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ORIGINAL ARTICLE

Lessons learnt from 20 + years of research on multilevel governance of energy-efficient and zero-carbon buildings in the European Union

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Abstract At global scale, the building sector accounts for 40% of total energy end use and almost 35% of greenhouse gas emissions. This makes it one of the most important sectors to focus on for reaching the 1.5–2 °C target of the Paris Agreement, to enhance energy security of supply and to alleviate energy poverty. The European Union (EU) is often seen as a leader in climate governance, which is also true for energy efficiency. The improvement of energy performance of buildings has been part of EU public policy for more than 50 years, making the EU a pioneer in the policy domain. Based on a semi-structured review of the scientific literature ($N = 90$), this paper is aimed at drawing the lessons from research on governance of energy-efficient and zero-carbon buildings in the EU. As for the findings, there is a multitude of policy instruments developed on different levels of governance, more or less integrated and managed by different actors and no single instrument is sufficient to stimulate energy-efficient and zero-carbon buildings. Five key challenges are identified in the governance literature examining the transition towards energy efficiency and zero-carbon buildings. An ambiguous leadership, heterogeneity of implementation, lack of incentives, limitations of non-regulatory policies and market-based instruments, and limited diffusion between governance levels. We also conclude that most policy instruments focus on new buildings which is problematic since the greatest challenge in the transition is the renovation of the large existing building stock.

Keywords Buildings · Energy efficiency · Governance · Multilevel governance · Policy instruments · Zero-carbon

Abbreviations

BREEAM	Building Research Establishment Environmental Assessment Method
CES	Coalition for Energy Savings
EC	European Commission
ECF	European Climate Foundation
EE1	Energy efficiency first principle
EED	Energy Efficiency Directive
EEOS	Energy efficiency obligation scheme
EGD	European Green Deal
EP	European Parliament
EPBD	EU directive on energy performance of buildings
EPC	Energy performance certificate
ERDF	European Regional Development Fund

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ESCO	Energy Service Company
ESIF	European Union Structural Funds
EU	European Union
EU-ASE	European Alliance for Saving Energy
GHG	Greenhouse gas
IEA	International Energy Agency
IGO	Intergovernmental Organisation
IPCC	United Nation's Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ISO	International Standards Organisation
LEED	Leadership in Energy and Environmental Design
MLG	Multilevel governance
MS	Member state
NGO	Non-Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
PPP	Public-private partnerships
RAP	Regulatory Assistance Project
REEEP	Renewable Energy and Energy Efficiency Partnership
SAVE	EU directive to limit carbon dioxide emissions by improving energy efficiency
TEU	Treaty of the European Union
TFEU	Treaty of the Functioning of the European Union
TJ	Terajoule
UK	United Kingdom of Great Britain and Northern Ireland
UNFCCC	United Nation's Framework Convention on Climate Change

Introduction

As the temperature rises on a global scale so does the need to promote a global transition towards sustainability and climate neutrality (IPCC, 2023). The International Energy Agency (IEA, 2021) estimates that the building sector accounts for 40% of total energy end use and 35% of greenhouse gas (GHG) emissions at a global scale. At the European Union (EU) level, the European Commission (EC, 2021) estimates that 40% of final energy is used in buildings and the sector accounts for 36% of GHG emissions. This makes the building sector one of the most important sectors for reaching the 1.5–2 °C target of the Paris Agreement. We can see a growing interest in the role of governance and policy to support both corporations and consumers to take the necessary steps towards sustainable innovations, where energy-efficient and zero-carbon buildings are an important aspect of a green transition.

The Paris Agreement on climate change mitigation and the Russian invasion of Ukraine have once again put the spotlight of EU energy and climate policy on energy efficiency measures (Kuzemko et al., 2023; Schwerdtle et al., 2023). The ambition is to save energy, reduce GHG emissions, limit import dependency and enhance energy security of supply, lower energy bills for households and companies and alleviate energy poverty (EU, 2023; von Malmborg et al., 2023). The IEA, in its World Energy Outlook 2023 (IEA, 2023), mentions energy efficiency as one of four key measures that can help close the gap between today's pledges and a 1.5 °C trajectory over the next 10 years—and to underpin further emission reductions post-2030. In addition, energy efficiency is seen as the 'first fuel' in the clean energy transition, leading to multiple benefits (Fawcett & Killip, 2019; IEA, 2019).

Improving the energy and climate performance of buildings is important if we are to decarbonise our societies by 2050. Energy efficiency of buildings has been an issue on the EU policy agenda for more than 50 years (Economidou et al., 2020; von Malmborg et al., 2023), and EU policies have expanded in scope and size over time as the EU has become more ambitious. The Energy Performance of Buildings Directive (EPBD) was first adopted in 2002 (EU, 2002) and the Efficiency Directive (EED) was adopted in 2012 (EU, 2012a). EPBD was recast in 2010 (EU, 2010). Both directives were amended in 2018 (EU, 2018a, b). EED was recast in 2023 (EU, 2023) and EPBD is currently being revised again (EC, 2021), with the recast EPBD calling for zero-emission buildings by 2030 and the EED setting up the exemplary role of the public sector by requiring renovation of 3% of the total floor area of public buildings yearly to meet the standards set in the EPBD (EC, 2021). The recast EED does also make the 'energy efficiency first principle' (EE1) binding, for actors to consider energy efficiency the first option in policy, planning and investment decisions across all sectors that affect the energy system (von Malmborg, 2023a, 2023b). This implies buildings too. The recast of these directives

is part of a substantial adaptation of the EU legislation to make the EU legislation 'Fit for 55',[1]named after EU's new GHG target. In June 2021, the co-legislators of the EU adopted a new European climate law, which states that the EU GHG emissions shall be reduced by 55% by 2030 and that the EU, by 2050, will be the world's first climate-neutral continent (EU, 2021). This is in turn part of the European Green Deal (EGD) (EC, 2019) that has also led to including buildings in the EU emission trading scheme. The expansion of the efforts to assist the transition towards energy-efficient and zero-carbon buildings in combination with the national energy saving obligations set up in the EED (EU, 2023) prompts us to examine the challenges identified in previous governance research regarding energy-efficient and low-carbon buildings. A large fraction of mainstream discourse on climate change mitigation and sustainable transformation have been dealing with the role of policy to enforce global, national and local regulations and legislations vis-à-vis creating the right incentives for corporations and consumers to make a sustainable transformation (Nordensvärd & Urban, 2023). There is a growing body of research that explore the 'role of governance, policy, innovation pathways and strategic management' (Matos et al., 2022, p. 4). Other research focuses on what will be 'informing policy, how policies should be developed and how transition management processes can be improved' (Matos et al., 2022, p. 4). Some research investigates how well-designed policies include coordination among consistent carbon pricing, performance-based regulations and public funding (Veugelers, 2012).

Kriegler et al. (2015) examine the effect of frontrunner coalitions, such as the EU, China and follower countries, has on the climate mitigation policy landscape. They found that early action in China had a positive impact on emissions but follower countries' technology responses to frontrunner tend to be limited (Kriegler et al., 2015). Thus, there is a need for dedicated policy instruments for innovation diffusion. Within a 2016 special issue of *Building Research & Information*, Visscher et al., (2016a, 2016b) argue that the current approach to regulatory codes in the built environment largely originates from the past and building regulations have been slow to engage with mitigating climate change and their design may not be suited to the nature of the challenges we are faced with. Buildings are not like any other consumable since it is where people live and work. Buildings are in extension so deeply integrated with the individual. Additionally, 85% of the current building stock in the EU will also be part of the building stock in 2050 (European Environment Agency, EEA, 2023), which is when the EU have decided to be a climate-neutral continent (EU, 2021). Buildings are central in the decarbonisation process of the EU, but the European Commission (EC, 2022) asserts that current efforts and trends are not enough to achieve carbon neutrality by 2050.

We argue therefore that there is a need for an overview of scientific research on the governance and policies attempting to regulate and promote energy-efficient and zero-carbon buildings in the EU—both new buildings and the renovation of existing buildings. The value of studying governance and connected policies is to create better understanding of potential policy pathways to reduce the building sector's climate footprint, offering new perspectives and pointing to areas for further research considering all components and their interactions and interdependence.

This article aims to explore and analyse the scientific literature on multilevel governance in the EU related to energy-efficient and zero-carbon buildings and how the EU is responding to the heterogenous challenges of multitiered governance arrangements related to the clean energy transition and decarbonisation of the building sector. By identifying the challenges of governing the transition, our conclusions can assist EU and its member states (MSs) as well as other international organisations in achieving their policy goals. The EU has often been highlighted as a frontrunner and a role model when it comes to environmental policy and climate governance (Jänicke & Wurzel, 2019). Therefore, the EU could be seen as a case of both an international organisation and a regional intergovernmental system of co-operation that tries to meet complex and interlinked issues of energy use, resource management and environmental demands.

There has been a rising literature on EU as a leader in the different aspects of climate change mitigation without being a traditional nation state. Hayward (2008) argued that we must see the EU as a leaderless

[1] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en (Last accessed 2 October 2023).

Europe but at the same time it is often praised for its exemplary global climate leadership (Schreurs & Tiberghien, 2007; Oberthür & Kelly, 2008; Oberthür & Pallemaerts, 2010; Jordan et al., 2012; Rayner & Jordan, 2013; Wurzel et al., 2017; Oberthür & Groen, 2018; Delreux & Ohler, 2019; Rayner et al., 2023). Jänicke and Wurzel (2019, p. 24) argue that 'merely focusing on top-level governance decisions and legally binding laws, which have a direct effect on MSs, cannot explain sufficiently climate governance innovations within the EU's multilevel climate governance system'. They argue that one needs to look at how indirect effects might play a role 'to explain why the EU's overall climate governance performance is often better than what the top level of the EU climate governance system has decided' (Jänicke & Wurzel, 2019, p. 24).

