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The actors of building modernization in small municipal administrations and their challenges

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Buildings account for about one third of greenhouse gas emissions in Germany, but the sector faces enormous decarbonization challenges. Because the sector's governance has often been neglected, this paper focuses on politico-administrative actors and their challenges in advancing climate and energy-related building modernization in small and medium-sized municipalities where many public buildings require modernization. Drawing on participant observation and co-production with local politicians and street-level bureaucrats from twelve municipalities in the federal State of Hessen in Germany, we develop a new typology of actors in building modernization and unpack a range of challenges whose precise characteristics tend to differ by municipality size. Importantly, most practitioners highlighted governance issues rather than the better-known technical challenges of building modernization. Solutions likely involve tailor-made approaches that fit individual contexts; while important, the challenges cannot be reduced to a lack of money and personnel alone.

Buildings play a crucial role in delivering greenhouse gas neutrality. Combustion in buildings accounts for around 35 % of final energy consumption and around 30 % of CO_2 emissions in Germany[1], our focus area. German (and, indeed, European and international) energy-related building modernization rates have stagnated around one percent for years[2] so that reducing greenhouse gas emissions in the building sector remains a major challenge. The German Climate Change Act (KSG - in German: Klimaschutzgesetz) requires net greenhouse gas neutrality by 2045 and has set up annual CO_2 emission budgets for individual policy sectors (with non-binding sector targets, following a revision). In 2023, the building sector exceeded its permitted annual emissions limit for the fourth consecutive year, constituting a significant action gap[3]. Most building-related research has focused on various technical aspects so far, while scholars have usually neglected vital governance issues, including the actors of modernization and their challenges[4–6].

In addressing greenhouse gas emissions from the building sector, municipalities play a key role because they own and/or operate many public buildings, and they may act as accessible role models for their citizens. This is especially the case as the urgency of climate action increasingly becomes visible locally, as, for example, more frequent and intense heat waves hit. According to the German Federal Ministry for Economic Affairs and Climate Action (BMWK), municipal non-residential buildings in Germany are on average around 35 years old, usually unrenovated (windows, insulation, heating) and equipped with outdated, inefficient, and energy-intensive technology[7]. That said, some municipalities can and do act on climate change, including energy-related building modernization, such as installing thermal insulation and on-site renewable energy generation[8,9] (henceforth simply "building modernization"). Extant research has typically addressed more general approaches of climate action in well-resourced and networked cities or metropolitan areas[10,11]. We therefore focus on building modernization in small municipalities, that is, those with under fifty thousand inhabitants in the German context.

Municipal actors could, in principle, be exemplary "initiators of actions"[12] by leading in modernizing their own building stock[13]. But it remains unclear who exactly the "initiators of actions" in small municipalities are or could be, especially given that dedicated studies of public actors in the building sector remain unavailable to date. While a broad range of municipal actors and individuals could in principle be involved in building modernization, we know too little about who they are, their characteristics, and their central challenges from a practice-based perspective, gaps in knowledge and understanding, which this paper begins to address. Using an exploratory and inductive approach, we draw on participant observation, co-production, and document analysis to identify and understand the actors and their challenges, and then for the first time connect the insights to extant scientific literature centering on municipalities and climate action, highlighting how actor challenges link with literature on bottom-up implementation through street-level bureaucrats. In so doing, we focus mainly on the formal municipal administration and its political

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leadership to propose a new typology of actors in municipal building modernization.

Armed with new knowledge of the actors of municipal building modernization, the paper then unpacks their specific challenges from an often neglected practitioner perspective. Earlier research suggests that many German municipalities face numerous general governance challenges, from constrained budgets and a lack of specialized personnel to an ageing population[12,14,15]. The administrations of small municipalities are generally smaller and thus less differentiated and specialized than those of big cities. Specific, building-related personnel, including architects, engineers, or accountants, consequently tend to be rarer in smaller municipalities. The latter, therefore, often depend on external expertise to tackle complex building modernization tasks[16]. Venturing out from these broad considerations, the more specific challenges and corresponding needs of small municipalities in building modernization have to the best of our knowledge, not yet been examined, although 98% of all German municipalities have fewer than 50,000 inhabitants[17] and insights from larger cities do not necessarily transfer to small municipalities[18].

In fact, researchers have so far generally neglected climate action in small municipalities[19]. Few existing research projects focus on small municipalities, let alone the buildings sector, and therefore, the knowledge about their precise challenges and needs remains limited[20–22]. Although general research on small municipalities has accelerated somewhat in Germany and beyond in recent years (for more information, see[19,22–28]), systematic studies remain scarce. Researchers often conceive small municipalities as some kind of scaled-down city or assign them to rural spaces. But using theories and concepts that were originally developed by and for large (and often successful) cities[29] potentially fails to adequately understand the unique conditions of small municipalities. Doing so has led to rather stereotypical ideas about small municipalities (including their residents and their administration) with insufficient empirical grounding[23]. The important role of "street-level bureaucrats" in local implementation has also not been analysed sufficiently[30,31]. Given these knowledge gaps, an exploratory and inductive approach to understand building modernization actors and their challenges in small municipalities is necessary.

To do so, we focus on politico-administrative actors, that is, individuals in small municipal administrations and their specific challenges in the field of building modernization. Politico-administrative actors play a key role in acting and implementing policies in municipalities. Existing literature on policy implementation offers useful insights to understand such actors and their challenges. Policy implementation may be understood as "[…] the activity in the policy process in which actors attempt to convert policy intentions and resources into actions resulting in specific policy outputs and ultimately in the achievement (or not) of intended policy outcomes."[32,33] In seeking to understand implementation, scholars often distinguish between top-down approaches (i.e., how higher levels of governance oversee implementation by lower-level actors) and bottom-up approaches, which center on the actors and individuals involved in implementation[33]. Here we link our inductively gained insights retrospectively with the latter perspective and more precisely, with so-called "street-level bureaucrats"[30,31] or "[…] those who are responsible for implementing various implementation objects."[34] As Lipsky explains, street-level bureaucrats vary in terms of their professional qualifications, acquired and system knowledge, and level of experience[30]. They often exercise considerable discretion during implementation, especially when targets and instruments/mechanisms remain unclear or even conflicting. Creative and entrepreneurial approaches while remaining within the bounds of the law are likely assets of street-level bureaucrats, but also personal resilience in facing demands from the hierarchy and other constraints[30,31,35].

