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The use, energy use and renovation of Swedish second homes in winter sport areas

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Abstract. The growing utilization of second homes has led to extended heating periods and, to some extent, renovations to enhance their standards, resulting in increased energy and resource consumption. This study, conducted in Sweden, investigates user patterns across various seasons, heating systems, and implemented energy renovation measures. Findings reveal that 40% of second homes in winter sport areas are inhabited prolonged periods during the winter, and more than half are used for shorter durations throughout all seasons, surpassing the usage frequency of second homes in general. Additionally, more than half of these second homes are heated to temperatures exceeding 16°C even when unoccupied. The predominant heating method is direct electricity (48%), followed by heat pumps (32%). Renovation activities primarily focus on interior surfaces, kitchens, and bathrooms to elevate standards, with less than 15% implemented energy-efficient measures like heat pump installation, added insulation, new lighting, or control systems. Considering reported user and heating patterns, along with energy renovations undertaken, the study estimates the energy-saving potential associated with various energy renovation strategies. By installing heat pump the energy consumption can be reduced by more than 50% and by lowering the temperature when the house is unoccupied the energy consumption may be reduced by almost 50%.

1. Introduction

The society struggles with significant challenges of transforming the built environment to increase resource efficiency and diminish its climate impact. Within the European context, the European Union (EU) has delineated explicit objectives pertaining to the energy efficiency of buildings, mandating that each member state devises a comprehensive strategy for the implementation and facilitation of energy renovations in extant structures. The overarching objective embedded in the recently introduced regulations encapsulated within the "Fit for 55" legislative package is the substantial reduction of greenhouse gas (GHG) emissions within the buildings sector, targeting a decline ranging from 29% to 40%, relative to the levels recorded in the year 2005 [1]. In Sweden, the National Board of Housing, Building, and Planning has devised a comprehensive national renovation strategy, accompanied by a roadmap aimed at enhancing the energy efficiency of the country's building stock [2]. The primary objective is to achieve a 50% increase in energy efficiency by 2030 compared to 2005, with the ultimate goal of phasing out fossil fuels by 2050. This initiative encompasses more than 8 million buildings, a substantial contributor to overall energy consumption, with over 600 000 classified as second homes.

In accordance with European Union regulations, every real estate unit is mandated to possess an energy performance certificate. This requirement serves the purpose of imparting information to both property proprietors and occupants regarding the energy efficiency of the respective property [3]. However, specific categories of structures, notably second homes, are exempted from the obligation to

obtain an energy performance certificate [4]. This exemption applies when such dwellings are utilized for less than four months annually, and their energy consumption does not exceed 25% of the overall energy demand if the residence were to be permanently occupied. It is noteworthy, however, that the validity of this exemption is questionable, given that the consequential impact on the aggregate energy consumption and power utilization attributable to second homes cannot be deemed inconsequential. A reason for the considerable energy use for heating is that many owners of second homes in cold climates such as Scandinavia, heat their houses to keep the temperature well above 0°Celcius to avoid freezing of water system which may cause leakage but also to avoid moisture damage and infestation of insects. A temperature of 15°Celsius is required by most insurance company to get a house insurance.

Second homes are valuation units (buildings) lacking registered residents, and include various types, such as agricultural units with building(s), single-family house units used limited time of the year, and those buildings with a market value below SEK 50 000 (4355 € in March 2024). Despite a noteworthy 20% reduction in energy use for Swedish second homes from 2011 to 2021, additional measures are imperative to meet the ambitious 2030 targets. While some energy renovation measures overlap between second homes and single-family homes, the distinct renovation needs and varying energy efficiency potential of second homes necessitate a focused approach.

In 2022, a national survey conducted in collaboration with the Institute for Quality Indicators in Sweden involved 3 750 respondents aged 16 to 90, resulting in a 51% response rate. Among the 1 826 respondents, 674 own or have access to a second home, representing over one-third of the participants. Notably, 202 of these second homeowners reported implementing energy efficiency measures in the past decade, with the installation of new heating systems being the most common, followed by a shift to energy-efficient windows. However, only about 20% of respondents undertook additional insulation measures for the roof, attic, facade, or foundation [5, 6].

