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Perspective

A finance scheme to help Germany's small private landlords sharply increase their buildings' energy performance: Tapping into the banking system

Ray Galvin [a,*], Steven März [b]

[a] Cambridge Institute for Sustainability Leadership, University of Cambridge, 1 Regent Street, Cambridge CB2 1GG, UK
[b] Urban Transition. Energy, Transport, Climate Policy, Wuppertal Institute, Döppersberg 19, 42103 Wuppertal, Germany

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ABSTRACT

Residential buildings were the source of 11.6 % of Germany's greenhouse gas emissions in 2023, emitting around 78 million tonnes of CO2e, mostly due to inefficient heating and inadequate energy efficiency. This needs to be reduced to near zero by 2045. This will involve deep energy performance renovation of some 23 million dwellings, which is expensive and seldom pays back through energy cost savings. Around 43 % of all rental dwellings, almost 10 million, are owned by small private landlords, most of whom show little enthusiasm for deep energy performance investment. Instead, they tend to save small amounts and spend these on piecemeal renovations, while avoiding debt. This study explores the potential of a novel savings and loan scheme that would better accord with their saving capacity, be profitable for banks, and fund large, one-off deep energy performance upgrades. It rests on the fact that the long-term, committed savings of landlords could act as M1 collateral for banks to create large amounts of new M2 money by issuing loans, from which they make reasonable profits. This would enable banks to offer low-interest loans to small private landlords who commit to such savings. These landlords would continue to commit monthly amounts, but these would be savings for only the first few years, then loan repayments. With the savings and loan scheme, we are contributing to the debate on new and creative ways to incentivize specific target groups to accelerate the decarbonization of the building stock.

1. Introduction

In this exploratory Perspectives paper we put forward a proposal to substantially reduce the finance gap in funding deep energy performance upgrades of old, privately rented homes. We do this in relation to Germany, though it could work effectively in many countries. By "deep" energy performance renovation we mean renovation that transforms a building from a large emitter of CO2e to a trivial emitter or even a net reducer, while sharply reducing energy costs. This usually involves renovating the building envelope to a heat transmission factor of 0.35 $W/m^2/K$ or lower, and often replacing fossil fuel boilers with electrically driven heat pumps, often backed up with rooftop photovoltaics.

Our proposal involves a savings and loan scheme which would be set up for small private landlords, though it could also work for owner-occupiers. The scheme would not require government subsidies but would be designed to be advantageous to both property owners and commercial banks. The government's roles would be merely to establish the legal and regulatory framework for the scheme, and to provide information and promotional material.

This is an interdisciplinary study as brings together knowledge of the banking system, the engineering and economics of building energy performance upgrading, and the attitudes and practices of private landlords.

Like most other European countries, Germany needs to sharply increase the energy performance of its older homes, to meet its climate goals and reduce energy poverty and dependence on imported fossil fuels. Germany aims to reach net zero CO2 equivalent (CO2e) emissions by 2045. In 2023 its total greenhouse gas emissions were 674 million tonnes of CO2e (tCO2e). The operation of buildings caused 102 million tCO2e, or just over 15 % of the total, of which 78 million tCO2e were from homes [1,2]. This equates to an average of about 2.0 tCO2e/y per dwelling. Buildings in the so-called "worst performing buildings"

* Corresponding author.
E-mail addresses: rg445@cam.ac.uk (R. Galvin), steven.maerz@wupperinst.org (S. März).

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category emitted 4.0–6.0 tCO2e/y per dwelling. Other un-renovated or only partially renovated buildings emitted 2.0–3.5 tCO2e/y per dwelling, but buildings that have undergone "deep" energy performance renovation often emit less than 1.0 tCO2e/y per dwelling (authors' calculations from [1]). Total emissions per dwelling have fallen steadily since 1990, but this is mostly due to increasingly high energy performance standards for new buildings, and it does not count embedded emissions in the construction process. Therefore there needs to be deep renovation of old buildings on a very large scale if Germany is to meet its climate goals from the building sector.

This would also help alleviate energy poverty, since CO2e emissions are mostly caused by energy use, and energy is expensive. The worst performing buildings demand 200–300 kilowatt-hours of heating energy per square meter of floor area per year (kWh/m^2/y) if heated to a healthy, comfortable level. Currently this costs 2500–3500 euros per year (€/y), equating to around 31.50–43.75 €/m^2/y. Unrenovated buildings not in this category demand 100–160 kWh/m^2/y, costing 1200–1900 €/y, or 15.00–23.75 €/m^2/y. The newest buildings, and older buildings renovated to very high standards of energy performance, demand only about 20 kWh/m^2/y for heating, costing about 300 €/y, or 3.75 €/m^2/y. To seriously mitigate energy poverty, the energy performance of old buildings needs to be improved to about this level. Closely related to this is the issue of how this renovation is to be paid for: what combination of landlord, tenant and government financial input is justified or even possible.

Note that we carefully distinguish between "energy performance" and "energy efficiency" in this paper. Obviously, the energy efficiency of building envelopes (walls, windows, roofs and basements) needs to be increased in order to reduce CO2e emissions. But this is not sufficient, for two reasons. First, costs of renovation rise exponentially as energy efficiency standards are pushed higher. If we aim for super-high energy efficiency for a building envelope, say around 20 kWh/m^2/y, we can end up paying ten to twenty times as much per tonne of CO2 saved, as we would pay by reducing CO2 through other means [3,4].

Second, renovation can reduce CO2 emissions much more deeply and cheaply if it includes switching from fossil fuel boilers to electrically driven heat pumps and installing onsite rooftop photovoltaics [5,6]. The advocates of energy renovation should therefore avoid a narrow focus on energy efficiency. A useful rule-of-thumb is to increase energy efficiency only high enough to make heat pumps work efficiently [7], and transition from fossil fuel boilers to heat pumps supported by photovoltaics.

Much has been written about the so-called "barriers" to energy renovation (see recent review by Alabid et al. [8]). Although we acknowledge that property owners face multiple difficulties in planning and executing a deep energy performance upgrade, the various barrier analyses make it clear that deep energy performance upgrading of the building stock is more than just a technological innovation process. Rather, social innovations are also needed to accelerate the necessary transformation.[1] Therefore, we aim to offer a possible solution rather than merely identify more barriers and their nuances. Our focus is also quite narrow, namely on finance, rather than other well-known issues such as reducing supply chain bottlenecks (Prieto et al., 2023) and administrative hassles [10] – though the latter issue does arise to some extent as we outline the proposed scheme.