Policymakers have focused on creating different frameworks within the EU multilevel governance (MLG) to handle environmental policy and to promote interactive learning at different levels (Bulkeley & Betsill, 2005; Kern, 2019). This often highlights the new challenges to govern climate change mitigation where 'MLG accounts for the increasingly interdependent and nested nature of climate policymaking across levels of governance' (Kreienkamp et al., 2022, p. 732). The complexity of understanding the EU and MLG comes down to the fact that the EU itself is an actor within the MLG system (see 'Multilevel governance in the European Union'). This means that there is a high level of interconnectedness between international, EU, national and sub-national levels. The EU could be seen as a good example of 'how actor coalitions may engage in vertical and horizontal upscaling or "multilevel reinforcement" of best practices, taking advantage of efficiency gains through coordination and functional differentiation' (Kreienkamp et al., 2022, p. 734). Policy making can flow 'upward, downward and sideways' across different territorial jurisdictions and types of actors (Hooghe & Marks, 2003, p. 233). However, there is a need to study the challenges and pitfalls that come with EU's uniquely advanced governance structures and how the EU as a leader can create opportunities for vertical and horizontal scaling and combat possible policy stagnation and paralysis (Schreurs & Tiberghien, 2007).

One particular challenge when it comes to policy and governance of energy-efficient and low-carbon buildings is the diversity of buildings and ownership/tenant structures (Meijer et al., 2010; Thonipara et al., 2019). There is a present building stock that needs to be renovated, while at the same time new buildings are built. In addition, there is a substantial difference between residential and non-residential buildings, with different ownership, landlord and tenant structures. Commercial buildings have other driving forces for going green than residential buildings. Tenants of commercial buildings may, if they have an environmental certification, choose only buildings that meet a certain standard. In all, this requires different approaches to governance as well as policy instruments.

Considering the EU leadership ambition with this policy change, governance of energy-efficient and zero-carbon buildings is used as a case to shine light on the challenges of the governance system in the EU. This article, which is based on a semi-structured literature review, identifies the current challenges of governing the transition towards energy-efficient and zero-carbon buildings on all levels of governance. Policy instruments are the tools used for governing the transition which makes them central when identifying the challenges. The goal is to increase our understanding of modes of governance, the policy instruments used on different levels and the challenges identified. This knowledge can be informative for policymakers and other actors active in the EU governance system when developing new policy instruments and modes of governance. The overarching research question in this paper is the following: What lessons can be learnt from the challenges present in multilevel governance of energy-efficient and zero-carbon buildings in the EU?

As for the findings, there is a multitude of policy instruments developed on different levels of governance, managed by different actors and no single instrument is sufficient to stimulate energy-efficient and zero-carbon buildings. Five key challenges are identified in the governance literature examining the transition towards energy-efficient and zero-carbon buildings: (i) ambiguous leadership, (ii) heterogeneity of implementation, (iii) lack of incentives, (iv) limitations of non-regulatory policies and market-based instruments, and (v) limited diffusion between governance levels. We also conclude that most policy instruments focus on new buildings which is problematic since the greatest task in the

transition is the renovation of the large existing building stock.

The remainder of the paper is structured as follows. The next section discusses MLG and polycentric governances as theoretical concepts for structuring the use of policy in a multilevel system. 'Method and material' gives a short note on method and material. 'Results and discussion' present the results of the review of governance research, focusing on the challenges to governing the transition identified in the literature. Finally, 'Conclusion and further research' draws conclusions and presents implications for further research as well as for the actors active in the governance of energy-efficient and zero-carbon buildings—particularly in the EU.

Governance of energy efficiency of buildings—notes on theory

To understand how energy efficiency of buildings is governed, there are several concepts that need to be considered: the actors involved, the instruments used and to what extent they are successful. One key aspect of the concept of governance is the involvement of non-state actors in the decision-making process. As we will see when presenting the results, the policy instruments used are sometimes created completely or in part by private organisations. The natural theoretical perspective to use when analysing the governance in the EU and its MSs is multilevel governance (MLG), which can be defined as systems of 'continuous negotiation among nested governments at several territorial tiers' (Marks, 1993, p. 392), where authority is not only dispersed vertically between levels of administration but also horizontally across different sectors of interest and spheres of influence, including non-government actors, markets and civil society (Bache & Flinders, 2004).

Multilevel governance

The theory originates from a critique of the dichotomy of domestic and international politics and was developed to simplify the complexity of EU policymaking. The theoretical concept has stimulated wide research on for example Europeanisation and the implementation of policy (Stephenson, 2013). Originally it was used to analyse and describe the governance structure of the EU structural policy, emphasising the parallel processes of decentralisation and Europeanisation (Hooghe & Marks, 2001; Marks, 1993), but has developed into a more general concept that has been applied in different context. For instance, it has been used as an approach to understand the dynamic interrelationship within and between different levels of governance and government (Bache & Flinders, 2004; Bache et al., 2016; Hooghe et al., 2010). In addition, institutional arrangements play an increasingly important role in addressing societal challenges. This is important for the debate on MLG as these non-state actors do not necessarily align with the jurisdictional boundaries of the state's administrative structure (Hooghe & Marks, 2003). The involvement of such non-state actors, e.g. the involvement of EU NGOs and other interest groups such as Regulatory Assistance Project (RAP), European Climate Foundation (ECF), Coalition for Energy Savings (CES) and the European Alliance for Saving Energy (EU-ASE) in the policy debate on EE1 (von Malmborg, 2023c), and European Community Shipowners Association, eFuel Alliance and Transport & Environment, as well as international interest groups such as World Shipping Council, International Chamber of Shipping, Environmental Defense Fund, Clean Air Task Force and the Getting to Zero Coalition in the policy debate on EU legislation for decarbonising maritime shipping (von Malmborg, 2023c), has always been a central part of the concept of MLG. However, limited attention has been given to understanding actor complexity within the EU, something Stephenson (2013) in his review suggest should be tackled with more efforts aimed at understanding its pluralistic nature of EU policymaking.

Even though MLG seems like the natural theoretical framework for this overview, there are other theoretical frameworks to consider. Promising areas of inquiry for other conceptions of governance are polycentrism (Ostrom, 2009, 2012), implying that the sharing of power between numerous scales of governance must be seamlessly interwoven through hybrid forms of energy governance and partnerships between different types of actors. While MLG was born out of a critique of the dichotomy of domestic and international politics, polycentric governance is aimed at bridging the gap between market solutions and government regulation when governing the use of common pool resources, suggesting that actors can

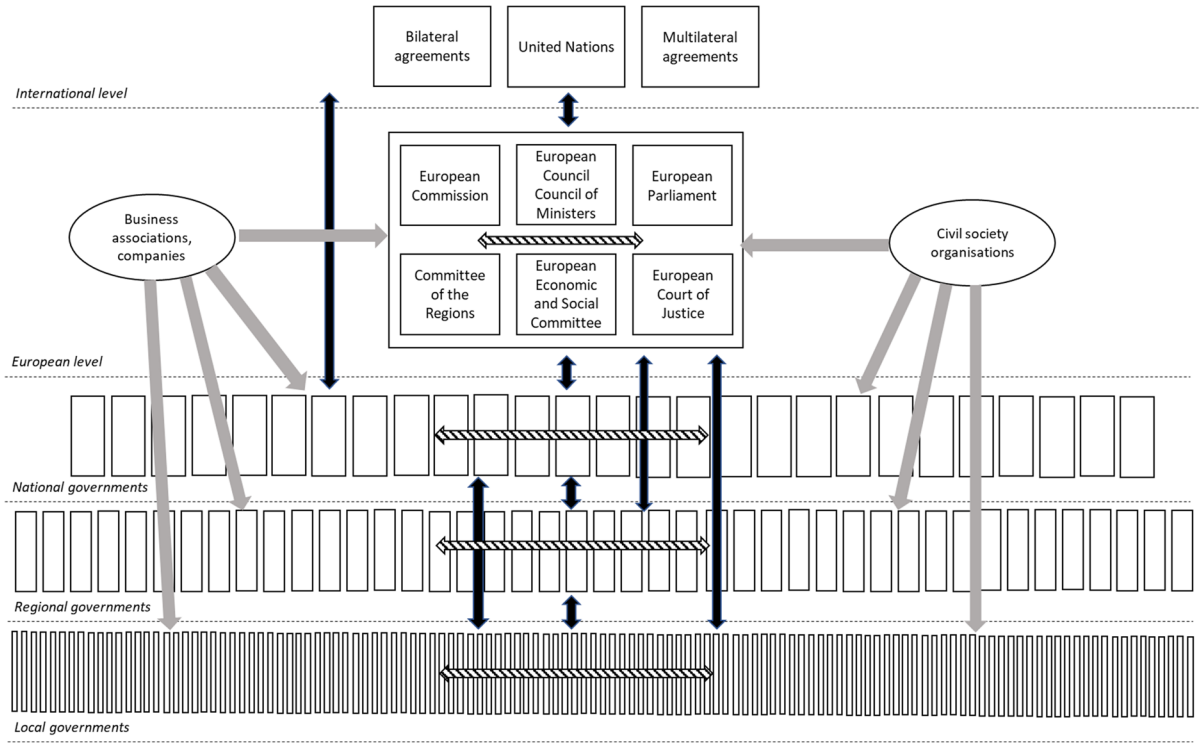

Fig. 1 Multiple layers in EU governance

govern through social interaction (Ostrom, 2010). It 'encourages experimental efforts at multiple levels' (Ostrom, 2009, p. 39) and challenges the notion that all climate policies need to be implemented at the global level. Both theoretical frameworks attribute importance to both private and public actors in governing policy issues. Type II governance as it is described by Hooghe and Marks (2003) is focusing on a vast number of task-specific jurisdictions similar to Ostroms' concept of polycentric governance. Depending on which aspect of energy efficiency one chose to focus on, both polycentric governance and MLG can be useful when considering the governance of the transition to energy-efficient and zero-emission buildings. The later has often been applied in the context of the EU politics, but it can also be applied in the global context through for example transnational public–private partnerships (PPPs) (Bensheim et al., 2010). PPPs are aimed at merging the market with the public sphere and can be found on all levels of governance (Bougrain, 2012; Hodge & Greve, 2016; von Malmborg, 2003). MLG is chosen as the main theoretical framework to analyse the policy instruments identified in previous research on the governance of energy-efficient and zero-carbon buildings.