In the federal state (or "*Land*") of Hessen in Germany, our focus area, municipalities enjoy a constitutional right to and tradition of self-governance[36]. Hessen's municipal distribution is similar to that of Germany and therefore constitutes a suitable study area (see Methods section below). For climate action, and especially building modernization, there are, however, no unambiguous, overarching policy trajectories to guide the Hessian municipalities. Aside from the aforementioned broad national targets for the building sector in the German Climate Change Law and emissions trading for fossil fuels, there are currently no specific guidelines for municipalities beyond general regulations for all buildings and the long-term national goal to reach climate neutrality by 2045. The Hessian Climate Plan generally focuses on information and voluntary approaches, sometimes supported by financial incentives and organizational assistance[37]. In addition, networks such as the Hessian "Klima-Kommunen" (climate municipalities) offer support[26]. The Hessian Energy Agency (LEA) offers additional opportunities for assistance and exchange.

While there are no definitive data on the nature and state of repair of Hessen's municipally-owned building stock, anecdotal evidence suggests that many municipalities are struggling with old and decrepit residential and non-residential buildings. For instance, a state news report indicates that public actors are lagging behind in installing solar panels in Hessen[38]. High demand after the Second World War generated significant (re-)construction in the post-war decades, which translates into an ageing building stock at the time of this writing. However, precisely what types of buildings municipalities own, to what extent they are planning to modernize them, and what challenges they face along the way remains, by and large unknown[39]. Based on background information (see "Methods" section), we structure our inductively gained insights with two key guiding questions, each specified by sub-questions, for presentational purposes: (1) How is building modernization organized in small municipal administrations?; (1a) Who are the municipal politico-administrative actors responsible for building modernization?; (1b) How are these actors embedded in small municipality structures and administrative processes? (1c) What more general actor types can be identified from the empirical material? (2) What are the main challenges that the municipal actors face in modernizing their municipal building stock? (2a) What hurdles do municipal actors need to overcome to advance building modernization and therefore climate action? (2b) How do these hurdles relate to the specific actor types?

To address these questions, we use inductively gained insights from 12 selected small municipalities in the Federal State of Hessen in central Germany. Hessen reflects Germany's overall municipal distribution well, making it a suitable case study (see Section "Methods"). The insights emerge from an exploratory and inductive transdisciplinary approach combining desk-based research and actor identification, as well as a co-productive process[40] and participant observation with a focus on practitioner perspectives. In working with practitioners, we drew on Hood's NATO-classification[41,42] of policy instruments, including nodality (information), authority (rules and regulations), treasure (financial resources), and organization, to identify challenges across different action areas. The remainder of this paper proceeds as follows: The next Section "Results" presents our results, including a novel typology of actor types that work on building modernization in small municipalities, their key challenges, and how they connect. Section "Discussion" concludes with suggestions for practitioners and future research. Section "Methods" presents our methodology in detail, including how we selected the participants and how we used collaborative processes to work with the politico-administrative actors, as well as their challenges in building modernization.

Results

The municipal actors of building modernization

The administrative actors who participated in our co-productive processes work on different organizational levels and in different units of their respective municipal administrations. We encouraged the (political) heads of administration (including mayors), but also operational staff with responsibility for building modernization to participate. This process returned a diverse and illustrative group of administrative actors involved in building modernization. In the following section, we address research question 1 and its sub-questions by elaborating on the actors' roles and positions within the municipal structures.

Publicly elected mayors serve as the heads of the municipal administration. In Hessen, they are directly elected, but have no formal training

requirement, so comprise a fairly diverse group in terms of professional backgrounds and experience[43]. Municipal administrations in Hessen typically contain various departments such as finance, estates and buildings, tourism, culture, and more, to fulfill their multifaceted tasks. Staff members from 6 of the 12 participating municipalities were employed in a dedicated building department, albeit with varying designations and scopes of responsibility. Three out of the six administrative actors were department heads. Four served as "climate managers" in their respective municipalities, three of whom held temporary positions based on a federal funding program. Climate managers represent a distinct administrative innovation in Germany in order to work across administrative silos and coordinate climate action across the municipality[44,45]. One climate manager held a permanent position with joint funding from several small municipalities. These municipalities had developed an inter-municipal climate action concept and agreed on joint funding for a climate action manager[46]. One mayor participated in project workshops only by himself, while two others attended some meetings in conjunction with staff from their administration. Five municipalities occasionally sent more than one representative to project workshops, suggesting a higher level of personnel capacity to engage. Four administrative actors in our workshops had previous experience in the private sector, while the others had longer histories of working in public administration. Based on our work with the municipalities, the actors involved in municipal building modernization can be grouped into the following categories, addressing sub-question (1c): Which more general actor types can be identified from the empirical material?

Mayors and other high-level administrators: Mayors in Hessen have broad responsibilities in structuring and running day-to-day administrative operations. They must implement the decisions of their municipal council. To do so, they are primus-inter-pares members of an executive municipal board ("*Magistrat*"), whose composition typically reflects the power balance of the council. The mayor and the executive board/administration also have the right to initiative by putting forward proposals and potential courses of action to the municipal council. With smaller matters, the executive board also typically holds direct decision-making powers. The council grants and limits these powers, especially with a view to spending, by setting upper financial limits for executive decisions.

In the area of building modernization, mayors and other high-level administrators thus decide how to organize the relevant tasks in the administration, and they also influence the extent to which modernization processes reflect a political and administrative priority. In so doing, they balance the need for building modernization with other administrative demands and necessities. We found that high-level backing for building modernization activities matters immensely for lower-level staff, because it drives available financial and personnel resources, but also the leeway and trust to implement innovative approaches and to tackle challenging and at times expensive modernization projects. The mayor of Weilrod personally took part in the workshops, underscoring the importance of municipal building modernization for a municipality that manages a particularly large building stock[47]. The mayors of Fischbachtal[48] and Ober-Ramstadt[49] participated in selected workshops, accompanied by municipal staff members.

Jack-of-all-trades: Generalists with broad administrative responsibilities but without specific building-related expertise. These individuals typically have general administrative training and potentially wield influence, particularly if they hold leadership positions in the administration. However, they often lack direct building-related expertise, generating dependency on external advisors for more technical aspects. These actors are typically found in smaller municipalities with less differentiated administrations, such as the municipality of Fischbachtal, the smallest among our 12 participating municipalities. The administration of Fischbachtal has a grand total of ten employees. The responsibilities of the building and property management department include processing building permits; general property management and property and building maintenance; maintenance and operation of supply networks, as well as urban planning. The tasks also include citizen and customer service. At the time of this writing, these tasks were handled by approximately 1.5 full-time equivalents. The responsible employees received general administrative training[48]. In Fischbachtal, everyday operations and urgent maintenance tasks consume a significant portion of the available time, so that very limited capacity remains for fundamental or strategic planning for building modernization. The lack of in-house building-related expertise necessitates the engagement of external consultants for project planning and aspects of implementation[48].