Further, we suggest that by far the biggest problems with deep energy performance renovations are their upfront cost and the fact that these "deep" renovations generally come nowhere near paying back, through energy savings, over the lifetime of the renovation measures – even if done in the most economically efficient way possible. This problem, which straddles the disciplines of engineering and economics, is further discussed in the literature review (Section 2).

The literature review also outlines current knowledge on the practices and attitudes of small private landlords. In particular, it asks how these attitudes and practices would impinge on and influence the likelihood of landlords undertaking deep energy performance renovation of their properties with the support of a savings and loan scheme that, we argue, would bring them considerable advantages. In the light of these engineering, economic and social insights, we then describe the proposed scheme, explore how both commercial banks and small private landlords could benefit from it, and suggest how it can be shaped to bring the biggest benefit to both banks and these landlords.

Section 2 reviews literature on the costs and benefits of deep energy performance renovation in Germany, and small private landlords' renovation attitudes and practices. Section 3 outlines the proposed savings and loan scheme and examines relevant features of the banking system, showing how banks would benefit from it. Section 4 discusses this in light of the need for widespread deep energy performance renovation, and Section 5 concludes.

2. Literature review: Costly renovations and small private landlords

2.1. Costly renovations

A theory has long circulated in academia that energy efficiency upgrades generally pay for themselves in the long run, through energy cost savings. Fisher and Rothkopf [11] were probably the first to introduce this notion, but it was widely popularised in academia through the work of Jaffe and Stavins [12,13]. It has since been applied extensively to energy efficiency upgrades in buildings, in studies such as Gerarden et al. [14], Giraudet [15], Müller and Berker [16], Berger and Höltl [17], Solà e al. [18], Myers [19] and Schleich [20]. However, none of these give cost-benefit analyses of deep energy performance renovation of specific case study buildings. Instead, the idea of economic viability is applied as an assumption, upon which other ideas are based. We find no peer-reviewed, empirically based studies from any temperate country showing case studies of deep energy performance renovation that pays back within the technical lifetime of the renovation measures.

A rigorous attempt has recently been made to test this assumption in relation to large numbers of specific, fairly typical case study buildings in Germany [3–5,21]. These included specific, typical small, medium-sized and large apartment buildings; typical detached and semi-detached houses, and countrywide averages of small, medium-sized and large apartment buildings.

The buildings in the studies are renovated (or in some cases renovations are modelled) to energy efficiency standards ranging from 70 kWh/m^2/y to 20 kWh/m^2/y. Typical, middle-range values are used for discount rates, opportunity costs, mortgage interest rates, and inflation rates for energy and CO2 taxes. The studies assumed that landlords increase the rent by a cost-neutral amount, meaning the tenants pay the landlord an extra amount equal to what they save due to lower energy costs. The landlord thereby gains all the financial benefit from the renovation. This puts the cost-benefit analyses on the same basis as if the property owner is an owner occupier.

The method of cost-benefit analysis modelling was transparent, going so far as to present the derivations of algorithms used.

Fig. 1 gives the most comprehensive set of results of these studies, showing the percentage financial return on investment after 25 years of operation. The best economic outcome is for a small apartment building (6 apartments) in Augsburg, with the building envelope renovated to a standard known as "EH140", which equates to about 70 kWh/m^2/y. This gives a payback of 54 % after 25 years, leaving a finance gap of 46 % of the upfront energy-efficiency upgrade costs.

[1] In this context, we define social innovations as 'new solutions (products, services, models, markets, processes, etc.) that, simultaneously, satisfy a social need (more effectively than existing solutions), create new or better capabilities and relationships, and make better use of assets and resources. In other words, social innovations are good for society and improve society's capacity to act.' [9]

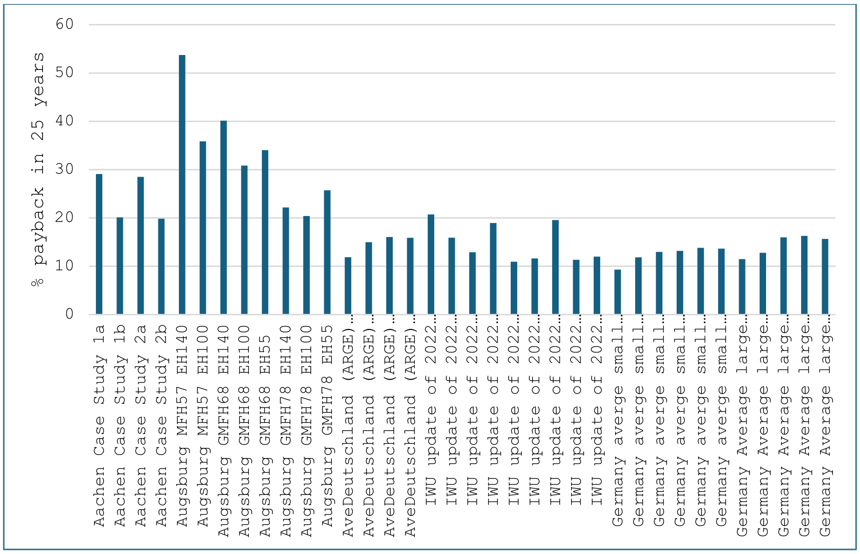

Fig. 1. Percentage payback over 25 years, in terms of net-present values, of case study energy performance renovations in Germany. "Anyway" costs not included.

The worst return is for a Germany-wide average of small apartments, renovated to 66 kWh/m^2/y. This brings an average return of just over 9 % after 25 years, leaving a finance gap of over 90 %. The average return for the 36 case studies is 15 %, leaving a finance gap of 85 % of the energy performance upgrade costs, which has to be met by the property owner.

An important point is that only the so-called "energy efficiency upgrade costs" are included in the costs of renovation in these studies. This excludes the so-called "anyway costs". These are costs that would have to be paid "anyway" if an old building were renovated merely to bring it up to a good standard. The German government insists that these costs may not be counted in cost-benefit analyses of energy performance renovations and publishes lists of items to be excluded from the cost calculations. These costs often amount to as much again as the energy efficiency upgrade costs.

For this reason, the renovation costs which landlords would actually have to pay are much larger than those assumed in the above results. The economic payback is much smaller and the finance gap much larger. We return to this point in our discussion of the savings and investment scheme in Section 3. Note that these "anyway" costs do not include internal renovations such as bathroom and kitchen upgrades. These belong to a separate accounting area.