Multilevel governance in the European Union

Governance and policymaking in the EU is a true case of MLG and is the setting in which the framework was developed. More than five supranational institutions, 27 national, 1200 regional, and almost 87,000 local governments (OECD, 2018) are linked in territorially overarching policy networks. To these, a fifth tier can be added, the international, as the EU is also a member of international environmental agreements such as the UN framework convention on climate change (UNFCCC), multilateral agreements such as the Clean Energy Ministerial (CEM), and several bilateral agreements with other states. These layers interact with each other in two ways: vertically across different levels of government and horizontally with other relevant actors within the same level. MLG in the EU consists of frequent and complex interactions between governmental actors and non-state actors such as business associations, companies and

civil society organisations and other interest groups, trying to influence EU policymaking (Fig. 1).

EU can be described as a mix of intergovernmental cooperation between sovereign MSs in the Council and the European Parliament (EP), codified through a succession of major treaties (Tosun & Graziano, 2022). Treaties are the primary legal basis, complemented by legislative instruments such as directives, regulations, decisions, recommendations and opinions, constituting the means through which the principles of EU integration stipulated in the treaties are applied, disputed and enforced.

According to the treaties, MLG in the EU shall respect competences, share responsibilities and cooperate between the various governance levels. Reference is made to the *subsidiarity principle*, enshrined in Article 5(3) of the Treaty of European Union (TEU) (EU, 2012b), aiming to guarantee a degree of independence for a lower authority in relation to a higher body or for a local authority in relation to central government. It therefore places decisions as close as possible to the citizens and ensures that that action at Union level is justified in light of the possibilities available at national, regional or local level.

However, there is a constant debate on subsidiarity and the need for collective action on the EU level. In the case of energy efficiency, MSs often contest EU policy, based on either sovereignty (subsidiarity claims) or substance (Herranz-Surralés, 2019; Wettestad et al., 2012). MSs usually want room for manoeuvring, flexibility, related to national circumstances. As for energy policy, EU does not hold exclusive competence (Dupont, 2020). While MSs keep significant sovereignty on energy policy, the EC has achieved since 2006 increasing competencies in the internal dimensions of EU energy policy (Herranz-Surralés & Solorio, 2022; Maltby, 2013), which since 2007 is based on Article 194 of the Treaty on the Functioning of the European Union (TFEU) (EU, 2012b). EU climate policy is based on Articles 191–193 of TFEU.

The decision-making in the EU follows what is called the'ordinary legislative procedure' (Roederer-Rynning, 2019). In the system, the directly elected EP must approve EU legislation together with the Council of Ministers (i.e. the governments of the 27 EU MSs) in an act of co-decision. The procedure starts with a legislative proposal from the European Commission (EC), who has monopoly, a right of initiative, to put forward legislative proposals in the EU. A call for new or amended legislation can also come from the Council (through Council conclusions) and the EP (through resolutions), requesting the EC to put forward legislation. Based on input from public consultation and the findings within the impact assessment, the EC formulates a proposal and addresses it to the EP and the Council simultaneously, which can adopt, reject or amend the proposition. The proposal is also sent to the European Economic and Social Committee and the Committee of the Regions, who can respond to the proposal but do not have a formal role in the decision-making process. For the Council to take a decision on legislation, qualified majority (> 65% of the votes) is needed. A group of MSs counting > 35% of the votes can block a decision, hence a 'blocking minority'. Agreements between the co-legislators are usually reached through tripartite interinstitutional negotiations (so-called trilogues) between the EP, Council and the EC. Once the text is agreed upon, the two co-legislators adopt legislation jointly, having equal rights and obligations. EU MSs are part of the process within the country but also must adapt their national governance strategies to the decision made on the European level.

As for governance of energy and climate, the EU adopted in 2018 a regulation on the governance of the Energy Union and climate action (Governance Regulation) (EU, 2018c). By setting common rules for MSs' planning, reporting and monitoring of energy and climate policies, it intends to help reach the EU climate and energy targets. Under the Governance Regulation, EU MSs develop integrated national energy and climate plans, covering the current state and progress made on the five dimensions of the Energy Union:

Decarbonisation (greenhouse gas reduction and renewables)
Energy security
Energy efficiency
Internal energy market
Research, innovation, and competitiveness

MSs are also required to develop national long-term strategies and ensure consistency between these strategies and their national energy and climate plans. Based on MSs' plans and strategies, the EC monitors the progress of the EU as a whole.

According to MLG theory, private actors are important in governance of different issues, including energy-efficient and zero-carbon buildings, both as advocates of different problem framing and public policy proposals and for providing policy and management instruments themselves, e.g. voluntary labelling schemes. Thus, both public policy and private initiatives will be within the scope of this study.

Method and material

To analyse the lessons learned from the scientific governance literature on energy-efficient and zero-carbon buildings in the EU, published in international scientific press, we have undertaken a narrative literature review, drawing on insights from a variety of perspectives and disciplines (cf. Sovacool et al., 2018). The focus on Europe, the EU and its MSs (including the United Kingdom (UK)), is derived from the shared competence in the policy area of energy and climate and the focus on subsidiarity and proportionality in the discussion around policy initiated by the European Commission. As mentioned in 'Introduction', the EU has also been very clear in its ambition to be a global leader when it comes to climate and energy and have made recent policy changes in accordance with this ambition. We acknowledge that there is a large grey literature that analyses the impact of policy instruments which could be informative; however, this lies outside the scope of this article and could be a study of its own. EU documents are used when referring to specific instruments and developments that relate to the points made in the literature.

A semi-systematic approach was taken when collecting the material, following the steps shown in Fig. 2 (cf. Snyder, 2019). We used a variety of search terms considering literature in English from 2000 and onwards. Academic literature in Web of Science, Scopus and Google Scholar was considered using multiple combinations of keywords focusing on *building, carbon, efficien*, energy*, *governance, policy* and *renovation*. The following keywords were used in our primary search, which was conducted in January 2023 and updated in September 2023:

governance + energy + efficien* + building
governance + low-energy + building
governance + zero-energy + building
governance + low-carbon + building
governance + zero-carbon + building
policy + energy + efficien* + building
policy + low-energy + building
policy + zero-energy + building
policy + low-carbon + building
policy + zero-carbon + building
governance + energy + efficien* + renovation
governance + low-energy + renovation
governance + zero-energy + renovation
governance + low-carbon + renovation
governance + zero-carbon + renovation
policy + energy + efficien* + renovation
policy + low-energy + renovation
policy + zero-energy + renovation
policy + low-carbon + renovation
policy + zero-carbon + renovation

In addition, we used cascading, looking at references in papers we found in our search using keywords. More than 1000 articles, books and book chapters were found from all over the world, out of which about 250 were selected for further analysis after sorting out literature that does not focus on governance in the EU. The UK is included, since it was part of the EU until January 2020. Several of the articles excluded focused on the US or Chinese contexts (e.g. Bedsworth & Hanak, 2013; Liu et al., 2019) and described and evaluated local building initiative in different parts of the US and China, applying the governance perspective. These articles might be interesting to analyse in a separate review, but the context differs significantly from that of the EU, which is why they are excluded from this review. In all, 90 articles, books and book chapters were ultimately found relevant to our study. Saturation was met when no further themes could be identified, meaning that including more articles would not further the understanding of governance for energy-efficient and zero-carbon buildings in the EU. The relevance of research forwarded by literature was determined by scanning abstracts and introductory texts, repeating each literature search with an alteration of search terms to fill knowledge gaps (see iterative loop in Fig. 2). We qualitatively assessed the literature's relevance for governance related to energy-efficient and zero-carbon buildings in Europe. We sought to promote introspection and reflexivity throughout the research process, helping us avoid overconfidence on the labels in

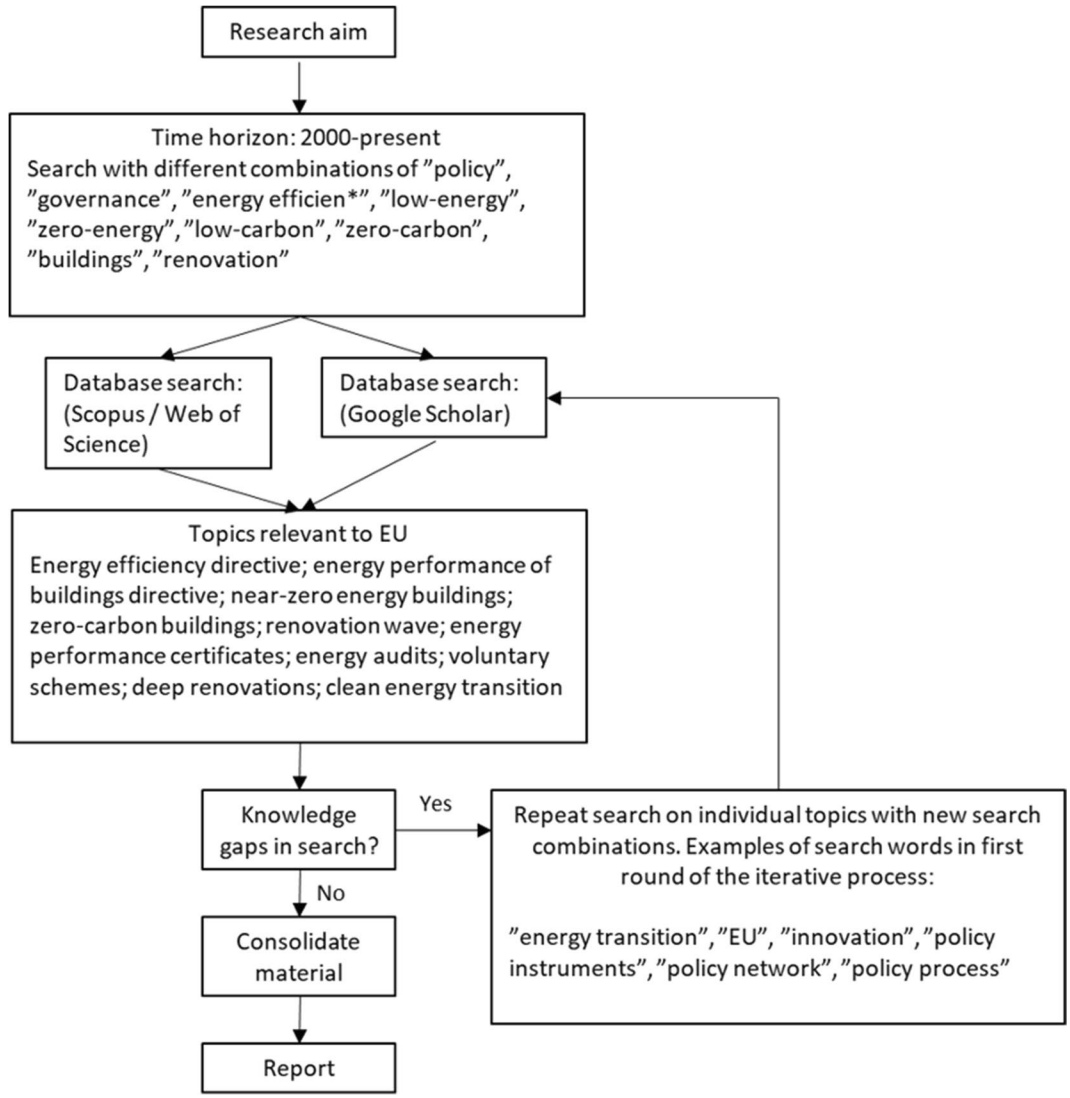

Fig. 2 Steps of semi-systematic literature review

the keywords, titles and abstracts of publications and consider ambiguities and conflicting perspectives in review findings that crosscut social and technical sciences (Alvesson & Sandberg, 2020; Tracy, 2010).