Climate Managers: Climate managers reflect an administrative innovation, which started spreading more rapidly across Germany from 2008, when the federal government instituted a dedicated funding program. Climate managers are often generalists, with backgrounds in geography, urban planning, political science, and/or technical aspects[44]. Their responsibilities typically span different administrative areas and often also include strategic communication and coordination tasks, which may include building modernization. Their effectiveness hinges on their ability to persuade colleagues, to network, and to gain personal standing within the administration. There are no formal training requirements for climate managers, and the contours of the profession were still being defined at the time of this writing. They are often recent university graduates and may hold temporary positions tethered to external funding. This means that their standing within municipal administration can vary, depending on their personality, training, and the openness of their colleagues to engage. In smaller towns, climate managers are often part-time or responsible for multiple municipalities simultaneously.

Occasionally, climate managers are employed through inter-municipal cooperation agreements. Their precise formal institutional location within the administration varies: Climate managers often hold cross-cutting positions that only report to the mayor, working across municipal departments; in other cases, they may be part of a department or unit, such as buildings or environment. Overall, existing research shows that the presence of climate managers leads to more municipal climate action[45]. In our project, the municipalities of Allendorf (Lumda)[50], Alsfeld[51], Bad Hersfeld[52], and Kaufungen[53] had climate managers with significant responsibilities for building modernization.

Building Specialists: Building specialists comprise trained professionals with backgrounds in architecture, engineering, or related fields. They possess significant building-related expertise, affording them greater independence from external experts when compared with generalists. In larger administrations, they may specialize and potentially also work as trained energy advisors. However, building specialists may have limited knowledge of administrative and political processes, which can pose barriers and can lead to frustration. We observed this actor group in larger municipalities with more differentiated administrations, including Bad Soden am Taunus, a municipality in the vicinity of the City of Frankfurt[54]. The Buildings and Properties department in the Building and Development division of Bad Soden am Taunus is responsible for the majority of municipal properties, except properties owned by the drinking water supply company. The department is responsible for the modernization and new construction of buildings, renting and leasing, maintenance and servicing, as well as the organization of building-related energy supply, including purchasing and billing. The department consists of 15 employees, some part-time, at the time of this writing. Six of them are formally trained architects, including the head of the department and a climate coordinator. The team also includes two clerks and one person responsible for building maintenance. Another staff member deals with room reservations, with one more responsible for billing and four for cleaning. In sum, it is evident in this example that there is a distinct division of tasks among the individual employees[54]. The municipalities of Bad Hersfeld[52], Alheim[55], Herborn[56], and Ober-Ramstadt[49] also have relatively differentiated administrative structures to manage municipal buildings.

Hybrid types: We also found some hybrid types, which combine aspects of the types explained above. In Allendorf (Eder), the climate manager is also a trained building specialist and energy adviser with extensive administrative experience, therefore combining different types of backgrounds and advantages[46]. Therefore, the formal position or job title

does not necessarily indicate the precise range of responsibility and the type of training.

Based on our observations and numerous direct interactions with administrators, we found that structural variables (town size, settlement structure type, and incorporated districts) influence the nature of administrative positions. Very small municipalities tend to have more generalist administrative units for the building sector and therefore rely more on external expertise—which may also be in shorter supply in smaller places—than their bigger counterparts. The larger the municipality, the greater the specialization for building modernization within its administration.

The challenges of small municipalities in building modernization

Identifying the challenges of building modernization in small municipalities involved a two-step, co-productive and participatory approach. In the first workshop, we engaged with the participants in a more general brainstorming session of their challenges. In a second workshop, we asked the municipalities to sort their challenges into a policy-instrument related scheme, drawing on Christopher Hood's famous work[41,42]. We translated Hood's *NATO*-classification of policy instruments into terms that resonate with practitioners in building modernization, referring to "information and advice" (for nodality), "rules and regulations" (for authority), "subsidies and finance" (for treasure), and "participation in networks and exchange" as well as "adjustments in administrative structures" (both for organization). Furthermore, following practitioner demand, we added a "miscellaneous/other" category in the process to capture any remaining challenges, notably those arising from specific construction or modernization projects. Strikingly, many municipalities reported similar challenges, suggesting that certain issues were common across most or all participants. Below, we describe the challenges by category, addressing our research question (2): What are the main challenges that municipal actors face in modernizing their buildings?

Information and consultation: Frequently changing laws and requirements demand significant time and resources to stay up to date. This challenge is particularly acute for small municipalities, which may only have a few employees with general administrative training. Because of complex grant funding mechanisms from higher government levels and the obligation to involve energy efficiency experts, small municipalities typically depend on external support. Participants noted that due to a shortage of Energy Efficiency Experts (EEE), consulting services to gain the necessary information and advice often had limited capacities, leading to significant delays. Additionally, some participants struggled to find independent and effective consultants, who are not equally available everywhere, with particular challenges in rural settings.

Other difficulties in this category emerged from missing or hard-to-access building documentation. Construction plans of old buildings are often not (yet) digitalized and subsequent changes were not always properly documented, or in one case lost altogether because of flooding in document storage facilities. Such gaps become a particular challenge when EEEs need accurate information for their assessment, which small municipalities cannot always provide easily. In addition, undocumented and/or previously unknown changes to building structures can lead to significant surprises and delays during modernization. Based on the workshop-based exchange, one staff member communicated a need for funding support to survey the state of the municipal buildings in order to plug existing gaps before embarking on the next steps.

Regulation & legal requirements: In line with or surpassing (inter) national requirements, the participating municipalities have climate neutrality targets, with some aiming for 2035 and others for 2045 (the latter as part of signing up as a Klima-Kommune and in synch with the existing Hessian target). However, there is an overall lack of planning and intermediate targets for achieving climate neutrality—including for built structures. One workshop participant insisted: "The goal is to make the municipal buildings climate neutral by 2045, but there is a lack of ideas, concepts, and visions on how this goal can be concretely achieved and what the next steps should be." The pathway to climate neutrality at the municipal level, therefore, often remains unclear due to a lack of corresponding decisions from municipal councils and/or insufficient financial resources. Climate-related building construction guidelines, such as those found in large Hessian cities like Darmstadt[57] or Frankfurt am Main[58], typically remain unavailable in smaller municipalities. In the absence of a clear regulatory and legal framework for climate neutrality at the local level, administrative practitioners often struggle to prioritize building modernization measures, both generally but also with a view to the order in which they may want to re-work their municipal buildings.

