·a, and a third quartile (Q3) of 82 kWh/m<sup>2</sup>·a.

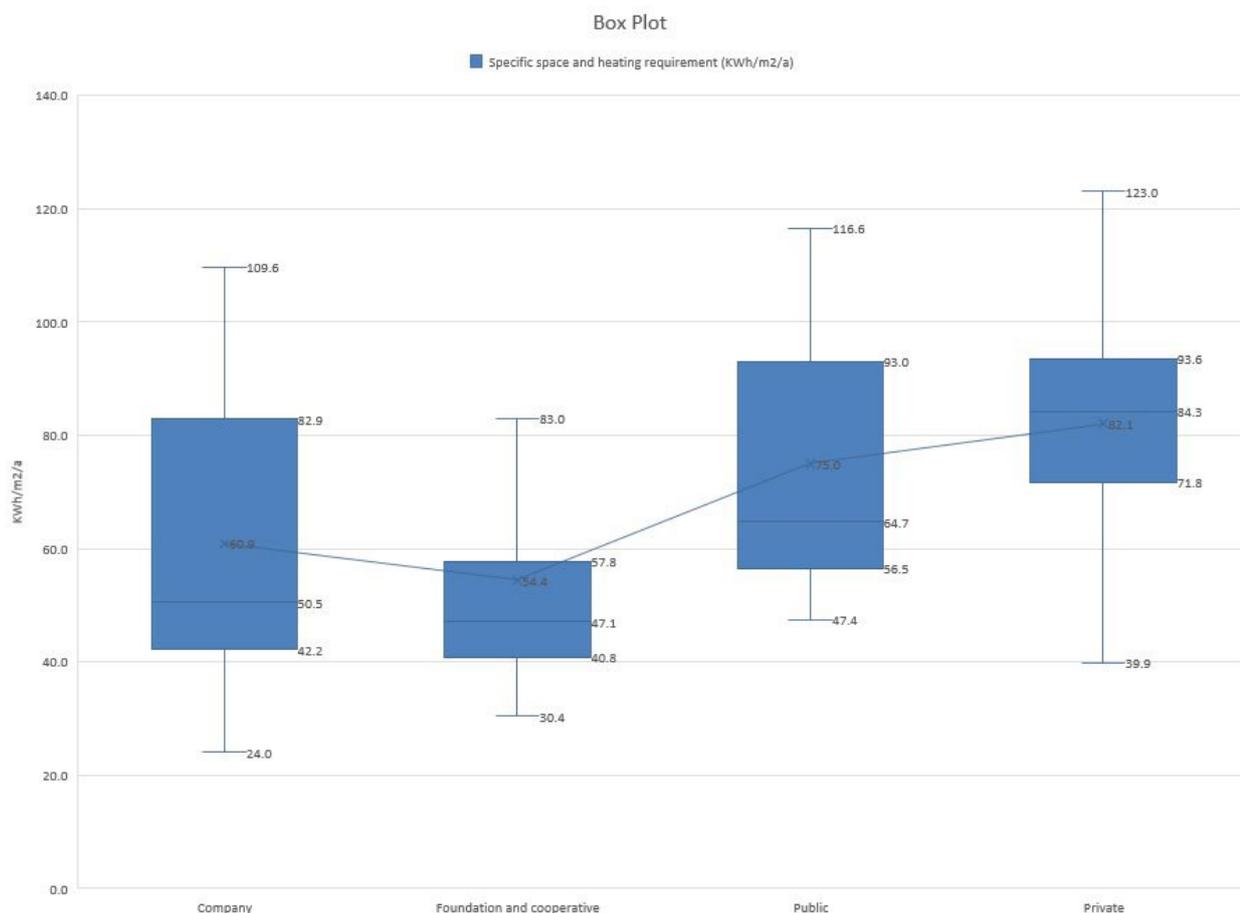


Figure 11 Box plot specific energy demand (KWh/m<sup>2</sup>/a) per ownership

Figure 12 shows the installed photovoltaic (PV) capacity by ownership type. The highest installed PV capacity is found in privately owned residential buildings (64% of the total), followed by company-owned

buildings (20%) and foundations (14%). By contrast, publicly owned residential buildings have the lowest installed PV capacity of all the ownership categories.