Crucially, the survey findings highlight the potential to halve energy consumption by adopting measures such as installing a heat pump or lowering the indoor temperature to around 5 degrees when the house is unoccupied [5, 6]. Despite previous studies on energy use and efficiency potential in second homes, information regarding current energy use, heating sources, and user patterns remains limited, especially for specific categories such as ski cottages, which are assumed to be used more wintertime and hence consume more energy during the heating season [7, 8].

2. Scope and aim of the study

This study focuses on a specific segment of the second homes primarily utilized during the heating season. The assumption underlying this choice is that these buildings are heated more extensively, leading to high energy consumption. Consequently, this category becomes crucial for targeting energy-efficient interventions. The primary objective is to examine the distinctions, if any, between second homes in ski resorts and conventional second homes concerning user patterns, energy consumption, and implemented renovations. Three research questions were formulated to guide the investigation:

RQ1: How does the usage of second homes in winter sports areas differ from that of second homes in general?

RQ2: How are second homes in winter sports areas heated, and to what temperature when unoccupied?

RQ3: What renovations and energy efficiency measures have been undertaken in second homes in winter sports areas?

3. Materials and methods

This study employed a digital survey with focus on second homes in winter sport areas. To efficiently reach a broad spectrum of second homeowners in winter sport areas, collaboration was established with Skistar, a company offering ski holiday services, including lodging and ski passes, in several resorts in the Scandinavian mountains. Many of their members own second homes in Swedish winter sport areas.

The survey, administered in February 2023, comprised a digital questionnaire with questions covering aspects such as ownership, user patterns across different seasons, primary heating sources, set temperatures when unoccupied, energy consumption, conducted renovations, implemented energy efficiency measures, house types, construction specifics, and building materials. Skistar distributed the survey to their members, and data collection spanned over two weeks after the survey was published, with results subsequently extracted. The entire questionnaire that was sent can be reached at: https://survey.mailing.lu.se/Survey/45054?c_rid=620y04xf019poLaFaDg-485635258%7C126828115

4. Results and analyses

The digital survey garnered responses from a total of 225 participants. The findings are presented in relation to each research question and are subsequently discussed and compared with results obtained from previous studies on Swedish second homes in general [6, 7].

4.1. How does the usage of second homes in winter sport areas differ from that of second homes in general?

The ownership, types of second homes and how second homes are used during different seasons are presented and discussed in the following sections.

4.1.1. Ownership and type of house. Among those who participated in the survey within the winter sport area, 73% indicated sole ownership, while 24% reported co-ownership of the second home. This response aligns with expectations, as the survey was distributed to members of Skistar, the majority of whom are owners of second homes. This outcome contrasts significantly with a national study among second home residents in general, which revealed that, among those who reported owning second homes, 43% were sole owners, and 57% had access to second homes. Of the 225 respondents, 52% reported ownership or co-ownership of an apartment, 39% a ski cottage, 5% a summer cottage, and 4% a villa or other types of accommodation. The reported living space was reported by 193 second home owners and ranges from 32 to 450 square meters, Figure1. The most frequently reported façade material is wooden cladding (80%), followed by timber logs (14%) and concrete, rendered, stone and brick (6%) altogether. The most common roof material is steel plate (52%) followed by brick and concrete tiles (24% and 14% respectively), and felt, shingle and green roofs (10%). When it comes to windows, the majority (73%) of the houses have 3 panes or more and the rest (27%) have 2 panes. Two third of the houses have mechanical ventilation and one third natural ventilation, in some cases combined with fans in kitchen and bathrooms.