A further finding of these case studies, reported in [5] is the effect of shifting from energy efficiency only, to energy performance, by replacing fossil fuel boilers with heat pumps and adding an economically optimised sized of rooftop photovoltaic system. This was modelled for two of the buildings (Aachen 1 and Aachen 2) based on two different building envelope energy efficiency standards for each building (70 and 50 kWh/m^2/y). Although this increases the upfront costs, it also increases the percentage payback considerably. In the best case (Aachen Building1, 70 kWh/m^2/y), the payback increases from 29.1 % to 42.8 % with heat pumps and photovoltaics (see Fig. 2). This level of increase is typical for shifting from an energy efficiency only upgrade to an energy performance upgrade, though it depends on the expectation that future increases in the electricity price will be at least as high as inflation. This is because much of the financial gain from rooftop photovoltaics is due to electricity cost savings.

We therefore assume, as a rule-of-thumb, that property owners would suffer a finance gap of around 40–50 % of the energy performance upgrade costs if they undertake deep energy performance upgrades – i.e., they increase the energy efficiency of the building envelope sufficiently to make heat pumps viable, and transition from fossil fuel boilers to heat pumps and photovoltaics. We have attempted to compare these

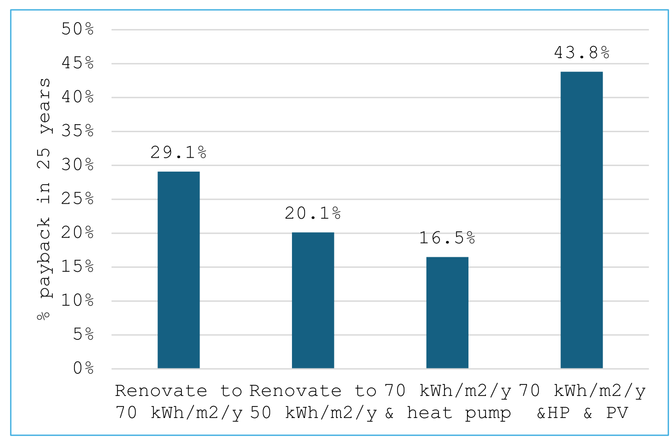

Fig. 2. Percentage payback in 25 years, 4 methods of renovating small apartment building (350 m^2 floor area).

percentages with studies from other countries, but find none that investigate the costs and benefits of energy performance upgrades for individual buildings that include heat pumps and photovoltaics. The closest that come to this are Fina et al. [22], Ramos et al. [23], Ramos et al. [24], Mena et al. [25] and Fleishhacker et al. [26].

It does not seem reasonable to expect governments to make up such a large gap with subsidies. Subsidies are available from the German Development Bank (*Kreditanstalt für Wiederaufbau* - KfW) for deep renovations, though these have to achieve a very stringent average U-value of $\leq$0.26 W/m^2/K. Further, there is an extra subsidy for "worst performing buildings" – those with theoretical energy consumption $\geq$ 250 kWh/m2/y and all others built before 1957. Our own back-of-the-envelope calculations suggest the KfW subsidy bill would be something over 140 billion € if all post-War buildings were renovated to high standards – an issue we explore further in a forthcoming paper. There are also grants of 15 % from the BAFA (Federal Office of Economic Affairs and Export Control) for individual measures on the building envelope. The 16 federal states also offer their own funding programmes.

There are many schemes in different countries that involve subsidies, but the scheme we are proposing is a commercially based savings and loan scheme. It does not involve subsidies such as the example of the UK's former Green Deal or Germany's current federal, state and municipal subsidies.

Further research has shown that Germany's large corporate rental housing providers have accepted the responsibility to provide the bulk of the finance to upgrade their entire stock of properties to net zero CO2 standard by 2045 [27]. In brief, these corporations dedicate about 30 % or more of the monthly basic rent (the rent not including service and utility charges) to a long-term fund. Their profits to shareholders are thereby reduced accordingly. From this pool of money they finance their ongoing project of energy performance upgrades.

It seems, therefore, that there is a need for small private landlords to have some means of investing in a scheme to help close the finance gap in renovating to high energy performance standards.

2.2. Attitudes and practices of small private landlords

Germany is a country of tenants. The rental ratio is high by international standards, at 58 %. At the same time, the ownership structure of the rental housing market is fragmented. Professional landlords (private rental companies, local housing companies, etc.) manage around a third of all rental flats, but two thirds, or around 15 million rental flats, are managed by small private landlords. Despite its quantitative importance, the focus in academic, media and political debate in Germany has not yet been sufficiently on this target group. The debate focuses strongly on owner-occupiers and housing companies. Accordingly, political framework conditions are also being developed for these actor groups.

In the last two years, two general studies have been conducted to better understand German private landlords [28–30]. Both use different survey data, but nevertheless come to similar conclusions in many areas, which are also in line with international studies [31–34]. Lang [35] conducted a systematic review and analysed a total of 18 studies on factors influencing investment decisions by private landlords. The spectrum goes far beyond purely economic and financial aspects. It ranges from socio-demographic factors (e.g. age), to sociological factors (e.g. relationship to tenants, social expectations), to factors that are more likely to be explained in terms of behavioural economics (e.g. value, beliefs, biases). Nevertheless, most studies identify financial aspects as key obstacles, and this highlights the relevance of new financing instruments.

In socio-economic terms, three actor-specific aspects stand out with respect to German small private landlords. Firstly, small private landlords are older than the average of the population. Around a third are pensioners. Around half are aged 60 and over. Secondly, they are well educated, have an above-average income and rarely have a migration background. Thirdly, they often own only a few apartments and the rental income is usually only a supplementary income for them. In the study by Voigtländer and Sagner [30], over 90 % of respondents stated that they rent out fewer than 6 residential units, while Bölting and Niemann-Delius' [36] figure is lower, at just under 50 %, and 75 % were found to have fewer than 16 residential units. This means that only a minority of small private landlords can live off their rental income. According Voigtländer and Sagner [30], 80 % of private landlords have a total gross income from letting of less than 20,000 euros per year. The basic findings of the studies also confirm those of older studies [37–40].

Based on the specific socio-economic profile of small private landlords, there are also typical investment and management routines that pose a challenge with regard to the necessary building transformation.

Small private landlords rarely adjust their rents in ongoing tenancies. According to Voigtländer and Sagner [30], 52 % of landlords do not adjust rents in existing tenancies at all. A further 27 % only adjust rents to cover their operating costs. Only 6 % increase rents due to renovations. Even for new tenancies, only every second landlord increases their rent. This confirms the findings of older studies. Henger and Voigtländer [41] found in 2011 that small private landlords rarely raise rents. März [39] finds that one reason is that small private landlords strive for a conflict-free tenancy, want to avoid (legal) disputes, and that, in any case, the rental income only represents a small additional income alongside their job. However, this means that the "Modernisierungsumlage", a law which permits landlords to increase the rent to cover the costs of energy performance upgrades (Civil Law 589, i.e., §598 BGB), which is essentially intended to secure the refinancing of investments in energy renovation, is not very suitable for small private landlords.