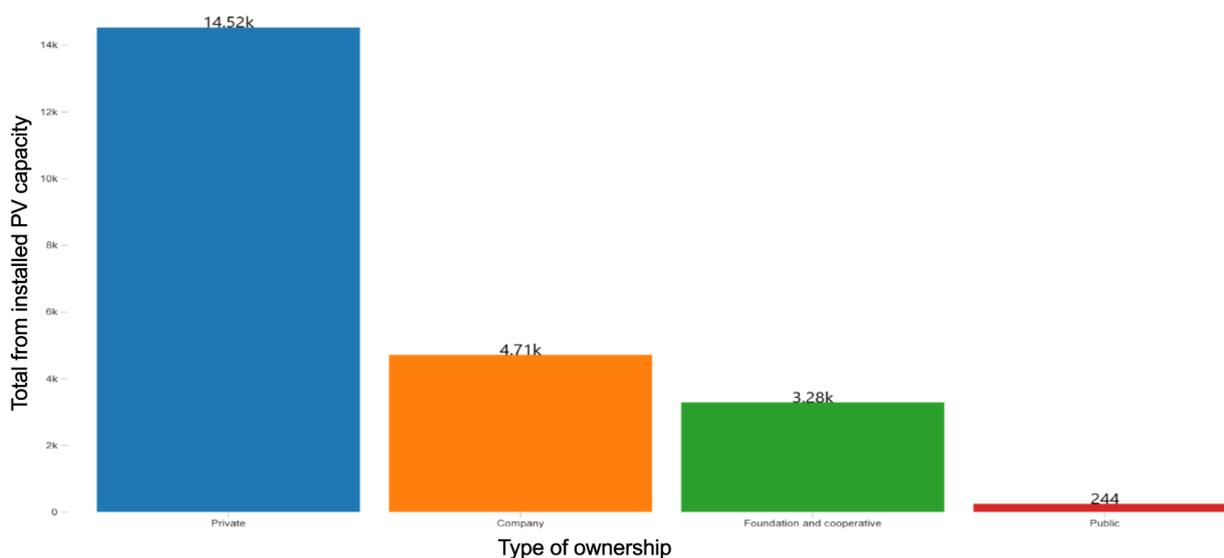


Figure 12 Installed PV capacity (kW) per ownership

### 4.3 Conclusions and Further Work

This report investigates the influence of ownership structures on building energy efficiency. Following a review of the relevant literature, an empirical analysis was conducted to assess the situation in the municipality of St. Gallen, Switzerland.

The analysis shows that non-residential buildings are predominantly owned by companies, often representing institutional investors. This ownership category exhibits the highest energy performance, characterized by lower specific energy demand and, by a substantial margin, the largest installed photovoltaic (PV) capacity. These findings are consistent with results reported in the literature, notably those indicating that buildings owned by institutional investors display the lowest CO<sub>2</sub> emissions within the Swiss building stock (Spuler et al., 2020).

Private owners account for approximately 28% of non-residential buildings and display significantly greater heterogeneity in energy performance. A large share of these buildings exhibits specific energy demands between 87 and 191 kWh/m<sup>2</sup>, which is high compared to other ownership categories within the same building type. In addition, private owners rely heavily on fossil-based heating systems (65%) and show relatively low levels of PV deployment. This observation aligns with previous studies highlighting the structural and financial challenges private landlords face when undertaking energy-efficient renovations (März, 2018b).

In the residential sector, ownership is dominated by private individuals, who represent 66% of the analysed building stock. This group also accounts for the largest share of installed PV capacity (64% of the total). However, in terms of overall energy efficiency, corporate owners outperform private owners. This disparity may be explained by the fact that private homeowners directly benefit from self-consumption of PV

electricity, while comprehensive energy-efficiency retrofits remain complex, costly, and administratively demanding (Ruokamo et al., 2025).

Across both residential and non-residential buildings, fossil fuels—primarily gas and oil—remain the dominant heating technologies, followed by district heating. Notably, geothermal heat pumps represent a significant share (16%) among privately owned non-residential buildings, indicating emerging diversification in heating technologies within this ownership group.

Overall, the results highlight the necessity for policy instruments and support mechanisms tailored to the specific needs and constraints of different ownership types (Azizi et al., 2019; Mangold et al., 2018; März, 2018a; Petkov et al., 2021). While corporate-owned buildings are clearly leading the decarbonization process, private owners, foundations, and smaller corporations require targeted support. Measures such as one-stop-shop solutions that simplify planning, financing, and implementation of renovation projects could significantly lower existing barriers.

Future research should focus on the development of innovative business models that address the heterogeneous needs of different ownership types. This includes designing decision-support tools adapted to owner-specific incentives and constraints, as well as exploring strategic policy frameworks capable of accelerating deep renovation and decarbonization across the entire building stock.

A crucial next step is to extend the analysis of ownership structures and their impact on building energy performance to additional Swiss cities and municipalities. While the findings from St. Gallen provide valuable insights, it is expected that regional differences—shaped by cantonal policies, urban development patterns, climatic conditions, socioeconomic factors, and the historical building stock—have a significant influence on energy-renovation dynamics.

A comparative study across urban, peri-urban, and rural municipalities would make it possible to:

- Identify regional patterns and differences in heating technologies, energy performance, and renovation rates.
- Better evaluate the effectiveness of cantonal incentive schemes and local energy-planning strategies.
- Determine whether certain ownership types vary by region (e.g., metropolitan areas vs. mountain regions) and how differently they respond to political or economic incentives.
- Develop region-specific decision-support tools within SEP (e.g., differentiated benchmarks or localized renovation and PV-potential analyses).
- Understand which business models or one-stop-shop concepts work more effectively in specific regions and how they should be adapted.

Combining local energy and ownership data from multiple municipalities would also allow for the formulation of broader recommendations for cantons and the federal level, such as more targeted funding strategies or the prioritization of regions with particularly low renovation activity.

In the long term, such an expansion would create the foundation for a Swiss comparative model of ownership structures and renovation dynamics. This would support planning authorities and market actors in aligning investments, energy strategies, and policy measures more precisely.

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