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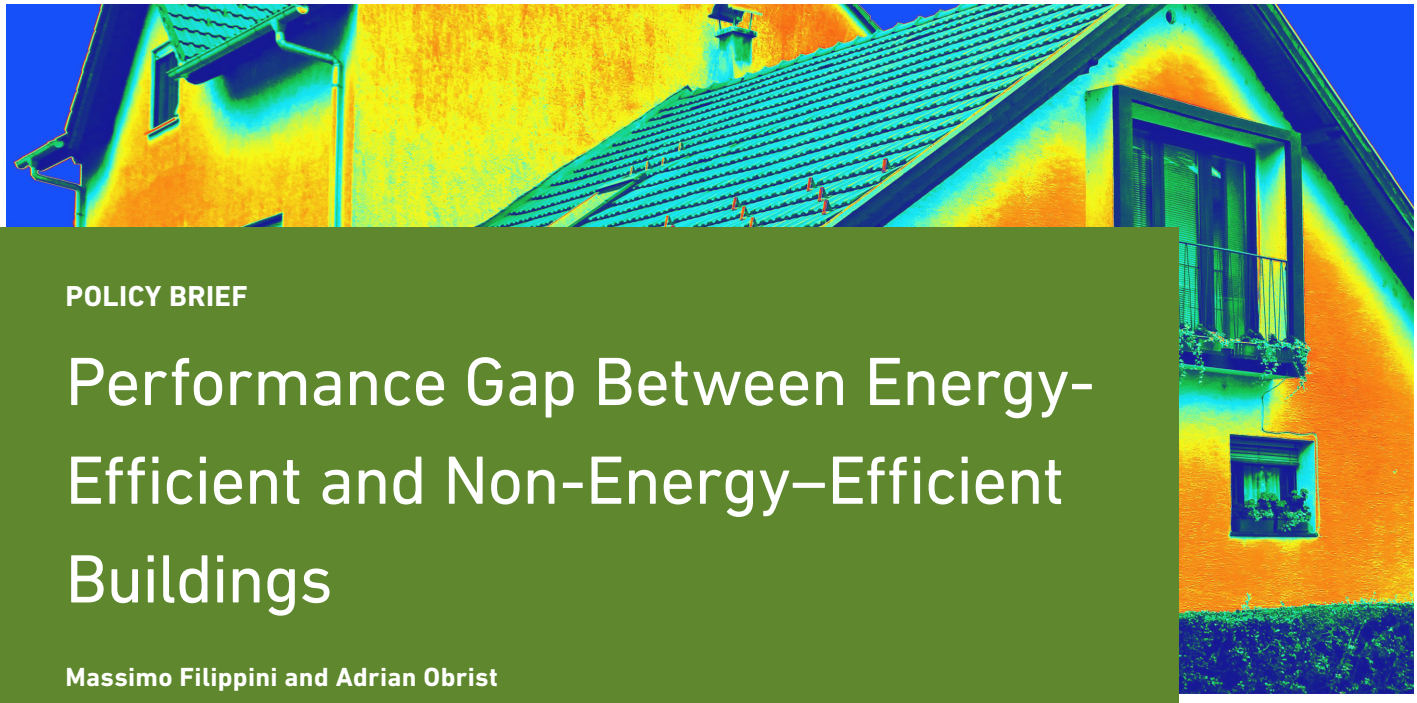

POLICY BRIEF

Performance Gap Between Energy-Efficient and Non-Energy–Efficient Buildings

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Executive Summary

- Evidence suggests residents living in Minergie-certified buil dings consume between 25% and 50% less total energy.
- The estimated energy-saving potential is lower than predicted ex-ante, which should be considered by policy makers when defining energy-policy scenarios.
- Green building certification systems may help to achieve greenhouse gas reduction targets.

Outline

In Switzerland, the building sector is responsible for approximately 45% of the country's total energy consumption. Most of the energy consumed in buildings comes from fossil fuels (Swiss Federal Office of Energy, 2018). Therefore, to promote sustainable development, adopting energy-efficient technologies in the construction and renovation of buildings is important. As Newell and Siikamäki (2014) demonstrated, information campaigns and energy-efficiency labels, such as Minergie-certification, can facilitate households' decision making by providing information on the energy-cost saving potential.

In 1998, the Swiss building sector introduced the Minergie certification scheme, which is characterized by an important thermal insulation and heat recovery ventilation system (from the outgoing stale air). Hence, households living in Minergie certified buildings should consume less energy than households living in non-Minergie certified homes. Moreover, we should keep in mind not only technological factors determine a household's total energy consumption. Ex-ante engineering calculations predict households living in Minergie-labelled buildings should consume 60% less energy than households living in conventional buildings (Beyeler et al., 2009). This difference is estimated by making some assumptions regarding the characteristics and residents› behavior of the household members, which may not reflect completely the real situation.

In our empirical analysis, we compare the observed energy consumption of Minergie and non-Minergie buildings by estimating an energy-demand function using panel data and econometric methods. In this empirical analysis, we consider different factors like household size or income that can explain the difference in energy consumption. After controlling for several socio-economic factors, our results suggest residents living in certified

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houses consume around 25% to 50% less energy than those living in conventional buildings.

Conventional and Minergie-certified buildings differ in many dimensions

Using bar charts for the group-specific averages and their confidence intervals, Figure 1 and Figure 2 illustrate the average differences regarding energy consumption values between households living in certified dwellings and in their non-labelled counterparts. We observe a significant difference in average total energy consumption between Minergie-certified and non-Minergie–certified houses.