Another issue is the lack of awareness of the energy performance of their own rental property or the ecological necessity of decarbonising the building stock. According Voigtländer and Sagner [30], around half of small private landlords have not carried out any energy renovation in recent years, with 71 % saying that they do not see any need to do so. 53 % also have no concrete renovation plans for the future. Financial reasons (financial barriers 56 %, availability of subsidies 28 %, uncertain amortisation 24 %) are cited as the main obstacle to renovations.

It should also be noted that in Germany all properties advertised for rent or sale have to have an EPC, in accordance with the EU's Energy Performance of Buildings Directive (see discussion in Economidou et al. [42]). However, there are two main reasons this does not always relate well to the rent. First, rents depend heavily on local supply and demand [43,44]. Second, in older, unrenovated buildings the official EPC figure is, on average, about 40 % higher than the actual consumption, a phenomenon known as the prebound effect (see review of recent studies on this in Galvin [45].The reluctance to invest can certainly be explained in part by current high material and construction prices. However, in a representative study, Cischinsky and Diefenbach [46] made it clear that the energy performance of rental properties owned by small private landlords (and in particular by condominiums, to which small landlords often belong) is significantly worse than that of owner-occupiers and housing cooperatives. März et al. [40] also found that small private landlords would face opportunity costs if they renovate, and energy-efficiency refurbishment investment decisions compete with other investments (e.g. fitted kitchens, the addition of balconies, etc.). Further, tenants are less willing to pay for energy efficiency than for heating systems powered by renewable energies [44]. Another special challenge is the 'landlord-tenant dilemma' [47]. In simple terms, this means that tenants benefit from the advantages of energy-renovation (e.g. lower heating costs, greater living comfort), while landlords bear the investment costs and risks. This situation is reinforced in Germany by the fact that landlords can and usually do pass on heating costs to their tenants, meaning that there is little incentive to invest overall.

As a consequence, the government's lack of awareness of the problem means that existing subsidy programmes are not sufficiently utilised, and urgently needed investments are postponed to the future. Necessary refurbishment rates of 2–3 % p.a. have not been achieved for years [48,49]. It can be assumed that without new impetus, no renovation momentum will be generated among the target group.

A third aspect relates to the way in which small private landlords invest. Small private landlords rarely carry out comprehensive renovations, due to the high investment costs and, above all, the organisational burden. Further, most small private landlords often still have a job or are unable or unwilling to cope with certain organisational costs due to their age. Instead, among small private landlords who do upgrade the energy performance of their properties, upgrades tend to be small and piecemeal. Their investment behaviour consists of a cyclical savings phase and an investment phase. They save money from their rental or other income, and once a certain amount of capital has been accumulated, certain improvements are carried out entirely from reserves or in combination with a loan. This is followed by another savings phase until the next work is carried out. This means that their investment behaviour differs from that of housing companies. However, little attention is currently paid to this fact.

Only those who completely renovate their buildings to a high energy performance standard currently receive federal subsidy support from the German Development Bank (Kreditanstalt für Wiederaufbau, KfW). Other grants are available for individual measures, but these are lower than the subsidised loan grants from the KfW. For example, anyone who refurbishes their home to KfW standards piecemeal over 5–10 years with individual measures receives less state funding than if they do this as a complete refurbishment. Politically, this perspective is understandable, but it does not correspond to the investment logic of small private landlords. At the same time, their investment behaviour means that it takes many years to renovate a building. In order to achieve the goal of being climate-neutral by 2045, the challenge here is to speed up the process (it should also be mentioned that from a carbon emission perspective this is sub optimal as it locks-in higher consumption until the next renovation).

As a result, it is clear that current framework conditions in general, but especially for small private landlords, are not suitable for decarbonising the rental housing stock in Germany by 2045. We therefore propose a new financing instrument to overcome a key obstacle, the high investment costs, which we describe in more detail below.

3. The scheme and how commercial banks would profit from it

We briefly outline the proposed scheme in Section 3.1. We then explain the structure of the banking system in Section 3.2, as there are widespread misconceptions as to how banking and loans work. In Section 3.3 we suggest how the savings and loan scheme would therefore benefit commercial banks that adopt it.

3.1. The savings and loan scheme

The idea of a savings and loan scheme arose out of findings on how some of Germany's large corporate rental housing providers finance their commitment to upgrade their entire stock of properties to net zero CO2 standard by 2045 [27]. In brief, these corporations dedicate about 30 % or more of the monthly basic rent (the rent not including service and utility charges) to a long-term fund. From this pool of money they finance their ongoing project of energy performance upgrades.

Because these corporations have thousands of rental properties, their rental savings are pooled so that, in effect, each building's renovation is funded by the rent savings from the whole stock of buildings. Small private landlords do not have this pooling option, so commercial banks would need to be involved as financial intermediaries and co-beneficiaries.

The property owner would commit to saving a nominated percentage of the basic rent, in a dedicated account, for a defined minimum period, say two years. After this, the property owner would be entitled to a 20–25-year loan at a very favourable interest rate, secured over the property.

Despite these different structures, the normative focus is the same: a sense of responsibility toward one's properties and to society. Our assumption throughout is that to accelerate the project of energy performance upgrades of privately rented homes, landlords need to adopt attitudes and practices of social responsibility comparable to those of large rental housing corporations. They also need to treat their properties as a business to be nurtured rather than a mine to be exploited. The scheme we are proposing is designed to make it easier for them to do this. This perspective thus builds on the debates in Germany and other countries on energy gentrification, i.e. the risk of rising rental costs and displacement due to deep energy renovation. It is therefore compatible with the German Tenants' Association's proposal for a one-third model, which aims to distribute the costs of the building turnaround equally between the state, tenants and landlords. In this sense, the scheme is an instrument for financing the landlord's share [50].The details of how the scheme would work depend crucially on how the banking system functions. We now explain relevant aspects of this in detail.

3.2. How banks get money and give loans

The modern banking system in almost all countries is based on a two-tier structure. At the top is the central bank. This is the government's own bank. It holds the government's bank account, and the government makes all its payments and receives all its income via its account at this bank. Every commercial bank is also required to have an account at the central bank, and this account is crucial for its day-to-day operations and its financial credibility (see explanations of how modern monetary works in, for example, Ingham [51], Wray [52] and the Bank of England's international publication Patel and Meaning [53] and McLeay et al. [54]).