Funding programs and financing: Obtaining grant funding from higher governance levels for building modernization typically involves complex and time-consuming proposal-writing and associated administrative processes, which require upfront resource investment and experience. Small municipalities with few employees, who are not highly specialized (e.g., see type *jack-of-all-trades* above), often lack experience in funding acquisition and frequently depend on external consultants to handle applications. The broad range of available funding opportunities from the German federal government and from the federal state level is often confusing and requires significant time and effort to navigate.

Specific funding requirements and frequent changes in funding conditions aggravate the uncertainty and difficulty in securing financial support. The participants described the multitude of ever-changing funding possibilities as a "complex funding landscape" or even a "grant jungle." The grants often only support direct investments, but not the costs for additional staff for project development. And when grant programs do provide resources for additional municipal personnel, such as the funding of climate managers from the German "National Climate Action Initiative" (NKI), these grants usually only last for a limited time (around 2–3 years). Once the funding ends, keeping the staff and continuing their work generates a lagged financial burden.

This state of affairs directly relates to another, frequently highlighted municipal challenge: financial constraints. Limited financial resources and tight local budgets frequently force municipalities to prioritize immediate building maintenance over long-term energy efficiency, climate adaptation, and other modernization measures, affecting their ability to implement comprehensive approaches, which building specialists typically recommend. Due to the annual budgeting logic, few municipalities have comprehensive and durable financial frameworks for long-term modernization planning. Some municipalities reported a significant drop in business tax revenues, leading to the suspension of planned modernization. When municipalities with severe financial constraints cannot afford a contribution to activate grant-based funding (usually between 10 and 50%), a vicious cycle of low resources continues.

Furthermore, grant funding requirements and administrative budgetary processes are often out of synch. One municipality described how it faced serious delays because it could not start the process of tendering before the corresponding grant agreement had arrived. Another municipality reported undergoing a 14-month review process in order to secure funding for updating its climate action concept. Once grant funding became available, a lengthy tendering process for defined tasks led to additional delays in the implementation phase, generating issues with the annual budgeting logic of both the grant funders and the municipality.

Participation in (municipal) networks: Many municipalities participate in mutual support networks, which foster exchange on various topics, such as the Hessian "Klima-Kommunen" (climate municipalities), a voluntary network of municipalities with the aim to promote climate action[26]. There are also other easily accessible exchange opportunities, such as an email list for Hessian climate managers. But given the bottom-up organization of the email list, the members are responsible for maintaining the contacts, as well as removing invalid e-mail addresses and adding new members—this was perceived as a challenge by some practitioners.

Districts, cities, and municipalities have also been using more formal types of cooperation, while retaining their independence and local identity. The Hessian state government supports municipal cooperation through funding and advice from a dedicated support center. However, coordinating

and networking various actors among different municipalities is time-consuming and requires extensive communication. For example, the Hessian municipalities Bad Camberg, Brechen, Hünfelden, Selters (Taunus), and Weilrod established an inter-municipal working group in 2019 to develop a concept for a joint fire department center. In 2023, they then founded an operating company and were then aiming for funding support from the federal State of Hessen[47].

Administrative structures: Almost all of the municipalities highlighted a notable shortage of administrative and specialized staff for building modernization. Staff shortages can, in turn, cause difficulties to cover responsibilities of colleagues who retire or who are on extended leave (e.g., parental or medical leave). This is especially acute in smaller municipalities, where few people are involved in the same field of work, making it difficult to cover for one another. And even when financial support from funding programs can be secured, lacking administrative capacity can hamper implementation, causing projects to stall. The municipalities frequently mentioned delays due to such administrative difficulties, and we also observed these first-hand, as practitioners with responsibility for participation in our project had to interrupt their engagement for months due to changes in their personal circumstances, such as for example parental leave. A lack of backup meant that the work could not continue as originally planned. In times of (local) crisis, municipalities tend to turn to their mandatory tasks, which typically do not include climate action and building modernization[59].

The generally considerable daily administrative load and operational tasks often leave little time for comprehensive strategic thinking and planning with a view to building modernization. This particularly affects complex, long-term modernization projects, where many aspects need to be considered, for example, which steps to take and in which order, which stakeholders to involve, how to finance measures, and many more. Furthermore, the process of researching sources of financial support often involves many departments in a decentralized way, adding an additional need for coordination and potentially causing delays.

Cumbersome internal hierarchical structures and staggered approval processes can delay decision-making even more, given that administrative staff may have limited access to (political) management levels. As a consequence, good cooperation between administrators and politicians is an essential condition for successful implementation, but mistrust between administrators and their political counterparts can delay or even block action. One participant used the following proverb to describe their challenges: "A prophet is without honor in his own country." Such mistrust may develop on the basis of different operational logics and priorities. In addition, building modernization project responsibilities are not always clearly delineated within municipal administrations, making it rather difficult to hold specific individuals or departments accountable.

Finally, administrative reforms (during the 1970s in West Germany and from the 1990s onwards in small towns in East Germany)[59] intended the stepwise incorporation of formerly independent surrounding villages, and as a result, small municipalities grew[60]. With the incorporation of the surrounding villages, the number of public buildings belonging to a single municipality expanded, including multiple town halls, fire stations, and community centers. The preservation of these public buildings is costly, but may have political significance. As one mayor explained: "Demolition is not an option. If the community center is demolished, I will no longer be elected there."

Taken together, our work and exchanges with the municipal administrators demonstrate that, beyond the well-known challenges of resource and personnel shortages in municipalities, a range of additional conditions make building modernization particularly challenging. These range from difficulties to find and use information to the complex coordination processes to acquire resources and manage projects. Such challenges tend to be particularly acute when building modernization is not a clear politico-administrative priority, which often results in minimal maintenance activities rather than more comprehensive building modernization, which would be needed with a view to functional needs and climate targets. As Fig. 1 highlights, each actor type contributed challenges from their perspective—some unique, while others were widely shared by others—illustrating the hurdles municipal actors need to overcome in order to advance building modernization (sub-question 2a).

While challenges related to funding programs and financing account for half of the issues mentioned, there is also a substantial focus on other themes, such as administrative burdens or intransparent funding conditions. Certain challenges, notably insufficient data on the building stock and difficulties in prioritizing, were only mentioned by building specialists and climate managers, while mayors focused on challenges with funding programs, as well as lacking municipal and federal targets for municipal building modernization.