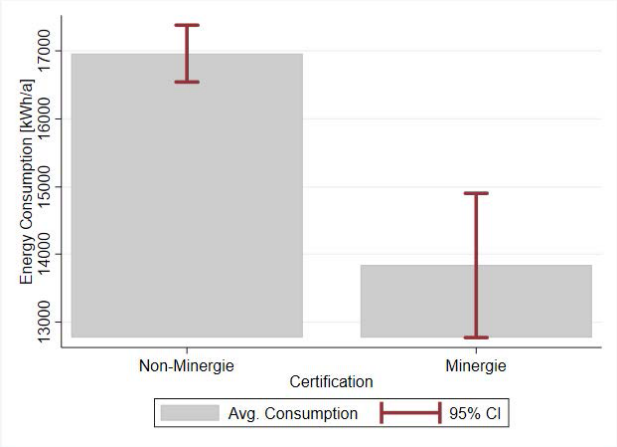

Figure 1: Average annual energy consumption in kilowatt hours: non-Minergie–certified vs. Minergie-certified houses (p-value of t-test: 0.000, N = 6570).

As shown in Figure 1, the average annual energy consumption of Minergie-certified buildings is around 14,000 kWh; non-certified houses in our sample demand almost 17,000 kWh or about 20% more energy per year. Non-Minergie–certified buildings differ to their labelled counterparts with respect to living area; therefore, we also computed the average annual energy consumption per square meter in Figure 2. Nevertheless, there is still a significantly lower specific consumption of around 20%. However, both certified and non-certified houses differ significantly in many more dimensions that potentially influence energy demand. Therefore, a simple comparison of the average total energy consumption of Minergie-certified and non-Minergie–certified houses can be misleading. For this reason, it is important to use a regression analysis approach that allows the possibility of considering several factors, such as household size, income, or age, that can explain the level of total energy consumption.

We specify a residential energy-demand model where energy is assumed to be a function of energy prices, capital price, level of energy services consumed, income, some household and building characteristics, and a binary variable reflecting a building's Minergie certification status. We then estimate the empirical

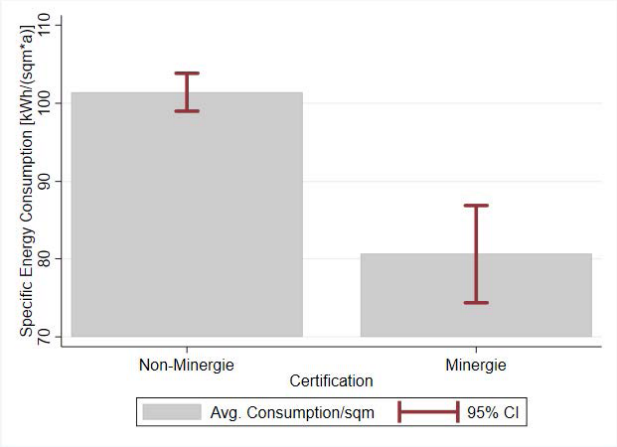

Figure 2: Average annual energy consumption [kWh] per square meter: non-Minergie–certified vs. Minergie-certified houses (p-value of t-test: 0.000, N = 6570).

model by using a random effects model and an instrumental variable alternative.

Households living in Minergie-certified buildings consume less energy than households occupying non-labelled houses

The primary goal of our empirical analysis is to estimate the difference in total energy consumption of households living in Minergie-certified dwellings and households occupying non-Minergie–certified buildings. By controlling for several household characteristics, we aim to be able to identify Minergie building certification's effect on total energy consumption. The results show households living in Minergie-certified buildings are associated with lower energy consumption of around 25% to 50% compared to households occupying non-certified houses, ceteris paribus. This effect is highly significant and even larger than the one calculated in the simple comparison of mean consumption previously mentioned.

The observed energy savings are lower than the theoretically predicted ones

Until about 2014, the reduction in energy consumption of a Minergie-labelled house compared to a conventional building was estimated to be around 60% from an engineering point of view (Beyeler et al., 2009). In this study, we have shown, in reality, this savings do not occur completely. Our study indicates energy consumption savings of about 25% to 50%, which is in line with Li and Carrión-Flores' (2017) findings for Energy Star-certified residences. Possible reasons for the deviation between observed and predicted energy savings include occupants' differential behaviors, erroneous technical assumptions, or non-compliance in the construction phase.

Implications and Policy Recommendations

Even though the theoretical savings potential was not confirmed, our results show the total energy consumption in the building sector can still be substantially reduced by constructing more houses carrying the Minergie label. Additionally, Minergie-certified houses emit much less CO2 than conventional houses because they are equipped with efficient heating systems based on electricity and, from 2017, rely on renewable energy sources. For this reason, measures that promote the construction and renovation of energy-efficient buildings, such as Minergie certified ones, could contribute to reaching the goals of the Swiss Federal Council defined as the Swiss energy strategy and the greenhouse gas emissions target.

The difference between ex-ante predicted and observed energy savings may affect the results obtained in the underlying scenario analysis of the impact of energy policy measures because these scenarios are based on some predefined building-sector energy-consumption levels. In this present case, the scenario based on a reduction of 60% could provide rather optimistic results compared to what we obtain. One way to mitigate the risk of differential target and observed outcomes is to base energy policies such as labels and certificates on observed consumption values instead of theoretical projections.

Conclusion

This study's results are relevant for policy makers looking for energy-policy instruments to promote the construction of energy-saving houses. Traditional building codes remain an important energy policy instrument, but this study's findings confirm the promotion of green building certification systems can also contribute to reduced energy consumption in the building sector, even though the theoretical savings potential was only confirmed partially. These results could be used by policy makers in public information campaigns to reinforce the message that green-certified buildings offer possible energy savings.

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