There are two basic kinds of money in the banking system, which we call in this paper M1 and M2 (though various countries use different labels, such as outside money and inside money, or high-powered and low-powered money). M1 is money created by the government via its central bank for payments of government expenses, such as wages, interest payments on government bonds, repayment of these bonds, etc. M1 also includes money created directly by the central bank, for such things as quantitative easing and lending to commercial banks to top up their accounts at the central bank when necessary. Governments do not have to get money from sources outside themselves in order to spend it. They spend it into existence (as is explained forcefully in the Bank of England's international informational publication [54].

In a well-functioning country, M1 money is the safest, most reliable money there is, because it is 100 % backed by the government. This is a crucial point for the savings and loan scheme, as explained below.

M1 money is effectively dissolved back into nothing when money is paid to the government for taxes, fees and fines. In any particular year or specified time-period, governments generally aim to create about the same amount of M1 money as they expect to receive back in taxes, fees and fines. If they create more than they receive back, they are said to be in "deficit".

M2, on the other hand, is money created by commercial banks as an IOU ("I owe you", effectively a promise to pay). M2 money is only as safe as the commercial bank which created it (though governments now tend to guarantee M2 deposits of up to about 80,000 €).

There are two main situations in which commercial banks create M2 money. First, they do so whenever a customer makes a deposit into her or his account. The deposit goes into the commercial bank's reserve account at the central bank as M1 ("high-powered") money, while the commercial bank credits the customer's account with its own-created M2 money.

The second way commercial banks create money is by giving loans to borrowers. Suppose a firm applies to Sparda Bank for a loan of 100,000 €. If Sparda approves the loan, it simply credits the firm's account with 100,000 €. It does not have to get 100,000 € from somewhere else or from its account at the central bank. It simply creates 100,000 € of new, M2 money out of thin air. This is equivalent to an IOU, or promissory note, from Sparda Bank.

Commercial banks make most of their profits by the interest they receive on the loans they issue. The more money they can create and lend, especially to reliable customers, the more interest they get and therefore the more profits they make.[2]

Commercial banks can create and lend M2 money like this because they have collateral in their accounts at the central bank, in the form of M1 money. This collateral is comprised of deposits such as the one outlined above, plus equity from net profits, sales of shares, etc. It is important to realise, however, that this M1 collateral only has to amount to a small fraction of the total amount of M2 they create by lending.

There is a common misunderstanding that commercial banks lend their customers' actual M1 money when making a loan: the idea that a customer banks 10,000 € and the bank then lends a portion of it to borrowers. As an increasing number of scholars of monetary theory point out, most economics textbooks make the mistake of asserting that commercial banks can only lend the money their customers deposit in

[2] Of course, banks can often increase their profits further by selling mortgages on to second-tier investors.

their accounts [51–54]. This misunderstanding is reinforced by the concept of the "fractional reserve ratio", in which successive banks are erroneously said to lend and re-lend customers' deposit money. Instead, all the money banks lend is created by them out of nothing. They lend it into existence, and they can create and lend as much money as they like, provided three basic criteria are met.

3.2.1. What limits the amount a bank can lend

There are limits on the amount a commercial bank can lend. First, a commercial bank's total reserves of M1 money in its central bank account need to be at a level which the central bank regards as adequate to act as credible collateral for the loans the bank makes. The Bank for International Settlements (BIS) – the so-called "central bank of central banks", based in Basel, Switzerland – recommends a set of very generous ratios of loan value to reserves for loans made to different grades of customer (though these are seldom *legally* enforced in Eurozone and other high-income countries). If a bank lends to an AAA-rated customer, it is recommended to have collateral on reserve in its central bank account of just 1.6 % of the loan amount. The percentage is higher for lower-rated customers, through AA+, AA, etc., down to B rated customers, for whom a 12 % reserve is recommended [55,56].[3]

Alternatively, the BIS recommends that banks study the history of loan defaults in their countries and use this to estimate the amount they need in reserve compared to the amount they have out on loan.

Second, banks need to keep their reserves of M1 money high enough so that the consequences of their lending will not prevent them from doing their daily reconciliation of accounts, with other commercial banks, at the central bank – a point covered further below. When a bank creates money to lend to a borrower, the borrower may use this money to pay a person who is a customer of a different commercial bank. Although the money created is M2 money, this results in the borrower's bank owing the other bank the same amount but in M1 money. At the end of the working day the lending bank has to transfer this money from its M1 account at the central bank, to the other bank's M1 account at the central bank. The banks have to reconcile their accounts with each other so that none owes any money to any other.

This is generally not a problem, however, because hundreds of thousands of payments are criss-crossing between banks every day, and they tend to cancel each other out. However, as the economist John Maynard Keynes pointed out [57], in order to be able to reconcile its account at the end of each day, a bank must be careful to keep in step with the majority of other banks' loan practices, so that it does not lend substantially more, in relation to its M1 reserves, than other banks are lending in relation to theirs.

Third, banks need to be cautious of possible forthcoming economic slumps [58]. If the economy appears to be going into decline or if there is too much risky lending which could lead to a crash, banks need to keep enough in reserve to cover possible waves of loan defaults or even bank runs.

Generally, then, *the more M1 money a commercial bank has in its account at the central bank, the more willing it will be to make loans,* i.e., to create more M2 money, and therefore the more interest it will earn and the more profit it will make. *This point is crucial to the property owners' savings and loans scheme, as explained below.* It leads to discussion of an important means by which a commercial bank can increase its reserves of M1 at the central bank: by attracting new deposits.

3.2.2. The advantage of new deposits

Whenever a commercial bank attracts a new deposit from a customer, its total of M1 money in its account at the central bank increases by the amount of the new deposit.[4] Therefore, at the end of each working day when the banks have to reconcile their accounts with each other, any additional amount of M1 it has gained, or has in its account long-term, is a considerable advantage. It may mean the difference between being a net debtor or creditor at the end of the day. If it is a net creditor it will avoid having to borrow overnight from the central bank or other banks and pay interest, to reconcile its accounts – since all the banks are required to owe each other zero money at the end of that day's reconciliation.

It is therefore an advantage to each bank to attempt to attract as much deposit money as possible, *including from deposits in other banks*. This will give it the M1 backup to enable it to create more M2 loan money, earn more interest, and make bigger profits, without running into the problem of being in debt to other banks at the end of each day. As we shall see, the profit that banks make by lending to borrowers are huge compared to the costs they incur by paying interest to depositors.

3.3. Why the savings and loan scheme will benefit banks

We now explore how the savings and loan scheme aligns with the above description of commercial bank deposits and loans.

The scheme proposes that for two years the landlord deposits a percentage of their basic rent (*Kaltmiete*, the rent excluding utilities paid via the landlord) in a special savings account at a commercial bank, say Sparda Bank. This money increases the total of Sparda's M1 money at the central bank. If the landlord had spent or deposited the money elsewhere, the M1 would have ended up in another bank's account at the central bank. But Sparda gets it and can depend on it because the property owner has made a contractual commitment to deposit it monthly in their special account at Sparda.