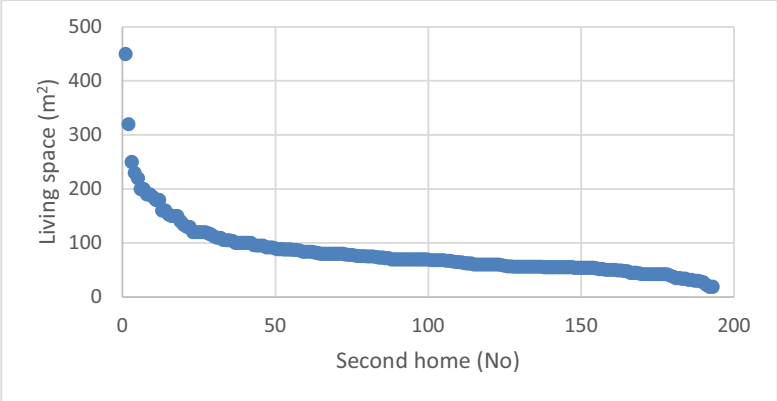

Figure 1. Living space in square meters reported by 193 respondents.

4.1.2. User pattern. The second homes in winter sport areas are obviously used longer periods to higher extent during winter season but also most probably shorter times during all other seasons, Figure 2. The usage patterns in second homes in winter sports areas differ significantly from a

previous study that involved 674 second home owners, clearly indicating that, in general, second homes are predominantly used during the summer. In contrast to winter accommodations, which are utilized throughout the entire season by only a small percentage of respondents, second homes, in general, are used by approximately 13% of respondents during the entire summer season, and by just under 5% during the spring and autumn season, but only a few percent during the winter. What is notable is that second homes, in general, are much more frequently used for day trips than second homes in winter sport areas, possibly explained by the likelihood that those are located farther away from respondents' primary residences.

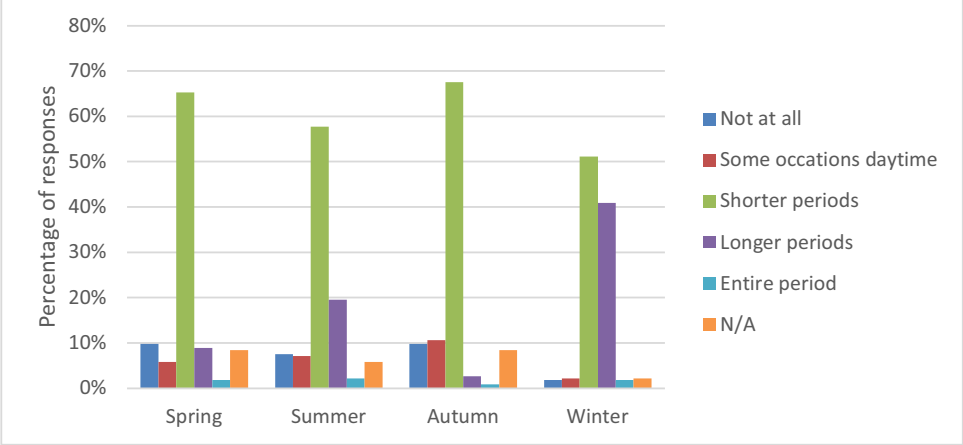

Figure 2. User patterns for second homes in winter sport areas.

4.2. How are second homes in winter sport areas heated, and to what temperature when unoccupied? The heating methods, set temperatures to which the second home is heated when unoccupied and typical energy use profiles for a subset of 30 second homes are presented and discussed in the following sections.

4.2.1. Heating methods. It is most common that the primarily heating system in second homes in winter sport areas rely on direct electric heating (48%) or heat pumps (32%), followed by wood stoves or tiled stoves (7%), district heating (8%), and other heating methods (5%), Figure 3. This differs significantly from second homes in general, where the proportion using direct electric heating as the primary heat source was considerably lower (32%), and heat pumps were at a similar level (30%). In contrast, a significantly larger percentage relied on wood stoves or tiled stoves (17.5%), with other heating methods accounting for 9%.