Results and discussion

Gupta and Ivanova (2009) argue that energy efficiency governance is a critical, non-controversial, and desirable priority issue for governance on all levels, including intergovernmental organisations, as it can simultaneously address four energy challenges: (i) energy and security, (ii) energy and development, (iii) energy and environment, (iv) and energy poverty (cf. IEA, 2019). The EU MLG system is made up of several interconnected levels ranging from global energy and climate governance through global private–public partnerships to the individual building level with standards developed within the industry and green leases agreed upon between property owners and tenants as well as other market solutions.

Jänicke and Quitzow (2017), Prontera and Quitzow (2021) and Jänicke and Wurzel (2019) argue

that EU has a relatively successful performance in climate and energy governance. Since the mid-1980s, the EU has developed a multilevel climate governance system that has facilitated leadership and lesson-drawing at all governance levels including the national, regional and local level. This is explained by two factors (Jänicke & Quitzow, 2017): (i) multilevel reinforcement and (ii) the mobilisation of economic interests at different levels of governance through low-carbon industrial policy. Taking a more critical view on EU governance of energy-efficient and zero-carbon buildings, Visscher et al. (2016a) argue that the effectiveness of current governance instruments, such as EPBD and EED, has had limited impact on actual GHG reductions and does not ensure actual energy performance to be achieved. Even though the EU might have been successful in constructing a cohesive governance system, the effectiveness of that system is more unclear. Visscher et al. (2016a) claim that to realise the very ambitious energy-saving goals of the EU, a radical rethink of regulatory systems and instruments is necessary. Energy performance of buildings and the behaviour of the occupants are not well understood by policymakers. New forms of governance are needed that have more impact on the actual outcomes. What those forms could look like is unclear and the problem of designing effective policy instruments might be more wicked than previously imagined, something that is highlighted when taking stock of the previous governance literature on energy efficiency of buildings. A governance system should be considered successful based on its ability to provide better outcomes, in this case higher energy efficiency and lower GHG emissions, especially considering the clear ambitions and goals adopted on the EU level. The policy instruments governing the energy-efficient and zero-carbon buildings are inherently interconnected which is why the findings are presented according to the governance challenges identified.

Going through the literature, the following five challenges relating to MLG are identified and will be presented below: (i) ambiguous leadership, (ii) heterogeneity of implementation, (iii) lack of incentives, (iv) limitations of non-regulatory policies and market-based initiative, and (v) limited diffusion between governance levels.

Ambiguous leadership

Even though the EU often is seen as the polity of analysis, it is an actor in global governance on energy efficiency, e.g. as a member of CEM,[2] the Renewable Energy and Energy Efficiency Partnership (REEEP[3]), and as the initiator of the Covenant of Mayors that in 2017 became the Global Covenant of Mayors by merging with the Compact of Mayors (EC, 2016).

There is limited research on the governance of energy efficiency of buildings on the global level. The fuzziness of the governance at this level, outlined below, is clearly problematic, especially when compared to the outspoken leadership role the EU takes on. Despite the leadership ambitions of the EU, the impact will always be limited. The international agreements that have been made only set targets and do not contain the concrete policies needed for a transition towards zero-emissions buildings.

Florini and Sovacool (2009) analyse some of the existing institutions in place to establish and carry out rules and norms governing global energy problems and describe the range of institutional design options available to policymakers. These include intergovernmental organisations (IGOs), summit processes, international non-governmental organisations (NGOs), multilateral financial institutions, regional organisations that involve two or more countries as members and hybrid entities. They conclude that current institutions have failed to develop the necessary regulations and to channel the necessary resources to deal with the global challenges of energy issues; in addition, several of the institutions have limited membership and focus on only a few energy issues (Florini & Sovacool, 2009).

On the other hand, the prevalence of global or multilateral public–private partnerships, like REEEP, in which the EU through the European Commission is a member, suggests that they may be successful where other governance structures fail (Sovacool & Florini, 2012). REEEP exemplifies a hybridised entity increasingly common on the global governance scene (Parthan et al., 2010). Unlike organisations

[2] https://www.cleanenergyministerial.org/ (Last accessed 2 October 2023).
[3] https://www.reeep.org/about-reeep (Last accessed 2 October 2023).

such as the IEA[4] and the International Renewable Energy Agency (IRENA),[5] REEEP is funded primarily by voluntary contributions and/or does not have restricted membership. Given their ability to attract private capital investment, increase efficient use of resources and maximise budgetary assets, global partnerships like REEEP have the potential to address various energy efficiency challenges and insecurities.

The global perspective of energy governance is also discussed by Karlsson-Vinkhuyzen et al. (2012), who believe that the view of a sustainable energy system as a global public utility can be used as an approach to reduce a widespread aversion to 'global energy governance', including global governance for energy efficiency of buildings. In particular, they stress the important roles of the International Standards Organisation (ISO) and International Electro-Technical Commission, the former of which having tens of technical committees on energy efficiency and more than 100 standards on energy efficiency of products, buildings, processes and organisations. ISO 13790:2008 relates specifically to energy performance of residential and non-residential buildings.

Since there is no global government, the policy instruments established globally are voluntary and although these global private–public partnerships have some advantages, Florini and Sovacool (2009) argue that it is unlikely that a comprehensive IGO will bring together the key players in the field of energy (efficiency of buildings) in order to harmonise their energy policies for the common good. It is unlikely that an overarching World Energy Organization with all-encompassing membership ever will be developed. Florini and Sovacool (2009) and Sovacool and Florini (2012) argue that, in the field of energy (efficiency), we will rather continue to see a set of different actors who widely claim to have legitimate power to issue rules for different parts of the energy policy area, often in conflict with each other and in a contradictory way.

Besides initiating the Covenant of Mayors, the EU through the EC has shown little interest in shaping a global institution focusing on policy and governance for energy-efficient and zero-carbon buildings. It is a member of REEEP, CEM and IEA. REEEP has little effect on energy efficiency policy and governance in the EU. More important is the IEA,[6] which has developed into a global policy advisor on energy, including energy efficiency. From exclusively addressing its MSs, IEA have devoted time for outreach to non-members. It coined the concepts of energy efficiency as the 'first fuel' and the 'multiple benefits' of energy efficiency, which have been integrated as key concepts in EU policy on energy efficiency (of buildings) (von Malmborg et al., 2023; von Malmborg, 2023a). IEA provides guidance on policies for energy efficiency of buildings and evaluates the policies of its members to stimulate policy learning.

While leadership in global energy efficiency governance is ambiguous, global climate governance has a clear influence on EU policy for energy-efficient and zero-carbon buildings. The first EU directive on energy-efficient buildings was the 1993 SAVE directive, requiring MS to establish programmes to reduce carbon dioxide emissions through improvements of energy efficiency in buildings. SAVE was a response to the adoption of UNFCCC in 1992 (Oberthür & Paellemaerts, 2010; Wettestad, 2000). Climate change mitigation and developments in global climate governance have framed EU policy on energy-efficient buildings since then (Economidou et al., 2020; von Malmborg et al., 2023). The adoption of the Paris Agreement in 2015 made the EC present the EGD in 2019 (EC, 2019), followed by the adoption of the European Climate Law in 2021 (EU, 2021). The climate law requires that EU GHG emissions are reduced with 55% by 2030 and that the EU is climate neutral by 2050. To meet these targets, the EC presented the Fit for 55 climate package in July 2021. The package included recasts of the EED and the EPBD. The revised EED was adopted in July 2023 (EU, 2023), and the revised EPBD (EC, 2021) is currently (October 2023) in the stage of trilogue negotiations.

EU has long since played a leading role in global climate governance, leading by example and calling for ambitious temperature and GHG reduction targets on global level (Delreux & Ohler, 2019). However, policies and measures on how to reduce GHG emissions, e.g. through improved energy efficiency

[4] https://www.iea.org/areas-of-work/technology-collaboration/buildings (Last accessed 2 October 2023).
[5] https://irena.org/ (Last accessed 2 October 2023).
[6] https://www.iea.org (Last accessed 2 October 2023).

in different sectors is not discussed in the UN climate change negotiations. These are mainly discussed at national and supranational levels. On this tack, the EU might be seen as a 'policy leader', leading by example through pushing forward stronger and stronger regulations on energy efficiency of buildings, but it has limited ability to lead the process globally. It will have to handle US, China's and other countries stances without any real authority and to a large extent lacking the means to be more coercive on a global scale. Will the MSs be as progressive as the Commission wants if other countries outside the EU do not follow suit? We can see that the ambition level in Europe is comparatively high, so are the results achieved but it still cannot live up to the challenges of climate change. Some scholars conclude that the current approach to regulatory codes in the built environment is a failure to anticipate and plan for the current challenges of climate change mitigation (Visscher et al., 2016a). Since there is no global government the informal leadership role of the EU is important, but one needs to recognise its limitations and realise that the position will be costly for the MSs, a cost not all are willing to pay.