We call the amount of this monthly deposit D_M. After 2 years the property owner has deposited $24D_M$. During the 2-year period the account has an average balance of $12D_M$, plus interest. We ignore the interest for the moment and only consider the average balance of $12D_M$.

Using this M1 balance as collateral, Sparda can *conservatively* create money and offer loans amounting to an average value of at least $120D_M$ during this 2-year period – an M1 to M2 ratio of 10 %. If Sparda lends this to a business, it may get 5 % interest. Over two years this intertest amounts to $120D_M$ x 0.05 €.

This equates to $6D_M$. This is equal to half a year's deposits. In other words, *the bank could easily make a profit of 25 % on the landlord's total deposits.* If, for example, the landlord invests 300 € per month, this would support a loan to a third party of 36,000 €, which would earn the bank interest amounting to 1800 € over the two-year period. An average balance of 3600 € in a deposit account thereby leads to a bank profit of 1800 €.

It would of course be slightly less than this because the bank will pay the landlord interest on the deposits, let's say a very generous rate of 5 %. But this stays in the M1 account and therefore does not reduce the bank's collateral in its account at the central bank.

However, this is a somewhat conservative estimate of the bank's potential profit. As we saw above, the Bank for International Settlements recommends a credit-to-deposit ratio of just 1.6 % when lending to an AAA rated borrower. In the extreme case, therefore, the bank could provide a loan to an AAA rated borrower of up to 62.5 times the average

[3] This is given as Part 1 in the Bank for International Settlements document known as "Basel II". The principle is that a reserve ratio of 8 % is multiplied by a further percentage corresponding to each level of credit rating. For example, the further percentage of AAA-rated customers is 20 %, so the recommended reserve ratio is 8 % X 20 % = 1.6 %.

[4] Banks use their own money, derived from profits, for capital investments such as buying bonds and equities. However, the money that private persons deposit with banks goes into the banks' reserve accounts at the central bank. This money is not owned by the banks in the same way as the banks' profits are, as it remains in liquid form to be available for the daily reconciliation of banks' liabilities to each other. That is why it is to the banks' advantage to have these deposits increase and to have a good portion of them stable, as in a customer's long-term investment.

value of the landlord's deposit account. i.e. 62.5 x 12D_M = 750D_M. If, for example, the landlord invests 300 €/month, this would support a loan of 225,000 €. Because the borrower is AAA rated, the interest rate would be lower, say 3 %. Over the two-year period the bank would thereby earn 13,500 € in interest. Yet the average amount in the landlord's savings account would be just 3600 € (plus whatever interest the bank pays on this). This is a profit for the bank of almost 400 %.

We noted that this is an extreme case. There are only 2 companies in the US with an AAA credit rating, namely Microsoft and Johnson & Johnson. Wikirating [59] lists the world's 148 top-rated firms according to their ratings by Standard & Poors, Moodys, and Fitch, as well as the average of these (the Corporation Average Index - CAI). Only six German firms are on this list: Allianz (with CAI rating AA-), BMW (A), Siemens (A), Daimler (BBB+), Volkswagen (BBB+) and Deutsche Telekom (BBB). A small bank like Sparda would likely have very little opportunity to lend to one of these, but a large bank such as Deutsche Bank would. More detailed research would be needed to identify banks that lend to highly rated firms and to map this over time.

However, small banks like Sparda lend large amounts of money to homebuyers, and these are secured by a first mortgage, usually with a loan to property value ratio of 80 % or less. Even if the homebuyer defaults on the loan, it is very rare for a bank to lose money, because it has first call on money from the auctioning off of the property.[5] We can therefore expect relatively high ratios of loan monies to reserves, and therefore very high profits for the bank if a property owner locks in a commitment to regular saving over two years.

What this amounts to is that banks would be incentivised to consider such a scheme because it would increase their profits.

After two years, there are two possible scenarios for the savings and loan scheme.

3.3.1. First scenario: a loan and the end of the savings

In the first scenario, after two years of committed saving, the landlord gets a loan for energy performance renovation of their property and withdraws the amount they have saved, using this also for the renovation. Currently Sparda's standard interest rate for a 20-year building finance loan[6] is 4.19 %. Assuming this is a table mortgage, their profit on this loan reduces in absolute terms as the loan is paid off over the 20-year period, but this steadily reduces the amount they have out on loan and enables them to make other loans, so their profit margins tend not to diminish.

Sparda could give a reduced interest rate as this would be offset, for them, by the profits they have made on the landlord's initial two-year investment.

3.3.2. Second scenario: a loan without withdrawing the savings

An even more attractive option for the bank would be if, after two years, the landlord gets the loan but does not withdraw the savings that have accumulated over these two years. Instead the landlord would guarantee to leave this in the account until at least the end of a 20-year mortgage. In that case, there would be an average amount in the account of 24D_M plus accumulated interest. Ignoring the interest for now, the bank could use the savings as collateral for loans to other borrowers for 20 years. If the reserve to loan ratio is 10 % and the loan interest rate is 5 %, the bank would get 1200 $D_M \times 0.05$ € as interest on loans based on this as collateral, over the 20 years. This is equivalent to 60 months of deposits, even though the landlord only made the deposits for 24 months – a profit of 250 %.

As an example, if the landlord invested 300 € per month for 2 years then left this in the account, this would amount to 7200 € (not counting interest). The bank could conservatively create 72,000 € of loan money for other borrowers based on this, and its profit after 20 years would be 5 % of this for 20 years, which (coincidentally) comes to 72,000 €.

To continue the example, if the landlord's 20-year loan is 66,000 € and the bank charges just 1 % interest on it, the landlord would make monthly repayments of 303.53 €, which is about what the landlord had originally been investing. *The bank's profit on the other loans it makes on the basis of the amount held in reserve would therefore be greater than the value of the property owner's loan.*

This second scenario would therefore bring an enormous advantage to the bank. It would also bring the advantage to the landlord in that, at the end of the 20-year loan period, he or she would still have their original savings of 7200 €, plus interest. This could form the basis for a new loan for further energy performance upgrading or modernization.

High energy performance renovations are generally considered to last 20–30 years, depending on their type (heat pump, insulation, etc.). The net present value of the benefits of these renovations, through energy and CO2 tax savings, can therefore be seen as accruing over a 20+ year period. This makes a 20-year loan period ideal, since part of the monthly repayments can come from the monthly benefits.