Discussion

The governance of public building modernization in small municipalities has been neglected so far. This paper contributes to addressing this gap by drawing on insights from a co-productive research and development process with 12 small and medium-sized municipalities from the State of Hessen in Germany. Compared to most other federal states, Hessen's above-average financial situation provides a favorable starting point for building modernization. It can be expected that investment levels here may exceed those in other federal states, offering insights into best-case scenarios (we thank one of the reviewers for suggesting to highlight this aspect). Buildings cause a considerable amount of greenhouse gas emissions, and public actors, including municipalities, have often been proposed as potential leaders or exemplars who can and should demonstrate good practice to their citizens[8,10]. Yet, too few have explored how small municipalities may live up to this role in building modernization and what challenges they encounter along the way.

This paper focused on the politico-administrators and their challenges in modernizing public buildings. The co-productive research setting allowed municipal political actors and local street-level bureaucrats to explore their challenges in depth and track developments together with scientists over a period of 2 years. A key, headline finding is that in this exploratory and inductive research process, the municipalities mainly prioritized governance questions, related to issues of funding and financial support, communication, and organizational structures and adjustments. The technical challenges of building modernization did not feature as prominently. This is an unexpected but highly pertinent finding, considering that extant research has typically centered on the many highly technical aspects of building modernization, for example, on the types of thermal insulation or the installation of renewable energy technologies. The findings indicate that vital governance aspects, including important practitioner needs, demand far more attention to expand local capacity to support building modernization efforts.

More precisely, smaller municipalities often remain too under-resourced and too under-staffed to address building modernization systematically and strategically. As a consequence, they often engage in ad-hoc and piecemeal modernization activities, responding to day-to-day technical and political necessities and demands. But well-networked and resourceful street-level bureaucrats within small municipal administrations were sometimes able to skilfully align resources, politico-administrative will and modernization strategies to overcome such challenges and leap forward, an effect that may be understood as "[…] "positive deviance," which refers to organizations (or individuals and teams within them) that achieve exceptional outcomes despite facing the same challenges as their peers.[35]" These individuals tend to benefit from support from their hierarchies, extensive and strategic knowledge, as well as individual and institutional resilience in the face of setbacks or changes in circumstances. In these cases, innovative approaches, including inter-municipal cooperation, started to emerge.

The street-level bureaucrats we encountered in administrations that are responsible for building modernization (sub-question 1a) may be topologized into *mayors and other high-level administrators*, *jack-of-all-trades* with general administrative training, *climate managers* with cross-cutting responsibility, and *building specialists*. The smaller the

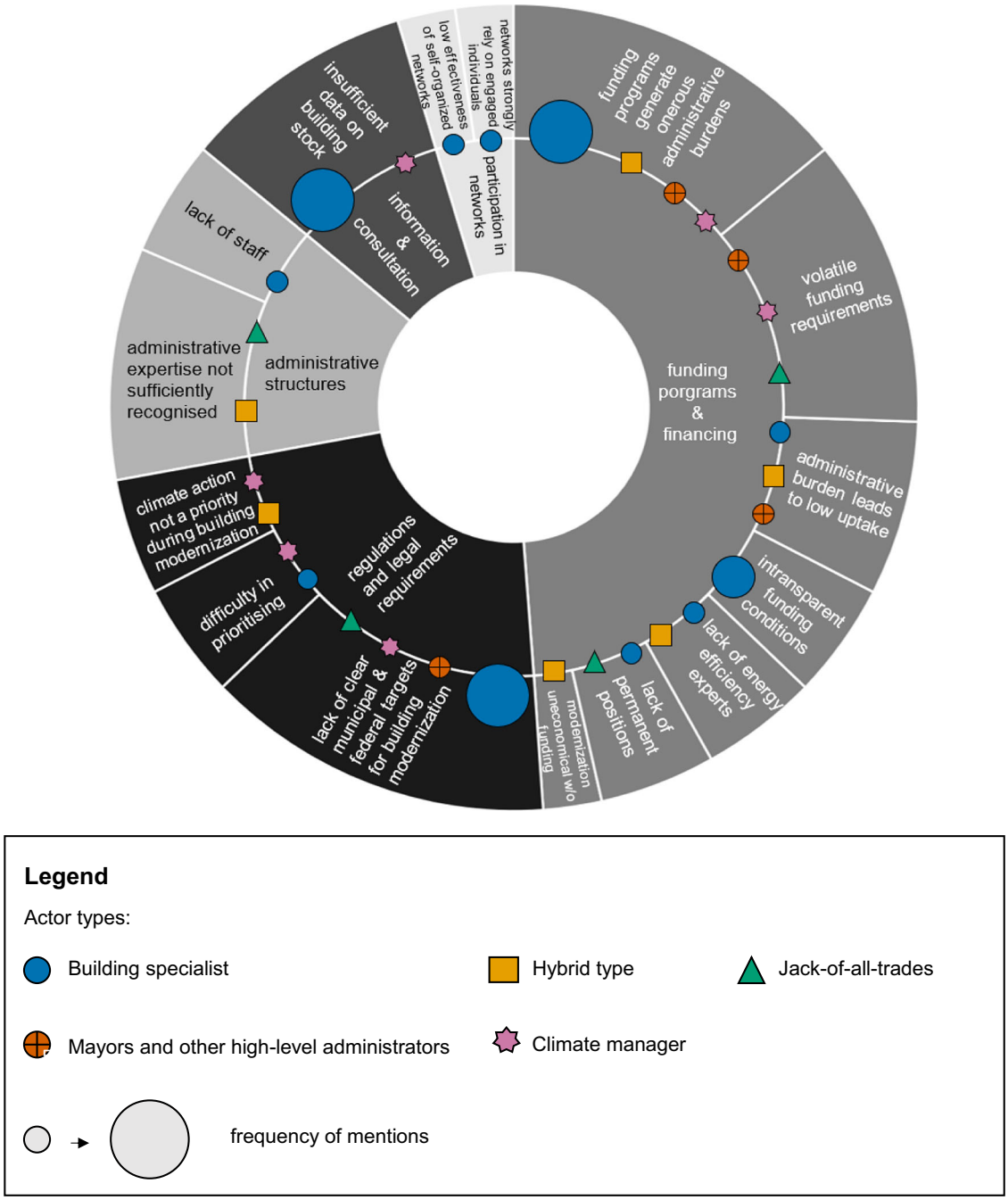

Fig. 1 | The challenges of municipal building modernization. Source: Municipal fact sheets on building modernization[46–56]; workshop documentation; personal communication.

administration, the lower the level of individual specialization, which in turn usually increases dependency on external expertise. Particularly, very small municipal administrations frequently suffer from a lack of staff with similar backgrounds and tasks, generating low levels of resilience and high vulnerability when individual or organizational circumstances change. Faced with general policy overload, prolonged absence—for example, because of an illness or because of parental leave—often causes quick administrative de-prioritization of building modernization and strategic planning as the focus shifts to pressing mandatory tasks.