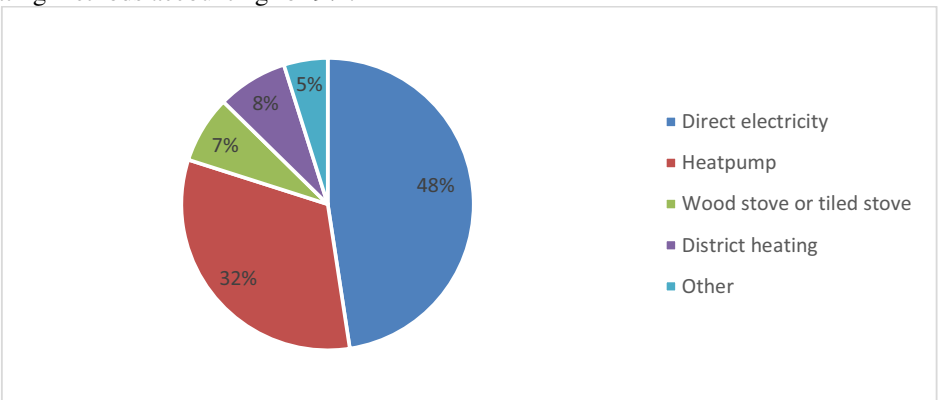

Figure 3. Primarily source of heating in second homes in winter sport areas.

4.2.2. Set heating temperature when second home is unoccupied. Something that distinguishes significantly between second homes in winter sport areas and second homes in general is the temperature to which respondents heat their accommodations when not in use. In winter sport areas, only 3% of the residences maintain a temperature of 5 degrees Celsius or lower when unoccupied, a third maintain a temperature between 11 and 15 degrees Celsius, and over 50% of respondents indicate that they heat their accommodations to 16 degrees Celsius or higher when unoccupied, Figure 4. This implies a notably high energy consumption which is not necessary and could be reduced substantially still taking moisture safety and freezing risks into account.

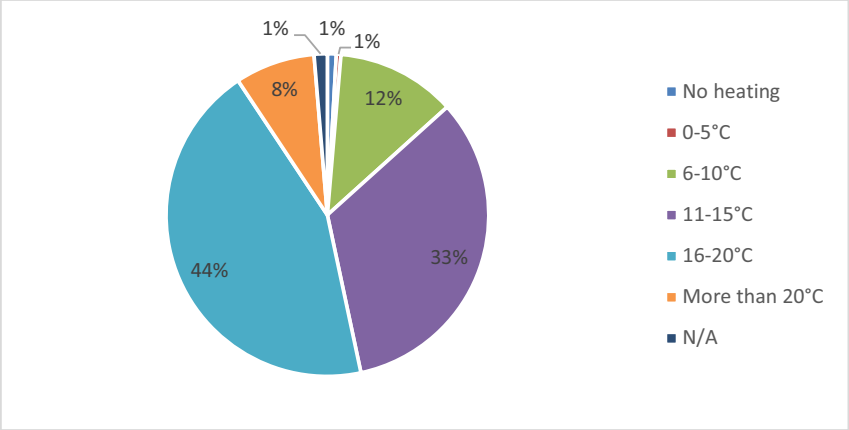

Figure 4. Set heating temperature when second homes in winter sport areas are unoccupied.

In this context, second homes in winter sport areas differ significantly from vacation homes in general. A large proportion (33%), as compared to second homes in general, maintain temperature levels at 11-15 degrees Celsius, and 52% at 16 degrees or higher, when unoccupied. In second homes in general, only 24% maintain a temperature between 11 and 15 degrees Celsius, and only 12% maintain a temperature higher than 16 degrees Celsius. In contrast, over 60% of vacation homes in general maintain a temperature below 10 degrees Celsius or have no heating at all when unoccupied.

4.2.3 Typical yearly energy use of second homes. Out of 225 respondents, 100 have reported their yearly energy use, which is presented in figure 5. The results show that the median yearly energy use is 142 kWh per square meters. The yearly average energy use is 149 kWh per square meter which is considerably higher than the requirements for new buildings in Sweden.