A further point is that even in cases where a deep energy performance renovation qualifies for subsidised state loans, such as those from the KfW, these generally do not close the entire finance gap. It is therefore usual for property owners to top up the state-supported loan with a non-subsidised loan. This may be from the same bank, since the KfW loan subsidies are channelled through commercial banks. The savings and loan scheme would therefore comfortably fit alongside the existing state subsidy system.

Finally, there is obviously a large legal corpus of rules concerning commercial banks, but we know of no restrictions that would impede this scheme.

3.4. Sensitivity analysis for range of mortgage interest rates

A greatly reduced interest rate on a loan for energy performance renovation would deeply reduce its net losses. We revisit the case study building reported in Section 2.1 and the costs and benefits of renovating the building envelope to 70 kWh/m^2/y, as summarised in Fig. 2.

Table 1 below gives more detailed data on the building, the costs of renovation and the parameter values used in the cost-benefit analysis. We consider only the energy performance upgrade costs, namely 92,947 € (i.e., excluding "anyway" costs") and assume that 10 % of the total costs are invested upfront. The net present value (NPV) of the benefits, assuming a 25-year lifetime of the energy performance upgrade measures, is 28,704 €. The CO2 tax rate was 30 €/tCO2 at the time the case study was done, so we have left it at that value for the sensitivity analysis. In fact it makes very little difference to the results as it is a very

Table 1
Case study building renovation parameters.

Pre-renovation consumption (kWh/m^2/y)	114.4
Post-renovation consumption (kWh/m^2/y)	70.0
Floor area, m^2 (4 apartments +2 mansards)	350
Total cost of renovations	207,016 €
"Anyway" costs	114,069 €
Energy performance upgrade costs only	92,947 €
Gas price	0.115 €/kWh
Discount rate	6 %/y
Cash invested upfront	20,701.60 €
Alternative investment return (for calculating opportunity costs on cash invested upfront)	7 %/y
CO2 tax rate (at the time of the case study)	30 €/tCO2
Gas price inflation rate	1.00 %

[5] One of the reasons for the financial crash of 2007–2008 was that banks had been offering mortgages with over-high loan to value ratios, sometimes in excess of 100 %. This is no longer the practice.

[6] https://www.sparda-west.de/baufinanzierung-neufinanzierung/?wt_mc=sea.google.baufi.brand&gad_source=1&gclid=Cj0KCQjw28W2BhC7ARIsAPerrcIjNYbviiB3jeqVCk813hQNQUlBUe9px_tw-pP1t9rdnt1dTCGKw9saAttfEALw_wcB

small part of the costs of heating.

Table 2 gives the results of a sensitivity analysis for a range of 20-year table mortgage interest rates. The last row shows how the net present value of the losses changes with the interest rate, and this is displayed graphically in Fig. 3. For a standard, 4 % interest rate the NPV of the losses is 26,261 €, but this reduces to 9326 € with a 0 % interest rate. The losses reduce by 4235 € for every 1 % reduction in interest rate. This indicates the considerable advantage to the landlord of a savings and loan scheme such as the one outlined above.

4. Discussion

A number of issues arise from the above explanation, such as: how small private landlords would benefit from the scheme; how it would relate to existing federal subsidies; and whether it would motivate these landlords to renovate. These are interrelated and will be discussed together.

To begin with, it is important to emphasise that our aim in this paper has not been to identify and/or increase fiscal supports or state funded incentives for deep energy performance renovation. Rather we aimed to explore the possibility of a savings and loan scheme which would be of commercial benefit to banks and of financial and practical benefit to small private landlords. The savings and loan scheme would therefore represent an additional instrument for small private landlords to finance investments in energy performance. The instrument should not be seen as an alternative to existing instruments, but as a supplement to them.

As noted in Section 2.2, small private landlords tend to have savings phases followed by investment phases, but these tend to be ad hoc and aimed only at stepwise renovation. Also, their savings phase tends not to lead to a loan, but instead only to a relatively small cash investment. The savings and loan scheme would therefore not substantially alter their ongoing cash flows, but would provide the major advantage of bringing forward the complete energy performance renovation of their properties. If they are already in the habit of saving, say, 200 €/month for future upgrades, they can continue to do so. They can also continue paying this amount when they get their loan, but now as monthly loan repayments.

For example, a loan of 40,000 € at 2 % interest will be paid off in 20 years with monthly payments of 202.35 €, if it is structured as a table mortgage.[7]

The scheme therefore would not only benefit banks, as discussed in Section 3, but would not require any major changes to the savings practices of small private landlords and would bring them the larger reward of a complete, technically integrated, deep energy performance upgrade. It also allows for more flexible solutions than a KfW loan, because the technical requirements are based on overall energy *performance*, inlcuding renewable energy, whereas KfW sets very high energy *efficiency* requirements for building refurbishment, as described above.

Table 2
Sensitivity analysis of effect of different table mortgage interest rates on NPV of net losses.

Mortgage interest rate	0.0 %	1.0 %	2.0 %	3.0 %	4.0 %
NPV of benefits (after 25 years)	28,704 €	28,704 €	28,704 €	28,704 €	28,704 €
Amount to borrowed (20-year term)	64,243 €	64,243 €	64,243 €	64,243 €	64,243 €
Monthly repayments	267.68 €	295.32 €	324.44 €	354.99 €	386.88 €
Total amount repaid	64,243 €	70,877 €	77,866 €	85,198 €	92,851 €
NPV of loan repayments	38,030 €	41,957 €	46,095 €	50,434 €	54,965 €
NPV of net losses with loan	9326 €	13,253 €	17,391 €	21,730 €	26,261 €

[7] If the bank can place a mortgage on the property this reduces their risk considerably and enables a lower interest rate to be charged, as well as satisfying BIS recommendations for a higher loan-to-reserve ratio.

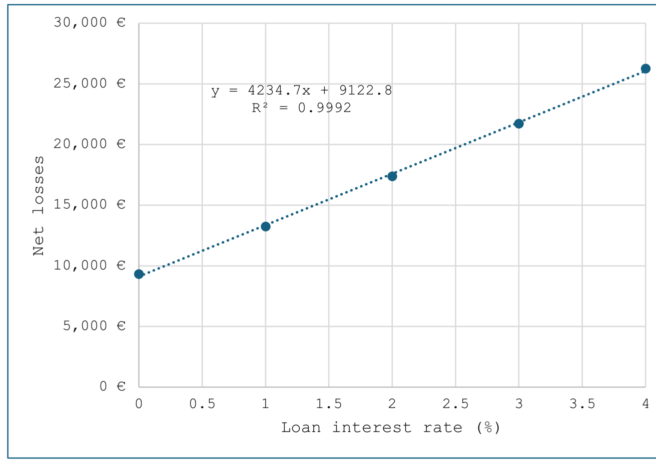

Fig. 3. Sensitivity analysis of net losses for case study renovation of 4-apartment building, floor area 350 m^2, building envelope renovated to 70 kWh/m^2/y, for range 20-year table mortgage loan interest rates. Not including "anyway" costs.