The upshot of our findings is that street-level bureaucrats can and already do make a difference in entrepreneurial ways in small municipalities. But they typically face a range of challenges, which we presented in the second part of this paper. The municipal challenges with regard to building modernization are multi-dimensional, and while resource and personnel shortages are certainly important factors, a municipality's building modernization "delivery capacity"[61] crucially cannot be reduced to them. Issues such as knowledge and political will/support, data availability, and access to external expertise play vital roles in enabling sustained engagement and successful outcomes in this complex policy area. Rather than one-size-fits-all solutions or "policy panaceas,"[62] the empirical findings suggest that municipal building modernization requires tailored policy solutions—potentially for sub-groups of municipalities—and support to address gaps as they appear. A pure technical focus is insufficient.

Table 1 | Municipality types in Germany

Label	Population range (Inhabitants)
large city	> 100,000
medium-sized city	>20,000–100,000
large medium-sized city	> 50,000–100,000
small medium-sized city	>20,000–50,000
small town	5000–20,000
larger small town	>10,000–20,000
small small town	5000–10,000
rural communities	<5000

Simplified and adapted version of the BBSR 2003 definition.

Lifting the gaze from the particular municipalities in the German federal State of Hessen provides additional hints on how far these insights may carry elsewhere. Hessen is one of Germany's richest federal states, and we selected municipalities with a minimum base level of interest in climate action and building modernization. It is therefore likely that their challenges will also appear in other municipalities, not only in Hessen, but potentially also other federal states and even well beyond Germany. A focus on the governance and capacity questions of building modernization is an often-neglected, but crucial element to ultimately reach climate neutrality at the municipal level[63]. A useful next research step would be to explore actors and challenges in building modernization quantitatively in order to understand existing problem patterns at scale and explore to what extent our findings can be corroborated elsewhere, especially with a view to the necessary and sufficient conditions of building modernization. The administrative structures of building modernization and staff resources vary significantly. Given that not all small municipalities are alike, additional research would benefit from more detailed, systematic insights into these variations.

Methods

This section describes our methods, beginning with a general description of municipal structures in Germany and our focus area, the federal State of Hessen, and then our sampling frame to arrive at our selection of the 12 participating small and medium-sized municipalities. The section continues with insights into the co-productive and participatory settings in which we worked to identify relevant municipal actors and their challenges. It closes with a conceptual overview of politico-administrative actors and their implementation tasks in small and medium-sized municipalities from the perspective of existing literatures.

Understanding the baseline: municipal types in Germany

Given that settlement structures vary considerably between countries, we begin with an overview of our focus area in Germany. Although Germany has no official definition of municipality types, the spatial sciences widely use the categories developed by the German Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) in 2003 (in German: Bundesinstitut für Bau-, Stadt- und Raumforschung). The definition is based on the municipal population and its central functions in the region, according to federal-state planning[15], see Table 1.

Germany has about 11,000 municipalities *in toto*, but only 81 of them contain more than 100,000 inhabitants. Small municipalities thus represent rather heterogeneous entities, which may fulfill different roles in their region. Sometimes, a single municipality covers large administrative areas because it comprises numerous formerly independent villages. Others have a compact settlement structure with a medieval town center[23]. Small municipalities in metropolitan areas might be characterized as commuter towns, where public transport and affordable housing matter immensely. By contrast, small municipalities in peripheral (rural) areas that face outbound migration may prioritize other issues, such as industry development, to generate local jobs. The combinations of such factors generate rich contextual conditions, which in turn produce place-based challenges for building modernization that cannot be reduced to one or very few indicator(s)[64,65].

The vast majority of Germany's municipalities are small or medium-sized: 98.17 % have fewer than 50,000 inhabitants. In the federal state of Hessen, this proportion is similar at 97.15 % (namely, 412 out of 422 municipalities). Taking a closer look at the corresponding population distribution in Germany, the data show that around 59 % live in municipalities with fewer than 50,000 inhabitants. In the federal State of Hessen, this number is even higher with around 68 %. Therefore, both Hessen's municipal structure and population distribution reflect Germany reasonably well, making the former a suitable case for drawing broader, nationally relevant insights[66]. Figure 2 illustrates the (BBSR) municipality types and their population share in Germany (see Fig. 2a) and Hessen (Fig. 2b). Darker textured surfaces indicate the municipality types at the center of this analysis, that is, any municipality which is not a "large" or a "large medium-sized" city.

In functional terms, German municipalities have mandatory tasks, such as providing child care or fire brigades. They also implement delegated tasks from higher-governance levels, such as issuing building permits. Municipalities may also engage in (legally speaking) voluntary activities, including providing public swimming pools or offering cultural activities/locations such as concerts or libraries[36,59]. To fund their activities, German municipalities enjoy a right to impose local business and property taxes as their main source of income; in addition, in-state financial transfers aim to equalize living conditions in all municipalities. Whenever higher governance levels delegate tasks to municipalities, the former must provide the necessary resources to do so. By and large, climate action and building modernization feature among voluntary municipal tasks by legal definition in Hessen, although the distinction from mandatory is not always straightforward. For example, mandatory child care provision or maintaining fire brigades usually also involves owning or at least operating municipal buildings, thus blending mandatory and voluntary tasks[59]. However, municipal climate action in the building sector, such as adding thermal insulation or installing renewable energy tend to be voluntary tasks in principle—while, of course, municipalities also have to obey generally applicable rules and laws for buildings across the country or the federal state. That said, given the right to self-administration, municipalities can of course autonomously make binding decisions regarding climate action for their own administration and in their jurisdiction (e.g., in the area of town planning).

Case study selection

We employed a data-driven approach to select 12 municipalities from the grand total of 412 in Hessen with fewer than 50,000 inhabitants. The goal was to identify municipalities suitable for and interested in a co-productive research project on building modernization. The selection process relied on ten variables sourced from Hessian municipal statistics, the Hessian "State Development Plan of Hessen" (in German: Landesentwicklungsplan, LEP), and existing variables and data from the project partners.