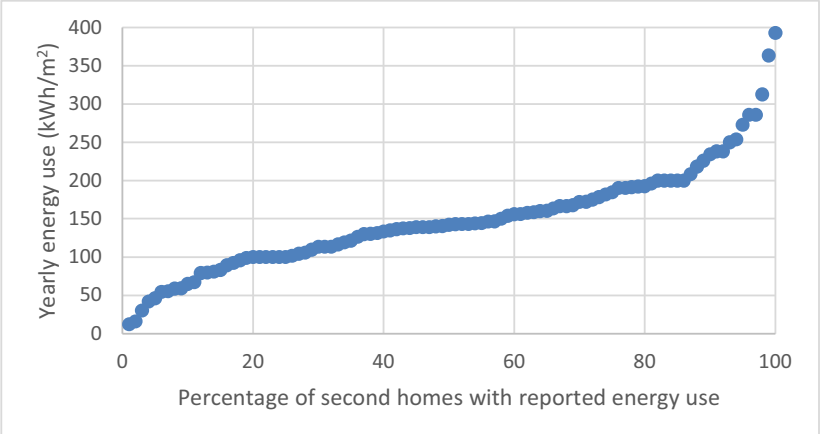

Figure 5. Typical yearly energy use reported from 100 second home owners.

4.2.4 Typical yearly energy use profiles of second homes. Out of the 225 respondents, 30 shared their energy use per month, most probably based on information of last year's energy use presented on the energy bill. The energy use is presented in Figure 6 as energy use divided by the floor area provided by the second homeowner.

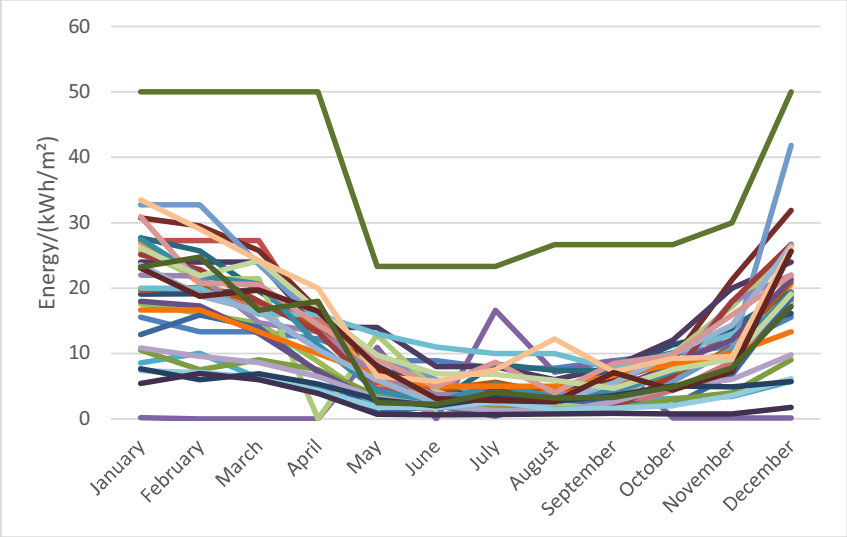

Figure 6. Monthly energy use in kWh per square meter reported by the owner of 30 second homes.

Most second homes consume between 5 to 35 kWh per square meter monthly during the heating seasons and between 0 and 10 kWh per square meter monthly during non-heating season. The primary heating sources in the second homes that reported energy use are direct electric heating and a wood stove, supplemented by an installed air-source heat pump, energy-efficient lighting, and control systems for electricity and heating. As seen in figure 5, the energy consumption in one particular second home deviates heavily from the others and reports an energy consumption of between 23 and 50 kWh per square meters. It is a 30 m^2 apartment in Åre, co-owned and utilized for extended periods during spring, summer, and autumn, but only during the day in winter, with heating maintained at 16-20 degrees Celsius when unoccupied.

4.2.5 Higher set temperature with heat pump? The question arises as to whether the second home is heated to a higher temperature when unoccupied if it is equipped with a heat pump. The results in Table 1 indicates that a higher temperature level is maintained in the house when unoccupied if the primary heating source is a heat pump compared to direct electric heating.

Table 1. The temperature to which the second home is heated to when unoccupied, for different main heating methods.

Main heating source	No heating	0-5°C	6-10°C	11-15°C	16-20°C	> 20°C	N/A
Electricity	1%	0%	9%	20%	13%	4%	1%
Heat pump	0%	0%	2%	10%	17%	2%	0%
Wood stove	0%	0%	1%	3%	2%	1%	0%
District heating	0%	0%	0%	1%	5%	1%	0%
Other	0%	0%	0%	1%	3%	0%	0%

4.3. What renovation and energy efficiency measures have been implemented in second homes in winter sports areas?
The year of construction, first and second renovation as well as renovation and energy efficiency measures carried out are presented and discussed in the following sections.