If the second version of the scheme is used, where the initial two years' savings remain in the bank, this gives landlords the further advantage that, at the end of the loan period, they are already qualified for a further loan. They can then adopt 20-year cycles (or longer) of comprehensive renovation, rather than piecemeal cycles of partial renovation.

With regard to existing finance instruments, the scheme is structurally comparable to an existing savings and loan scheme in Germany known as the 'Bausparvertrag'. This financing instrument is well established in Germany and basically also consists of a savings and a loan phase, but the savings phase is significantly longer and all the savings are withdrawn to help finance the renovation. The basic idea of a savings and loan scheme is therefore familiar to landlords, though what we propose has a different and more effective structure.

Further, the significantly shorter savings phase compared to 'Bausparvertrag' would bring forward investments. Until now, small private landlords have often had a long savings phase, even just to undertake small piecemeal energy renovations. These are no longer compatible with climate policy goals. At an individual level, bringing forward large investments can also be seen as a kind of insurance against rising CO2 prices for landlords. In Germany the landlord and tenant pay a CO2 tax on heating energy consumed in the home. But the landlord's share of this depends on the energy performance of the dwelling: the higher the energy consumption per square meter of floor area, the higher the landlord's share. The landlord is thereby doubly disadvantaged by poor energy performance: not only is there more tax due to higher consumption, but the landlord's share of this tax payment is also higher.

From 2026, the CO2 price in Germany will be set by the market, and the expectation is for a rapid increase in price. This will substantially increase a landlord's costs with a poorly performing building. Once again it is important to mention that future CO2 tax levels for fossil fuel based home heating cannot be predicted with certainty. The best a landlord or other property owner can do is assume that their Ministry's estimates are reliable (in this case the Federal Ministry for the Economy and Climate Protection – *Bundesministerium für Wirtschaft und Klimaschutz),* which is what the empirical studies we drew on for this paper have done.

In addition, energy performance will become more of a rental criterion in future as energy costs rise. Small private landlords will therefore find it more difficult to rent out flats with poor energy performance in the medium term or will have to bear part of the operating costs themselves, which in turn limits their ability to invest.

Another important issue is that the savings and loan scheme is conceived in a way that it does not require any government funding. It is utilised directly via a private bank. It would be possible in theory to have the interest rate on the loan further reduced by a KfW subsidy, or to have an additional KfW subsidised loan, but the KfW would have to set this up in such a way as not to complicate the process. It is important to keep the administrative effort for small private landlords as low as possible. A strength of the scheme as outlined above is that it is simple to organize and implement. Further, compared to state subsidy programmes, there is more planning security because the conditions are not dependent on the budget situation or political constellations that are influenced by competing lobbies or policy considerations.

Further, many small private landlords already have experience of working with their bank in relation to their building(s), usually from the financing or purchase of properties. There is usually a trustful relationship there. Such a relationship is unlikely to exist with the KfW or the other federal funding agency - BAFA. It is also the case that grants and loans from BAFA and KfW are usually not sufficient for deep energy renovation, so landlords have to take up private loans anyway. This means that a landlord would have several lenders (local bank plus KfW/BAFA) or at least several loan applications for one and the same project. It is also not uncommon for local banks to be reluctant to support KfW loans (due to the administrative workload and low returns) and therefore to advise customers against them. In our scheme, there is one single partner for the entire project.

The scheme addresses a key obstacle, namely high investment costs for comprehensive energy performance upgrades. However, it will not contribute to a significant increase in refurbishment rates on its own. It should be embedded in a policy mix that also addresses other obstacles. In addition to the provision of information and advice, instruments such as one-stop shops [60] are needed to support small private landlords in the concrete implementation of these measures, from clarifying issues relating to building/rental/tax law and acquiring tradespeople, to communicating with tenants and inspection authorities.

A question we have not considered is the issues that would arise where a building has multiple owners. In Germany there is an increasing tendency for the legal title of multiapartment buildings to be divided on a per apartment basis. This can make decisions on energy renovation more complex. Any finance scheme has to have the support of all the owners, so all would need to be recruited to the initial savings endeavour.

Finally, since commercial banking systems in most high-income countries (and many others) are guided by the BIS in their loan to reserve ratio practices, we see no reason why schemes similar to this would not work in other countries.

5. Conclusions

Germany is currently far from achieving its targets for decarbonising the building stock by 2045. Current projections assume a cumulative reduction gap of 32 million tonnes of CO2 for the building sector by 2030 which is far from sufficient. There are many reasons for this. One factor is certainly the heterogeneous property ownership structure in Germany. Around 80 % of all residential buildings are managed by private individuals. Small private landlords manage around two thirds of all rental properties. A comprehensive subsidy system (KfW, BAFA) has been in place in Germany for many years, which addresses one of the central obstacles, the high upfront capital costs. However, the subsidy programmes take too little account of the specific investment routines and inherent logic of different property owner groups. Instead, there is a 'one-size-fits all' logic.

The Saving and Loan Scheme presented here is a first step toward a differentiated approach. We have attempted to link the investment logic of small private landlords with the business model logic of banks. The starting point for our considerations was the mechanisms of the current banking system, and we have suggested how these can be matched to the target group of small private landlords. The developed Saving-and-Loan-Scheme does not require any state subsidies, but develops its effect primarily from its accuracy of fit with the specific investment logic of small private landlords. It is therefore an unbureaucratic, streamlined and culturally appropriate approach to triggering additional investment impulses.

The Saving and Loan Scheme is based on theoretical considerations and calculations using models. It also excludes certain framework conditions (e.g. the tax system). Whether and to what extent the approach is an interesting financing product for banks in practice and whether it would be accepted by the target group of small private landlords would have to be tested in a pilot phase. For example, a bank in a local authority could decide to test such a scheme for a limited period of time. The next step would be on a country-wide basis: an action plan for testing the concept with market players, for example associations of small private landlords, German banking authorities, the Bundesbank, the European Central Bank, the Consumer Institute (*Verbraucherzentrale*) and relevant federal ministries.

The Saving and Loan Scheme proposed here is primarily intended as a contribution to the debate, which should make it clear that new instruments are needed to accelerate the decarbonisation of the building stock. We need the courage to explore new paths and experiment with social innovations. It is important to harmonise the necessary ecological targets with the needs of investors and tenants in order to maintain or increase acceptance for the transformation path.

CRediT authorship contribution statement

Ray Galvin: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Steven März:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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