Finally, on internal leadership in the EU as a 'policy leader' on energy-efficient and zero-carbon buildings, the EC is considered a so-called 'policy entrepreneur' (Maltby, 2013; Bürgin, 2023). This is due to its monopolistic right to put forward EU legislation (Herweg & Zohlnhöfer, 2022). Policy entrepreneurs 'reveal themselves through their attempts to transform policy ideas into policy innovations and, hence, disrupt status quo policy arrangements' (Petridou & Mintrom, 2021, p. 945). They work at problem framing, developing policy proposals, team building, networking, leading by example, and exploring ways to scale up change processes (Mintrom, 2019). The EC converts issues to narratives on problems to be solved and proposes possible solutions. It then links problems to policy options and the politics. This linking provides the basis for policy change. However, other policy actors are regularly trying to influence the EC problem framing and policy options, either as lobbyists or policy entrepreneurs. In addition, the Council and the EP can request the EC to put forward legislation. Interest groups are also trying to influence the positions of MSs in the Council and MEPs (including the rapporteur). Some aim for stronger policies than the EC, some for weaker. Policy entrepreneurs differ from lobbyists in that they try to influence policy in a more activist way in a certain area where they have expertise. Policy entrepreneurship is 'a proactive and sustained effort, starting from a concrete policy proposal or at least a general idea, to promote policy change' (Becker, 2023, p. 2). A policy entrepreneur is more involved in the technical and legal aspects of the solutions to a problem. On energy efficiency in general and energy-efficient buildings in particular, formal coalitions such as CES and EU-ASE, assembling thousands of companies, business associations and municipalities, are usually acting as policy entrepreneurs advocating strong policies (von Malmborg, 2023a, 2023b). The recent policy change making EE1 a binding principle, with implications for large building projects, was heavily influenced by the policy entrepreneurial agency of the Brussel based think tank RAP and environmental NGO ECF (von Malmborg, 2023b).

Heterogeneity of implementation

Current EU legislation on energy-efficient and zero-carbon buildings is made in the context of the Paris Agreement and global energy and climate governance. Policies are mainly directed towards MSs, whose governments shall decide and implement national legislation directed towards citizens, business, and public organisations (bodies) on regional and local level. National governance systems differ between members in the EU. Consequently, the governance in the EU is diverse (Pereira & Da Silva, 2017; Rubino, 2017). For instance, MSs apply different thresholds for the energy performance certificates (EPCs) of buildings from A-G (Li et al., 2019). The co-existence of diverse energy models promoting different scales of reference and actors may result in 'scalar clashes' which, according to Palle and Richard (2022, p. 1), creates 'a chaotic status quo, disrupting the EU's transition towards clean energy sources'. Building a common EU energy policy that combines the dual objectives of transition and integration does not just require upscaling energy systems, but also setting the adequate policies at scale(s) to implement this transition (Palle & Richard, 2022).

The EU ambition to take leadership in the transition towards energy efficiency and EU policy on energy efficiency of buildings has been around since the early 1970s when the European Council adopted a

Table 1 Categorisation of policy instruments for energy-efficient buildings in the European Union. Modified from Economidou et al. (2020)

Type of policy instrument	Examples of policy instruments
Regulatory	Building codes; minimum energy performance standards for new and existing buildings (EPBD); energy efficiency standards for appliances and equipment (Ecodesign); energy efficiency first principle, (EED); energy saving obligations; refurbishment obligations; procurement regulations (EED); phase-out of inefficient equipment (Ecodesign); binding criteria for sustainable investment funding (EU Taxonomy regulation)
Financial and fiscal	Grants/subsidies; preferential loans; tax incentives; energy taxation (energy taxation directive); Horizon Europe; European Regional Development Fund (ERDF); EU Structural Funds (ESIF), Cohesion Fund (CF); InvestEU
Information and awareness	General information; information and awareness campaigns; information centres; energy audits, energy management systems (EED); energy labelling schemes, energy performance certificates (EPBD, energy labelling directive); individual metering and billing (EED); demonstration programmes; Covenant of Mayors
Qualification, training and quality assurance	Professional training; training courses; vocational education; quality standards
Market-based	Incentives facilitating third-party financing; energy service companies (ESCOs) (EED); energy efficiency obligation schemes (EEOS) (EED); incentives for producers of innovative technologies; technology deployment schemes; technology procurement
Voluntary action	Voluntary certification and labelling programmes (e.g. BREEAM, LEED); voluntary and negotiated agreements
Infrastructure investment	Investment in transportation infrastructure (e.g. railways, road networks); energy infrastructure (e.g. generation plants, power grids)
Research, development and innovation	Research and innovation programmes (e.g. Horizon Europe, LIFE Climate Change Mitigation and Adaptation); European Structural and Investment Funds (e.g. European Regional Development Fund (ERDF), EU Cohesion Fund)

resolution promoting energy savings in 1974 (Economidou et al., 2020; von Malmborg et al., 2023). Since then, a plethora of directives and other policies and measures to promote energy efficiency in buildings have been adopted in the EU. A comprehensive but not exhaustive overview of policy instruments for energy-efficient and zero-carbon buildings in the EU is presented in Table 1.

As of today, EU policy on energy-efficient and low-carbon buildings is mainly manifested through the EED and the EPBD (Economidou et al., 2020; Rubino, 2017; Visscher et al., 2016b; von Malmborg et al., 2023). These directives, amended in 2018, EED recently recast and EPBD currently being recast, include mandatory provisions on minimum energy performance requirements for new and existing buildings, EPCs (labelling), national renovation plans, requirements for renovation of buildings owned and occupied by central government, mandatory energy audits, and requirements for (individual) metering and billing in multifamily buildings and multipurpose buildings. In addition, national energy saving obligations, the energy efficiency first principle recently being made binding, the EU Taxonomy and different EU funds provide further incentives for improving energy efficiency and reducing climate footprints of buildings.

Several studies analyse how MSs implement EU legislation. Annunziata et al. (2013) provide an overview of the national regulatory frameworks focusing on three aspects: (i) integration of energy efficiency and renewable energy requirements, (ii) translation of investments in energy saving into economic value, (iii) commitment towards the target of 'nearly zero-energy' buildings. They find that EU MSs have adopted different approaches in the design of their national regulatory framework. This is confirmed by Pereira and Da Silva (2017) as well as Apergis and Garćia (2019). This heterogeneity consists of four main factors (Annunziata et al., 2013): (i) different authorities involved in energy regulations, (ii) traditional building regulations and enforcement models, (iii) different contextual characteristics, and (iv) maturity of the country in the implementation of

energy efficiency measures. Ringel (2017) shows that Germany has proclaimed energy efficiency to be the 'first imperative' but that a systematic monitoring system is required in combination with formal and informal policy coordination. Pereira and Da Silva (2017) have analysed the presence and composition of institutional structures, financial, and human resource capacity, and the political support for energy efficiency measures for each of the, at the time, 28 MSs. They confirmed the complexity of implementing energy efficiency measures and identified a need for MSs to develop institutional capacities related to the transposition of EU directives (cf. Cabeça et al., 2021). In parallel, the differences between individual MS governance capacities should be considered by the EU institutions, most notably the European Commission and the Parliament, when formulating and implementing future EU policies.

Confirming the heterogeneity of energy efficiency governance and policies in the EU MS, Kern et al. (2017) have analysed policy goals and instruments aimed at stimulating energy efficiency in buildings in Finland and the UK, when the UK was a member of the EU. They found that both countries have very complex policy mixes that have evolved over time, encompassing a variety of goals and instruments and make use of a range of different instrument types to encourage users to reduce their energy consumption. Their results support the suggestion by Howlett and Rayner (2013) that strategic patching of policy may be a more promising approach for policymakers than the creation of completely new policy packages. Policy patching can produce a coherent and consistent policy mix. However, this strategy could in turn lead to a complex system of rules making it difficult for actors to understand and implement policy, while also prolonging the transition. The challenge of finding the balance between effective and realistic policies is considerable, especially in the policy domain of buildings.

It is important to pay attention to the quality of work on construction site. Construction errors are responsible for most of poor energy performance of buildings in practice. Barbero et al. (2023) analysed the relationship between training of blue-collar workers and energy efficiency in the construction sector across EU MSs. They found (i) a lack of systematic process to codify the best practice into reusable knowledge, (ii) lack of industry-wide shared vision, (iii) differences in the nature of the training available in the energy efficiency domain, (iv) different levels of reliance on a trained and skilled workforce in energy efficiency, and (v) lack of efficiency of legislative frameworks, policies, and government incentives. Their research also identifies the need for adapted instruments to promote mutual recognition of energy skills and qualifications in the European construction sector.

A heterogeneity of implementation could lead to problems of reaching standards and policy goals. MLG could lead to strong aspirations but also make it difficult to reach the goals on the different levels. The difference in implementation highlighted by Annunziata et al. (2013) is closely connected to the problems of subsidiarity enshrined in the TEU (EU, 2012b) and scalar clashes brought up by Palle and Richard (2022). With reference to differing national circumstances, such as legislative and building traditions, climate conditions and the nature of the building stock, MSs are requiring flexibilities in implementation. The EU's legitimacy for increasing competencies and legislating standards is limited, leading the EU policymakers to rely more on soft methods. The difficulty of harmonising policy limits the effectiveness of governance, and the high ambition of the EU is very much dependent on the willingness of the MSs to be an active party of the transition. For a successful transition EU policymakers need to consider and account for differences between MSs and rethink the role of harmonisation and integration.

In mid-2010s, EC President Jean-Claude Juncker launched the 'Energy Union' in mid-2010s (EC, 2015). This was a major step to deepen EU cooperation in energy and climate policies. As part of the 'Clean Energy for All Europeans' legislative package from 2016, EU legislators adopted a regulation on the governance of the Energy Union and climate Action—the Governance Regulation (EU, 2018c). This requires MSs to report on a regular basis their energy and climate targets, policies to reach the targets, progress and explanation of any discrepancies. Although governments remain central to the process, 'they operate within a hybrid institutional framework combining supranational and intergovernmental elements, in which formal and informal authority distribution is unstable and contested' (Bocquillon & Maltby, 2020, p. 39).