4.3.1 Construction and renovation years. The results presented in Figure 7 reveal that approximately half of the houses were constructed between 1970 and 1990, and after a period of stagnation, construction resumed at a steady but not as prolific pace throughout the entire 2000s. Among the oldest houses, many have undergone one or two renovations. Notably, in houses built in the 2000s, renovations occur within a few years of completion, in contrast to houses constructed in the 1980s, which underwent renovation only after 25-30 years. The likely cause is not that new buildings are of lower quality and in greater need of renovation, but rather the desire for a raising standard, even in the second homes.

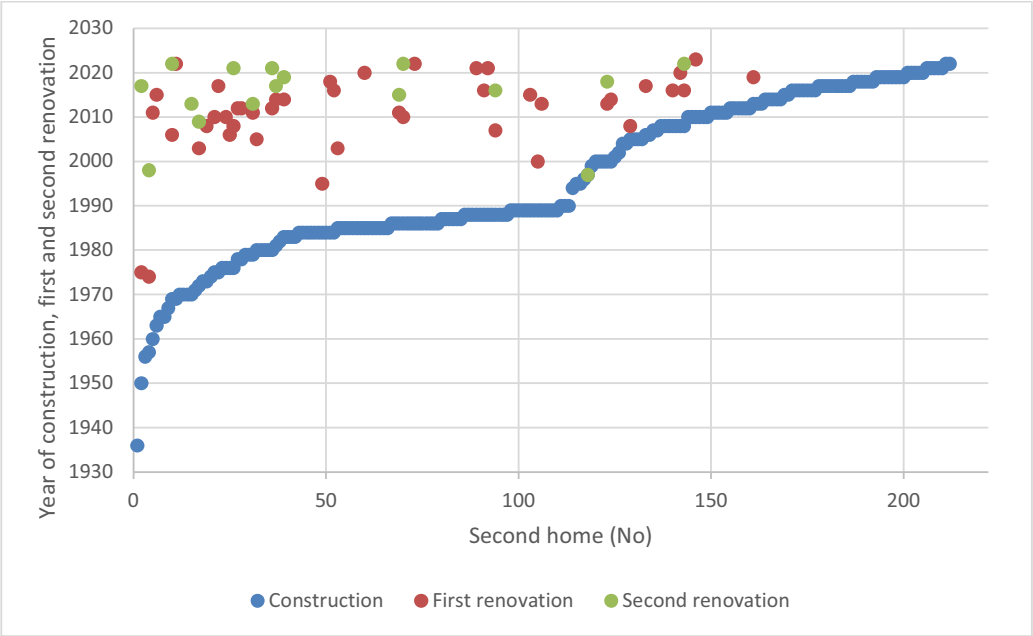

Figure 7. Year of construction in raising order for each second home, and first and second renovation, stated by the respondents.

4.3.2 Renovation measures performed. The majority of renovations, nearly 50%, have focused on interior surfaces, with kitchens (34%) and bathrooms (35%) being predominant, Figure 8. These renovations have primarily occurred during the 2000s, a period when there was a trend toward giving homes a facelift, extending to vacation homes as well. Another reason for the frequent renovations could be the increased wear and tear experienced by many houses and apartments due to rental activities. However, this ongoing trend has implications for resource utilization.