Our selection aimed to maximize variance in spatial distribution, thus we considered variables such as administrative district, county, and structural area. Hessen exhibits a general north-south spatial gradient, with sparsely populated rural areas more common in the north and urban agglomerations in the south. Additional variables focused on identifying the level of existing climate action within municipalities. These included whether a climate action manager was present (yes/no), whether the municipality had a climate action plan (yes/no), whether there was a climate action plan at the county level (yes/no), and whether the municipality was a member of Hessian Klima–Kommunen, a state-driven municipal support network (yes/no). The Klima-Kommunen comprise Hessian cities, municipalities, and counties committed to climate action, covering both mitigation and adaptation[26]. To join, municipalities must sign the network's Charter, committing them to become climate neutral by 2045, produce an action plan, and submit an annual report on implemented measures. By April 2024, 387 of the 422 Hessian municipalities and counties had signed

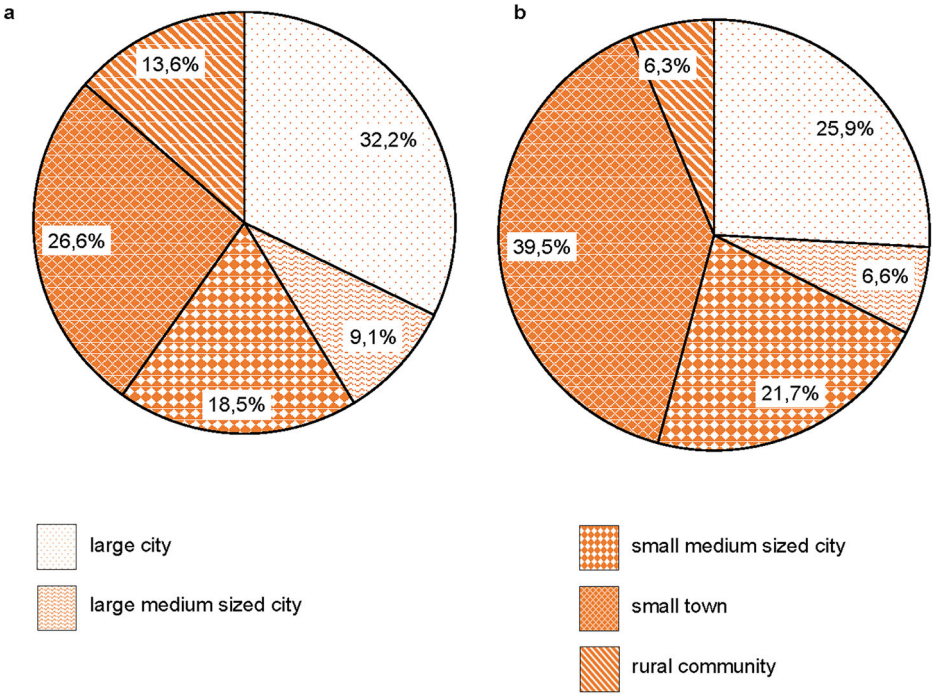

Fig. 2 | Municipality types by population share. **a** Germany. **b** Hessen. Data source: Own presentation and calculation based on data from the BBSR[71].

the Charter. Variables representing municipal political and financial characteristics also featured in the selection procedure. The aim was to capture variance in the political background of the directly elected mayors, the strongest political group in the council, and debt per capita. Additionally, we obtained data on municipal climate action from a dedicated database of the Hessian Klima-Kommunen.

These variables allowed us to generate a shortlist of 30 municipalities. The mayors of the preselected municipalities were then invited to participate in the research project (via email and phone contact). After several preliminary conversations, 12 municipalities agreed to participate. See Fig. 3. These municipalities expressed a keen interest in the project and agreed that staff involved with building modernization would participate in regular meetings and workshops with the research team (see Spieker & Frommer, in preparation). The selected municipalities were invited to a kick-off workshop in March 2023. Two more workshop cycles in the 6 months that followed were used to identify key actors and their challenges.

Description of the municipalities/groups

The selected municipalities are spread throughout Hessen and range in population from about 2000 to 30,000 inhabitants. Fischbachtal[48] and Allendorf (Lumda)[50] are the smallest among them, with under 5000 inhabitants, situated in rural areas. Alheim[55], Weilrod[47], Allendorf (Eder)[46], Alsfeld[51], and Herborn[56] are predominantly rural, characterized by numerous incorporated districts. The extensive municipal infrastructure reflects this historical legacy, including separate town halls and fire stations in each of the former independent villages. Alsfeld and Herborn are also historic towns along the German Timber-Frame Road with picturesque centers. Preservation of these historic buildings often plays a pivotal role during modernization efforts.

Erzhausen, Ober-Ramstadt[49], Kaufungen[53], and Bad Soden am Taunus[54] are situated in more densely populated areas close to the cities of Darmstadt, Kassel, or Frankfurt am Main. These municipalities feature more compact settlement areas, excellent public transportation connectivity, and a generally more urban character than the other municipalities we selected. For instance, Bad Soden am Taunus has more than three times the population of Weilrod but occupies a surface area more than five times smaller. Bad Hersfeld, the largest among the municipalities in the project, is a county capital and houses the administration of the northern Hessian county of Hersfeld-Rotenburg. Table 2 lists the participating municipalities, their population sizes, and the number of non-residential and residential buildings they own.

Understanding the politico-administrative actors and their challenges

The findings in this paper emerge from a larger research-project, which involved trust-based and sustained interactions between politico-administrative actors and the project team in workshop settings. Using elements of co-production, a participatory approach, and participant observation, the project team and the municipalities worked on building modernization at the municipal level by fostering enduring, trust-based relationships. We therefore applied a bottom-up logic to understand the actors that implement municipal building modernization.

Following selection, we invited all participants and other interested individuals from relevant organizations and governance levels for a kick-off event, where we began brainstorming and documenting the challenges of municipal building modernization, following the concept of problem framing in transdisciplinary research processes[67]. In two more workshop rounds, we used actor and process mapping exercises with the participating municipalities/individuals to unpack the actors and the processes of municipal building modernization from the perspective of the politico-administrative actors. Each municipality was asked to map their processes and actors in building organization onto flipchart paper, accompanied by a scientist to assist in the process. The participants brainstormed their main challenges in the area of building modernization and then categorized them with an adapted version of Hood's typology[41,42]. Between the workshops, frequent email contacts, and individual phone calls assisted in building trust and underlining the constructive intention of our joint project.

In order to analyse the diverse materials generated in these co-productive processes[68], we relied on document review in order to extract semantic patterns and lines of argument. We validated the findings within the research team (involving about 10 individuals) and presented them at a scientific conference and a workshop for additional external validation and input. On the whole, the inductive approach therefore relied on intersubject meaning-making, given the lack of theoretical priors with a view to building modernization in small municipalities.