Table 2 Overview of current financial instruments supporting energy renovations in the EU, classified according to market saturation and type. Modified from Bertoldi et al. (2021)

	Traditional and well established	Tested and growing	New and innovative
Non-repayable rewards	-Grants and subsidies -Tax incentives	-Energy efficiency obligations	-Energy efficiency feed-in tariffs
Debt financing	-Soft loans -Leasing	-Energy performance contracts -Energy service agreements -Revolving funds -Commercial loans	-Energy-efficient mortgages -Crowdfunding -Property assessment clean energy -On-bill finance
Equity financing	n/a	-Energy performance contracts -Energy service agreements	-Crowdfunding

Another observation made is that most of the policy instruments focus on new buildings, either residential or non-residential or both. It appears to be harder to govern the retrofitting of existing buildings (D'Agostino et al., 2017). The current renovation rate in EU is 1% on average, spanning from 0.1 to 1.8%,[7] and only 5% of the renovations meet the standards of deep renovation (Remeikienė et al., 2021), why EPBD sets a target to double the renovation rate. In 2020, the EC proposed a 'Renovation Wave' (EC, 2020) as part of the EGD (EC, 2019). Understanding the challenges of governing the transition and the limitations of the policy instruments in use should be informative for policymakers when they develop new policies in the field of energy efficiency of buildings. If the high ambitions set by the EU are to be realised these challenges need to be addressed, especially considering the limited progress made so far.

Lack of incentives

An important part of governing the transition is to increase the incentives to renovate the old building stock and build more energy-efficient and zero-carbon when building new. The incentives to renovate are especially important seeing that 85% of the buildings that exist today will be part of the building stock in 2050 (EEA, 2023). One central aspect is the financing possibilities available. Developers and property owners often find it difficult to obtain funds for the development or retrofitting of energy-efficient or low-carbon buildings (Bertoldi et al., 2021). Banks and other providers are hesitant that the additional costs will not be represented in these buildings' future market value and fear that lenders will not be able to pay back loans provided (Bertoldi et al., 2021). The limited research on the financial policy instruments focuses on different stages of market saturation (traditional, growing and new) as well as types (reward, debt financing, and equity financing) (Bertoldi et al., 2021) (Table 2).

There are frequent interactions between financial instruments and other EU policy instruments (Bertoldi et al., 2021). For instance, financial instruments are often linked with EPCs, where incentives are awarded to projects achieving a certain energy class. Financial instruments constitute an integrated part of any comprehensive energy efficiency policy framework due to their potential ability to incentivise stakeholders, balance risks, and provide direct support to investments that generate significant and long-lasting energy savings (Bertoldi et al., 2021). There are however significant challenges with financial policy instruments. For example, today's business models are in general based on cash flow from production, not reduced consumption. Similarly, building owners may be concerned that they will not own a building long enough for investments in energy efficiency and low-carbon buildings to be repaid before they possibly sell the building (Ohene et al., 2022). This problem should be less for residential buildings than for commercial buildings. There are various instruments for this, which are applied, i.e. in the EU, such as (i) revolving loan funds and (ii) climate bonds or related forms of tripartite financing. None of these financial instruments has yet shown satisfactory results indicating that the problem is more than a lack of financing options (Gouldson et al., 2015; Karakosta et al., 2021;

[7] https://energy.ec.europa.eu/system/files/2016-11/buildingrenovationrates_0.pdf (Last accessed 2 October 2023).

Li et al., 2023). In publicly owned buildings in Italian municipalities, short pay-back time and low budget solutions tend to prevail over long-term planning (Annunziata et al., 2014b). This further highlights the importance of creating a well-functioning system of funding.

As shown in Table 1, there are several EU funds that could help finance research and innovation as well as building and renovating energy-efficient and zero-carbon buildings, e.g. Horizon Europe, European Regional Development Fund (ERDF) and the EU Structural Funds (ESIF). ERDF and ESIF have been successfully applied for renovating and improving the energy performance of residential buildings in the Baltic states, with particular focus on low-income households (Blumberga et al., 2018).

In 2020, the EU adopted the EU Taxonomy regulation (EU, 2020) as a sustainable finance framework to help direct investments to the economic activities most needed for the transition in line with the EGD objectives. The taxonomy is a classification system that defines criteria for economic activities that are aligned with a net zero trajectory by 2050 and the broader environmental goals other than climate. It is used for evaluating projects and enterprises applying EU funding from, e.g. Invest EU. The Taxonomy for climate mitigation covers several sectors, including building renovations and new buildings. Within building renovations, any major renovation according to EPBD and any renovation that reduces energy consumption by at least 30% is eligible under the Taxonomy (Schütze & Stede, 2021). As for construction of new buildings, the annual primary energy demand must be 20% lower than the national 'nearly zero-energy buildings' standard to be eligible. A drawback with the Taxonomy, Schültze and Stede argues, is that it lacks a pathway towards climate neutrality by 2050 for renovation of buildings.

Energy audits and energy management systems are promoted as effective tools to drive investment in energy efficiency measures in the residential sector. They are mandated through the EED (von Malmborg & Strachan, 2023). All enterprises, including small and medium-sized enterprises that exceed 85 TJ of annual energy use, will have to implement an energy management system. Otherwise, companies will be subject to an energy audit if their annual use exceeds 10 TJ. However, when Murphy (2014) explored the role of audits on investment in energy efficiency measures by private owner-occupied householders in the Netherlands, a significant part of the recommendations that come with energy audits was ignored. One central reason for this was that households found their homes to be sufficiently energy efficient. A comparative analysis shows that those who received energy audits did not to any great extent implement or intend to implement any measures than those who did not have energy audits done (Murphy, 2014). The results point to the challenge of incentivising renovations in owner-occupied buildings, which become even more problematic when the incentives are split. Other instruments are more focused on energy savings, like the system of individual metering and billing that is part of the EED. It is supposed to provide better information on energy use to households (Terés-Zubiaga et al., 2018) and, by doing so, incentivises them to reduce their energy use through changed behaviour. However, it has been criticised for reducing the incentives of building owners to renovate their buildings, causing a split incentive (von Malmborg, 2021, 2022). Another critique is that it may increase energy poverty (von Platten et al., 2020). This is since the installation, at least in Sweden, focused on buildings with the worst energy performance—buildings in which low-income occupants are overrepresented.

Buessler et al. (2017) point to the challenges being different depending on the building type based on ownership structure. The co-owned buildings face the challenges of creating collective action, reaching an agreement between the co-owners with diverging interest and multiple incentives (Buessler et al., 2017). They proposed four actions to accelerate the energy retrofitting of collective management properties: (i) implementation of a strategic plan for an ambitious 50-year energy retrofitting of buildings across the territory, (ii) a significant investment in energy retrofitting accompaniment, (iii) single access point and a simplification of assistance, and (iv) a more rigorous legislative framework, requiring that also all collectively owned properties make energy diagnoses. It is clear from their analysis that the current governance system does not handle the different interest and the lack of incentive present in collectively managed properties. There is a general agreement within the literature that the incentive structure in collectively or multiowned properties, commonly known as apartment or condominium buildings,

probably is one of the more difficult challenges policymakers are facing (Bright & Weatherall, 2017; Buessler et al., 2017; McCarthy et al., 2018). The question is if the solution to the problem of low rates of retrofitting can be solved by more of the same?

The use and support of markets are based on the idea that they will when functioning correctly create incentives for change. Energy service companies (ESCOs) and energy performance contracting are seen as private-sector delivery mechanisms for energy efficiency of buildings, often directed towards building owners (Bertoldi et al., 2006). Bertoldi and Boza-Kiss (2017) present a comprehensive overview of the ESCO industry in EU MSs and neighbouring countries. They analyse drivers and barriers and suggest recommendations on additional measures to further promote the national and EU markets. They are driven as much by market forces such as increasing energy costs, growing awareness, development of partnerships, as by dedicated policy instruments, regulations, and financial solutions. The EU energy services directive and its successor, EED, include provisions stimulating energy service providers, e.g. through mandatory energy saving obligations for the MSs (Labanca et al., 2015).

The mandatory energy saving obligations regulated in EED provide a link between the EU level headline target on energy savings, MS regulation and market incentives through energy efficiency obligation schemes (EEOSs). ESCOs have an important role in EEOSs. MSs must reduce a certain amount of energy every year but can choose which sectors to address in national legislation and policy as well as what policy instruments to use. According to a report by Ricardo Energy & Environment[8] to the Commission, 42% of expected energy savings in the period 2014–2020 are reported from the building sector, showing that this policy measure is important for stimulating energy efficiency of buildings. To meet the EED requirements on national energy savings, 15 MSs referred to EEOSs for meeting all or part of the energy savings (Fawcett et al., 2019). According to Fawcett et al., (2019, p. 65), due to the limited experience with using EEOS for delivering deeper energy efficiency improvements, it is difficult to predict whether or not this type of policy instrument can deliver more costly and complex energy saving measures than other policy instruments. The new multiple benefits framing of EU energy efficiency policy (von Malmborg et al., 2023) can be challenging to integrate in EEOSs (Fawcett et al., 2019).

The idea behind stimulating and regulating markets, creating new financing solutions and inform the habitants is to increase the incentives of building owners and tenants to lower energy consumption and increase efficiency. It is on the building level the final decision is made and the lack of incentives to retrofit buildings is a major challenge in the governance of the transition that needs to be accelerated. To reach the EU goal of at least doubling the annual renovation rate of the building stock (EC, 2021), more purposeful incentives are needed. Governing through general financing solutions seems to have limited impact and the different ownership structures need to be considered when developing policy.

The lack of incentives to renovate is a central problem seeing that it is the building owners and managers that are making decisions on the lowest governance level. There are plenty of financing options (Bertoldi et al., 2021) but they seem to be ineffective in creating incentives to renovate existing buildings. The challenges are particularly prominent when collective action is needed in co-owned buildings (Buessler et al., 2017) or when incentives differ between tenants and owners. Another example of policy instruments that have failed to create incentives is the energy audits for owner-occupied buildings (Murphy, 2014) which are not used to take action to increase energy efficiency. The challenge of creating incentives is considerable and policymakers need to increase their knowledge of the behaviour of the actors to be able to create a governance system that increase the likelihood of actors wanting to contribute to the transition; this includes creating effective markets. Designing policy instruments to improve energy efficiency and reduce GHG emissions from buildings requires knowledge of the barriers to decision-making in the building sector.