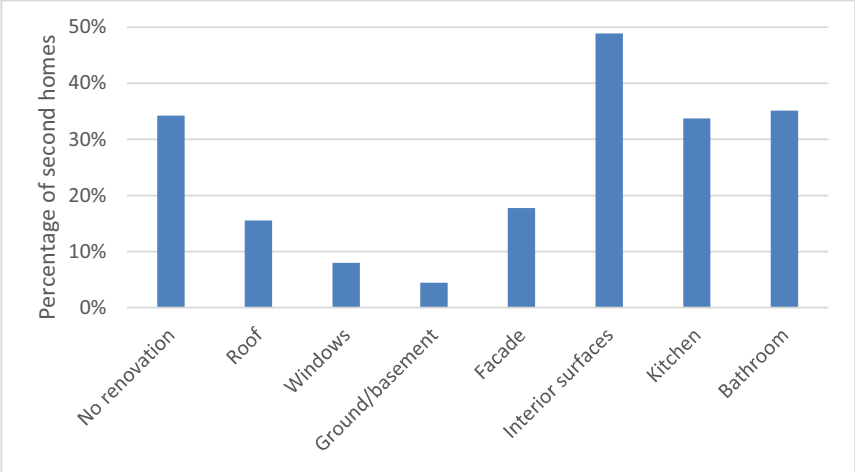

Figure 8. Renovation measures carried out during the last 10 years, stated by respondents.

4.3.3 Energy efficiency measures performed. The results show a clear indication that second home owners in winter sport areas are more inclined to allocate investments towards visible interior enhancements rather than investing in energy efficiency measures such as installing a heat pump, changing lighting, or implementing timed control of electricity and heating, Figure 9. Only about 15 percent of owners have undertaken such measures during the same period.

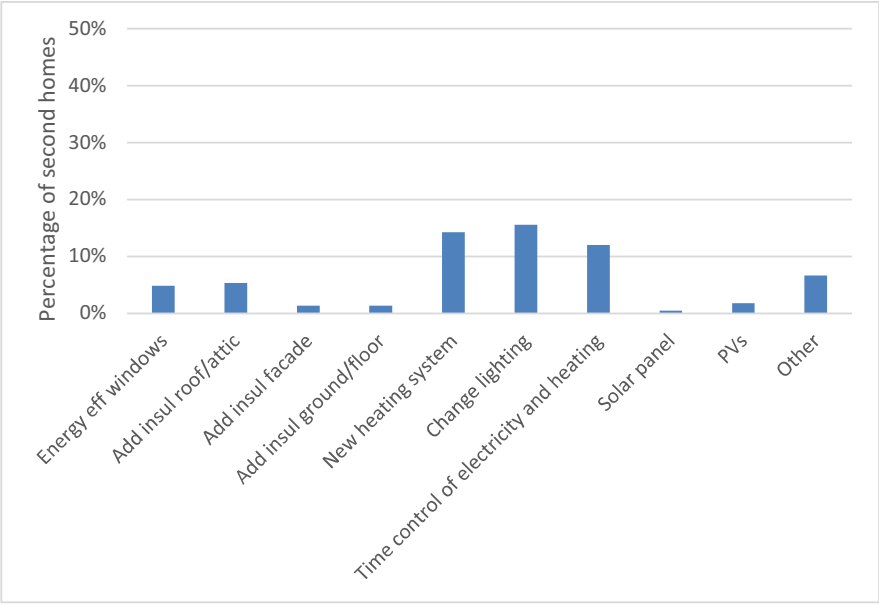

Figure 9. Energy efficient measures carried out during the last 10 years, stated by respondents.

4.3.4 Energy efficiency potential of second homes in winter sport areas. Previous studies by Gutke (2023) and Mjörnell (2024), have demonstrated that installing a heat pump can reduce energy consumption by 56% [6, 8]. If this measure were implemented by the 90 second homes that rely on direct electric heating, still maintaining temperatures between 11 and over 20 degrees, and do not yet have a heat pump, they would lower their electricity consumption considerably. Another alternative to installing a heat pump could be lowering the temperature to approximately 5 degrees Celsius when the

second home is unoccupied, a measure shown in previous studies to reduce energy consumption by 44% [6, 8]. This could be applied by the over 120 households still heating their homes with direct electric heating to temperatures ranging from 6 to over 20 degrees Celsius when unoccupied. The energy saving potential would probably be even higher than 44% since the second homes in winter sport areas are heated to much higher temperatures than second homes in general.

5. Discussion and conclusions

Second homes situated in winter sport areas exhibit a dual pattern of utilization, characterized by more extended occupancy during the winter season and shorter stays throughout the other seasons. This observation underscores the dynamic nature of these residences, catering to both the heightened activity associated with winter sports and the intermittent use during non-winter periods. Understanding and accounting for these usage patterns is essential for implementing tailored strategies and solutions to optimize energy efficiency and resource utilization in second homes located in winter sport areas.