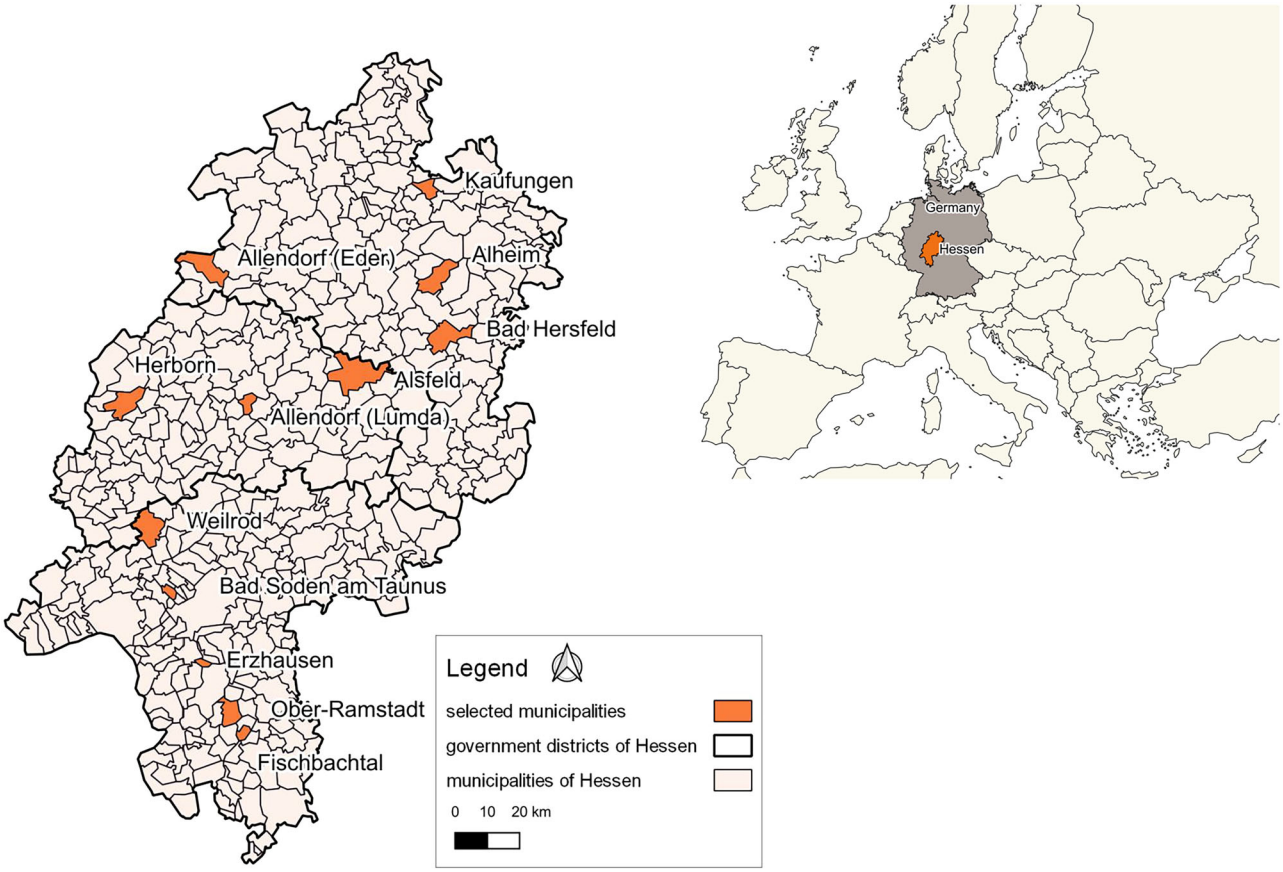

Fig. 3 | Selected municipalities in Hessen, Germany. Data from the Hessian State Office for Land Management and Geoinformation[72] and from the Hessian State Statistical Office[73]. This figure has previously been used in the Project Documentation "Gebäudemodernisierung Gestalten", Schader-Stiftung[74], as well as in the final project report[75].

Table 2 | Number of buildings owned by each municipality

Municipality	Population	Non-residential municipal buildings	Residential municipal buildings
Fischbachtal	2760	11	0
Allendorf (Lumda)	4069	8	1
Weilrod	6731	86	0
Allendorf (Eder)	7739	32	5
Erzhausen	8147	15	0
Kaufungen	12,790	27	17
Ober-Ramstadt	15,211	40	9
Alsfeld	16,392	69	1
Bad Soden am Taunus	23,174	31	3
Herborn	25,835	90	10
Bad Hersfeld	30,643	61	50

Source: Data provided by the participating municipalities;10/2024.

Linking the insights with extant knowledge

Existing literature suggests that even small municipalities in Germany may not be understood as unitary actors, but rather consist of different component parts. To begin, there is the distinction between the political level (for example, municipal councils and mayors) and the usually more permanent administration, consisting of professionals with specific training and expertise to execute defined tasks[59]. Most administrations furthermore contain different departments or units, which are typically organized in a functional way. However, we know today that each of these component parts brings to the fore their own set of interests and strategic approaches. In other words, the aim of a rational, Weberian bureaucracy, which faithfully executes commands from the political level in a machine-like fashion, has at best ever partly come true[59]. Rather, public administrators also influence municipal action in their own right, by, for example, acting as "policy entrepreneurs"[69,70] to effect change.

In order to understand street-level bureaucrats in building modernization and their challenges, a first step involved working with them to brainstorm their challenges. To structure the insights, we drew on policy instrument literature. Hood suggests that policy instruments may be grouped into those that relate to nodality (information), authority (rules and regulation), treasure (financial resources), and organization—together known as the "NATO" classification[41,42]. Such instrument classifications also offer a useful guide to understanding implementation challenges of municipal governance. The challenges that street-level bureaucrats face with a view to these approaches also remain, by and large, unknown, but utilizing the classification somewhat unconventionally can lead the way to them.

Data availability

Some data reported in the manuscript draw on other, project-related publications, notably the municipal profiles of building modernization[46–56]. Other data from co-productive processes were collected in confidential environments through participant observation and coproduction, where Chatham House rules would make further publication inappropriate.

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Author contributions

J.J.S. and A.W. both participated in the implementation of the research project and contributed to its scientific and organizational development (J.J.S. as consortium leader). J.J.S. and A.W. drafted the manuscript text and contributed to various rounds of editing. A.W. prepared the figures, and J.J.S. led the writing of the original project proposal.

Competing interests

The authors declare no competing interests. J.J.S. is a Guest Editor of *npj Climate Action* but was not involved in the journal's review of, or decisions related to, this manuscript.

Additional information

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