Remeikienė et al. (2021) reviewed the literature on drivers and barriers to energy-efficient renovation in the EU. The most important barriers were high expenses and the opaqueness of costs, reluctance to borrow funds, lack of political incentives

[8] https://energy.ec.europa.eu/system/files/2016-12/final_report_evaluation_on_implementation_art._7_eed_1.pdf (Last accessed 2 October 2023).

and changing policies, insufficient technical capacities, and diverging customer preferences. Mata et al. (2021) found that economic constraints (uncertain long-term economic returns/payback periods), followed by information and support, and technical/professional issues were the most important barriers. Ohene et al. (2022) also identified legislative barriers (insufficient regulations, policy, and implementation efforts) to be important. Blomqvist et al. (2022) found that hidden costs and bounded rationality were prominent barriers due to problems in acquiring and analysing information.

Filippini et al. (2014) estimated the impacts of different policy instruments on energy efficiency in the EU residential sector. They found that improved energy efficiency can be linked to the introduction of financial incentives and energy performance standards such as building energy codes, while informative measures such as labelling and educational campaigns did not seem to have significant effects. The results are also found to be in line with results from previous studies. Bigano et al. (2011) found a positive impact of the EU energy efficiency policies as a policy mix.

The limitations of non-regulatory policy instruments

The nature of the MLG system in the EU and the differences between the building stocks and climatic conditions in the MSs (Meijer et al., 2010; Thonipara et al., 2019) make it difficult to use binding regulations without flexibilities. As a response, new forms of governance based on voluntary action have developed on different political levels. Both MLG and polycentric governance attribute importance to both private and public actors in governing policy issues. Type II governance as described by Hooghe and Marks (2003) focuses on a vast number of task-specific jurisdictions and is similar to Ostrom's concept of polycentric governance. In MLG, there is a choice for the legislator to let the market fix the problem or to adopt public policies.

Putnam and Brown (2021) explore the role of grassroots initiatives in the UK, analysing how they address key barriers associated with delivering retrofit at scale. These include engaging households, developing local supply chains and overcoming economic barriers. Their findings suggest that 'community-led retrofit is effective at engaging households, can contribute to local supply chain development, help households access financing, and be a valuable delivery partner for local authority fuel poverty schemes' (Putnam & Brown, 2021). However, while community-led retrofit offers an alternative approach to retrofit governance, it is unlikely to deliver residential retrofit at scale without a broader government programme of financial and regulatory support.

The environmental and energy performance of non-domestic buildings is a complex problem due to conflicting interests and split incentives. This is particularly challenging in tenanted spaces, where landlord and tenant interactions are regulated through leases that traditionally ignore environmental considerations (Janda et al., 2016). They conceptualise 'green leasing' as a form of 'middle-out' interorganisational environmental governance that operates between organisations, alongside other drivers. In their study of Australia and the UK, Janda et al. (2016) reveal an increasing trend towards green leases in prime offices but not in retail or sub-prime offices. According to them, adopted green leases, generally introduced by landlords, contain a variety of ambitions and levels of enforcement. As an evolving form of private–private environmental governance, green leases form a valuable framework for further landlord–tenant cooperation within properties and across portfolios (Janda et al., 2016). In its current form, it is however unlikely that the instrument will work in other parts of the building stock where the demand is lower.

As found in our literature review and discussed above, many governance instruments tend to be mandatory and prescriptive (cf. Visscher et al., 2016a). These regulatory instruments are often part of EU directives like the EPBD and EED. As a complement to traditional, mandatory governance instruments (e.g. building codes and planning legislation), firms and other organisations have been experimenting with alternatives since the 1990s. Examples include the (i) certification and classification of buildings (Smith & Fischlein, 2010), (ii) new forms of financing (Bertoldi et al., 2021) (see 'Lack of incentives'), and (iii) innovative ways of generating and disseminating information (Van der Heijden, 2016). This trend, which focuses on integrated solutions with voluntary approaches, has come to be termed 'new governance' (Holley et al., 2012; Wurzel et al., 2013). These complementary policy instruments were established

to tackle the challenge of incentives and increase the appreciation and demand for buildings that meet higher standards.

Van der Heijden (2016) has, with a critical eye, analysed different new-governance instruments from Australia, Asia, Europe and North America to understand better this new governance for energy-efficient and low-carbon buildings. The dominant type of new-governance instruments for low-carbon buildings is 'certification and classification'. Such instruments, often competing (Smith & Fischlein, 2010), allow for the assessment of buildings against a number of criteria. A certificate is issued if these criteria are met. Classification gives an indication of the relative performance of buildings within the same certification instrument. Three forms of classification are identified, (i) benchmarking, (ii) rating, and (iii) labelling, the latter of which builds on a holistic approach to classification (Sesana et al., 2019). These instruments do not certify energy efficiency or carbon intensity individually, but classify buildings based on overall performance related to different sustainability credentials. Well-known instruments are BREEAM and LEED (Forsberg & von Malmborg, 2004; Seinre et al., 2014). These are examples of national classification that have been disseminated to other countries, making them two of the leading international standards. Smith and Fischlein (2010) suggest that 'this competitive market vetting results in pressures toward the convergence of governance rules over time but doesn't seem to lead to a single winning set of rules'. The same problem as with other voluntary policy instruments such as green leasing between tenant and owner as described by Janda et al. (2016) becomes apparent. Certification and classification instruments have, thus far, achieved most promising results in high-profile *new* commercial building development, such as offices in central business districts of major cities (Van der Heijden, 2015). This is where developers and property owners expect and get high returns on their investments. In combination of larger publicly traded companies needing to report on their environmental impact, green leases can be of considerable value. These instruments have been less successful in changing the market for residential buildings, older buildings or less prestigious commercial building development.

Another set of non-regulatory policy instruments seeks to generate and disseminate knowledge on how to construct and retrofit low-carbon buildings and how building users' behaviour can be modified to achieve reduced energy consumption. An example of the former is the National Information Centre for Sustainable Building[9] and the National Renovation Centre,[10] both established by the Swedish government. In both cases, information is disseminated by energy and climate advisors[11] available in all Swedish municipalities and co-financed by local authorities and the national government. Energy and climate advise related to buildings is available in 14 languages.[12]

At first sight, new-governance instruments appear to be promising complements to traditional, coercive instruments (Van der Heijden, 2016). This is because they are often designed to solve specific problems that traditional policy instruments do not handle, but also because they go beyond the one-size-fits-all approach of traditional instruments and can exemplify new ways of solving problems. That being said, Van der Heijden (2016) finds that new governance with a focus on voluntary instruments appears most promising in the high end of new commercial property development and has limited impact in other areas of the construction and property sectors. New-governance instruments have achieved marginal results in the areas of residential buildings, existing buildings and building user behaviour (Van der Heijden, 2016). This is problematic because these are the areas where traditional, mandatory governance instruments also fail to deliver results. It is not the high-end properties innovative modes of governance are needed but it is where they are developed. The incentives are naturally higher for owners of high-end property to increase the energy efficiency because large multinational companies are able and willing to pay a premium. This might indicate that policymakers should

[9] https://www.ivl.se/vart-erbjudande/forskning/hallbart-samhallsbyggande/informationscentrum-for-hallbart-byggande.html (Last accessed 2 October 2023).

[10] https://www.renoveringscentrum.lth.se/ (Last accessed 2 October 2023).

[11] https://www.energimyndigheten.se/energieffektivisering/jag-vill-energieffektivisera-hemma/energi--och-klimatradgivning/#:~:text=Energi-%20och%20klimatr%C3%A5dgivning%20%C3%A4r%20en%20opartisk%20och%20kostnadsfri,p%C3%A5verka%20klimat%20och%20milj%C3%B6%20s%C3%A5%20lite%20som%20m%C3%B6jligt. (Last accessed 2 October 2023).

[12] https://www.energimyndigheten.se/snabblankar/other-languages (Last accessed 2 October 2023).

focus even more on the other parts of the building stock when developing policies.

Limited diffusion between governance levels

Traditionally, environmental and energy policymaking primarily views sub-national levels of government in terms of their roles in implementing and enforcing legislation developed by national governments (Jänicke & Quitzow, 2017). However, with the emergence of the concept of sustainable development and its emphasis on local participation, this began to change and culminated in the 'Local Agenda 21' process launched at the Earth Summit in Rio in 1992 (Burström, 2000). A process of change over the past decades can be seen in the field of climate and energy governance as well (Fuchs & Hinderer, 2014), where local governments act as service providers, major employers, community leaders, campaigners, regulators, planners, developers and landlords (Lo, 2014). Local-level policies and initiatives are increasingly seen as potential drivers of green innovation, competitiveness and economic development (cf. von Malmborg, 2003, 2007). The project database of the Covenant of Mayors[13] provides empirical evidence that the energy and climate policy process has mobilised strong economic interests at the local level, especially in the building sector (Jänicke & Quitzow, 2017). Cities and local communities, often organised as networks (Gustavsson et al., 2009; Khan, 2013; Parag et al., 2013), use national and European policies and incentives in the form of directives, regulations, subsidies, or public procurement, to mobilise economic and civil society interests for climate-friendly technologies, such as renewable energy or low-energy buildings (Bulkeley & Betsill, 2005). National and EU policies have stimulated strong activity and experimentation among local communities with pioneer cities such as Freiburg, Manchester, Copenhagen and Malmö playing an important role (Jänicke & Quitzow, 2017; Smedby, 2016; Smedby & Quitzau, 2016).