The predominant heating sources in second home in winter sport areas are direct electricity or electricity-operated heat pumps. When it comes to heating practices users exhibit a diverse range of approaches. A mere 3% of the surveyed residences uphold a temperature of 5 degrees Celsius or lower during periods of vacancy, while a substantial one-third opt to maintain temperatures between 11 and 15 degrees Celsius. Astonishingly, over 50% of respondents acknowledge heating their accommodations to 16 degrees Celsius or higher when unoccupied. This pattern signifies a considerable and potentially avoidable energy consumption, suggesting an opportunity for substantial reduction. Since the yearly average energy use is 149 kWh per square meter based on reports from 100 second homes, which already is considerably higher than the requirements for new residential buildings in Sweden even though the second homes are only used part time of the year, the potential for a reduction in yearly energy use is huge. Addressing and mitigating these elevated heating practices could lead to significant energy efficiency gains, aligning with sustainable and resource-conscious principles.

The predominant focus of renovations, encompassing nearly half of the cases, has centered around interior surfaces, particularly kitchens (34%) and bathrooms (35%). Notably, the surge in these renovations aligns with the broader trend observed during the 2000-tiess, characterized by a collective inclination towards rejuvenating residences, including second homes. The prevalence of renovations could also be attributed to the wear and tear induced by rental activities, adding an additional layer of demand for refurbishments. While this sustained trend reflects an ongoing commitment to property enhancement, it concurrently raises concerns regarding resource utilization, necessitating a conscientious approach to balance aesthetic and functional improvements with sustainable practices.

Based on the responses from the surveyed cohort who reported having undertaken renovations, the prevalent focus was on enhancing interior surfaces. Subsequent priorities included improvements to kitchens, bathrooms. Out of the 225 second homeowners, only 15% acknowledged implementing energy efficiency measures within the past decade. Notably, the primary energy efficiency measures involved change lighting followed closely by installation of new heating system and control system for electricity and heating. These findings underscore the evolving landscape of second home renovations and the potential for energy-conscious upgrades within this demographic. In conclusion, the optimal energy-efficient measure for all secondary residences involves the installation of a heat pump, a finding consistent with prior investigations focused on second homes in general [6]. While the integration of a heat pump signifies a substantial reduction in energy consumption, it is imperative to acknowledge the associated costs. The investment is anticipated to yield returns over time; however, it is crucial to recognize that this undertaking contributes to a comparatively significant climate footprint. Notably, Gutke (2023) reported that the manufacture of a heat pump may result in emissions ranging from 1500 to 9500 kg of CO_2 per unit, contingent upon the extent of refrigerant reuse [8].

The second most efficacious strategy involves reducing the temperature in unoccupied secondary residences, a practical adjustment that manifests a substantial impact, particularly when these homes are utilized infrequently or for brief durations. Notably, certain insurance companies in Sweden stipulate a

minimum heating requirement of 15°C during periods of non-occupancy, ostensibly to mitigate the risk of freezing and leakage in water pipes and installations. Nevertheless, maintaining a temperature of 5°C within the house is posited as a viable alternative, thereby presenting a feasible solution without compromising the integrity of the property [6].

Other energy renovation measures such as additional insulation on the roof, attic or façade or changing windows have been assessed as less efficient when it comes to reducing energy use and GHG (greenhouse gas) emissions in second homes in general [6]. Since most second homes in Skiareas are constructed during the period 1970-1990, during and after the energy crises, the energy performance of these buildings is certainly higher than for second homes in general, where a substantial part was constructed before that period of time [7].

A thing to note is that the comparisons between this questionnaire from ski resorts and the general data mentioned is that data from winter sport areas is still a subset of the general data, meaning that the discrepancies mentioned in this paper is probably even larger.

Future studies will analyze possible moisture risks connected to lower temperatures when unoccupied and how much saving there is from installing a heat pump which temperature setpoint can usually not be set below 10°C.

Acknowledgements
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