Local and regional governments have a crucial role in delivering public policies relevant to the uptake of low-energy and low-carbon buildings. Our review of the literature finds several modes of governance and policy instruments used at local and regional level: (i) self-governing, i.e. control of direct energy use and GHG emissions from government facilities, (ii) network governance through enabling community engagement, (iii) green public procurement and tendering, (iv) an integrated design strategy for sustainable energy systems in urban areas and buildings, (v) energy audit programmes, (vi) urban development projects, and (vii) the Covenant of Mayors including (inter)regional cooperation among cities. Urban development projects can challenge mainstream building practices through a combination of different modes of governing (Bulkeley & Kern, 2006; Smedby, 2016; Smedby & Quitzau, 2016). Such initiatives, where municipalities push for harder energy performance standards in the building permits for new buildings than provided by national building codes, provide important insights into the role that local governments may play in terms of pushing developers from mainstream building practices towards the uptake of more radical energy-efficient solutions by enabling socio-technical translation (Smedby, 2016). However, this not possible in all MSs due to differences in national legislation. It was used in several cities in Sweden, until the Swedish parliament changed the planning and building act, restricting municipalities to set stricter energy performance criteria than stipulated by the law. However, municipalities continued to demand higher energy performance as a criterion for getting a land instruction for new buildings on land owned by the municipality. Findings from Malmö, Sweden, indicate improved performance when the programme was combined with a dialogue process together with developers in a showcase area of Malmö (Smedby & Quitzau, 2016).

Public authorities can play a crucial role fostering demand for energy-efficient buildings through green public procurement and tendering. Annunziata et al. (2014a) found that it can contribute to the energy efficiency governance at local level if municipalities undertake a path which integrates increasing energy and environmental awareness and technical know-how and expertise. The use of green public procurement by local authorities based on sustainability criteria, including the energy performance of buildings, to promote zero-energy new housing developments was found in the Netherlands (Tambach & Visscher, 2012). Depending on national legislation, green

[13] https://eu-mayors.ec.europa.eu/en/home (Last accessed 2 October 2023).

public procurement can focus on publicly and privately owned buildings. In some MSs, public authorities rent privately owned buildings. Tambach and Visscher also suggest the following municipal climate governance approach and instruments: (i) an integrated design strategy for sustainable energy systems throughout the city: in both urban areas and buildings; (ii) encouragement of community engagement for the deployment of renewable energy sources; and (iii) (inter)regional cooperation among cities in similar climatic zones on the development of both more uniform calculation methods for zero-energy buildings, and of a more uniform methodology for cities to monitor progress towards the self-set targets (Tambach & Visscher, 2012).

As mentioned, training of blue-collar workers in the construction sector is important to realise energy-efficient and zero-carbon buildings on the ground. Barbero et al. (2023) identified differences across EU MSs and a need for adapted instruments to promote mutual recognition of energy skills and qualifications in the European construction sector. Simpson et al. (2020) analysed the role of building professionals as 'middle actors' who can either enable or inhibit a societal transition to zero-carbon buildings. They found that collaboration between academia, vocational training and industry could support sideways initiatives to better enable delivery of zero-carbon buildings. Although policymakers and regulators on different levels need to create routes to capture, listen to and use the perspectives of building professionals, at present, these actors have very little upstream influence.

An increasing number of cities and municipalities are joining transnational initiatives to reduce climate impact and transition to clean energy. One such initiative is the Covenant of Mayors, which was initiated in the EU in 2008 with the ambition to bring together municipalities that commit on a voluntary basis to achieving and exceeding the EU's energy and climate goals. The Covenant of Mayors initiative has more than 11,700 signatories as of June 2023, covering 341 million inhabitants from European, Central Asian, and South Mediterranean cities in 55 countries. The Covenant of Mayors initiative introduced a first-of-its-kind bottom-up approach to energy and climate action, and its success quickly went beyond expectations (Kemmerzell, 2018; Kona et al., 2018; Melica et al., 2018). Kona et al. (2018) reaffirm the potential of the Covenant of Mayors to contribute ambitious and long-term energy and climate goals. However, although the vertical and horizontal activities show a significant impact on local and regional measures to reduce climate impact and a transition to clean energy, criticism has been raised that there is a self-selection process in play where proactive and ambitious cities become members Covenant of Mayors. The Covenant of Mayors has failed to reach out to less ambitious municipalities and cities (Kemmerzell, 2018). The Covenant of Mayors is however the most interesting case of a new form of governance that directly connects local levels horizontally, something we have not seen previously.

A common feature in all the above-mentioned approaches, stable and long-term-oriented European and/or national financial support for municipalities seems to be needed for municipal climate and energy governance with focus on low-energy and low-carbon buildings to become successful. Local governments in Sweden and Norway have benefited from the financial incentives made available by the national government regarding low-carbon transition (Emelianoff, 2013; Nilsson et al., 2012). The EU cohesion funds are frequently used by municipalities and regions to stimulate energy upgrades in residential, commercial, and public buildings. Economidou et al. (2023) found that 60% of the examined schemes are offered in the form of grants and subsidies, and 45% of them targeted residential upgrades. However, they found that available national and EU funds could be better utilised at local and regional levels. MLG, in this sense, is important because the institutional capacity of local governments often depends on the discretion of other levels of government. While most studies have focused on pioneering cities and networks, Fuhr et al. (2018) argue that the broader effects of local climate and energy actions and their relationship to regional, national, and international policy and governance frameworks have not been studied in enough detail. The willingness of local governments to experiment with new forms of governance and combine them with the top-down instruments created at the EU and national level is not as apparent on other levels in the MLG system. In relation to the lack of attention given to the interactions between levels, scholars introduce the concept of upscaling and contend that local climate initiatives must go hand in hand with higher-level policies and be better integrated into the MLG

system (cf. Dobravec et al., 2021; Jänicke & Quitzow, 2017).

The complexity and size of the governance system increase the importance of policy learning and diffusion. There are structures that are set up for the diffusion of best practices. One example is the Covenant of Mayors where one of the main purposes is to disseminate ideas between local governments (Kona et al., 2018). This horizontal diffusion is important, but lessons and experiences are not transferred vertically within the governance system to the same degree, especially upwards. This is especially problematic since policy experimentation seems most prevalent on the local level. The commonly used top-down perspective of MLG have had a large influence on the previous literature. The review of the literature indicates that further research is required to determine how local knowledge can be disseminated to other levels, especially considering the reasoning of Jänicke and Wurzel (2019) who argue that the EU level are performing worse when it comes to governing climate mitigation. The actors within the multilevel system of governance need to imitate successful implementation of policies and learn from the experiences of others if we are to see a transition towards energy-efficient and zero-carbon buildings.

Conclusion and further research

The aim of this review has been to explore the challenges linked to MLG in general and the EU in specific, facing complex environmental policy challenges such as transitioning to more energy-efficient and even zero-carbon buildings. If the EU can be conceptualised as an environmental policy frontrunner, it becomes of particular interest to study how they solve issues that arise within the MLG system. The challenges identified in the scholarly literature become key to understanding the interdependence of existing modes of governance and policy instruments on multiple levels used to promote a transition. Even though the EU often is perceived as a global leader when it comes to climate change mitigation, within energy efficiency there is a fuzziness in global governance with ambiguous leadership. Actions taken on energy-efficient buildings at this level of the governance system are in general voluntary (REEEP and Covenant of Mayors). The IEA is important as policy advisor and for the policy learning of the Commission and MSs, but the EU level is central in an effective transition. However, implementation of EU policies differs among MS (Pereira & Da Silva, 2017; Rubino, 2017) which highlights the difficulty of designing effective EU-wide policies and could be part of the explanation of the remaining challenges in the policy domain. There are questions of how far we can push environmental policy without any coercion as what we see now is the mismatch of perceived alarming problems (climate change, natural resource depletion, rising needs of a growing population) with a governance system that are not able to cope with global nature of the problem of transitioning to sustainability. Based on the findings from this review, we identify a clash between the political feasibility of voluntary approaches and incentives with the radical changes of hard regulation. This clash can also be observed in the debate on UN climate change policy. 'In some way the light touch regulations fit the overall reluctance for hard targets, strict deadlines, closing loopholes and equitable burden sharing. It is more based on hope for future positive negotiations and pledges, hence postponing the hard decisions for the future' (Nordensvärd & Urban, 2023).

Within a heterogenous EU, part of a complex global governance system—there is a challenge to actually create effective binding measures in a time where the viability of policy coercion is slipping away. The focus is no longer on the environmentally desirable, but on the politically feasible. This will probably help to overcome diplomatic gridlock and policy inaction, but it will also exacerbate the inconsistency between talk, decisions, and actions, since almost nobody wants to admit this paradigm shift openly (Geden, 2016, p. 792). We can therefore see a gridlock of global problems and national governance where the EU is somewhere in the middle. We will see an increasing debate on coercion versus voluntarism as policymakers grapple with political feasibility where voluntarism relies very much on the nature of incentives.

Public policy instruments are often complemented with private, voluntary instruments, in what is called 'new governance'. However, even though private policy instruments such as certification schemes (Smith & Fischlein, 2010) and green leases (Janda et al., 2016) have some merits, they seem to only be effective under certain circumstances, e.g. in office buildings in high-end areas of large cities

(Van der Heijden, 2016). If the goal is to live up to the ambitions set out by the EU legislators, voluntary policy instruments need to be complemented by compulsory instruments. Voluntarism and market solution can work in some situations but often mean a lack of uptake of policies. The high cost of renovation work, an undervaluation of distant payoffs, and the existence of split incentives limit the rate of renovation, mainly in co-owned buildings (Buessler et al., 2017; Nässén et al., 2008) and the potential of innovative policy instruments like new forms of financing highlighted by Bertoldi et al. (2021). Additionally, the lack of diffusion within the MLG system means that the potentially effective policy experiments are not disseminated vertically to other levels or horizontally to other regions/nations.

The research shows that it is at the national and local level where most policy and governance innovations are produced. For example, experimentation with new policy instruments seems to be most developed at the regional/local level, e.g. network governance, experimentation in public planning, green public procurement, and the Covenant of Mayors, but there is limited diffusion and coordination between governance at different levels. This limits policy learning and the diffusion of best practices within the multilevel system. We can therefore see that MLG issues on implementing regulations and policies on European level happen within a larger ongoing discussion of governance without government and policies without regulations.

We identify several areas for future research. More focus is needed on renovation of the existing building stock, especially on single family buildings which are rarely mentioned in the literature reviewed, where effective governance, especially of the coercive type, could be argued the most difficult to implement. Another, more overarching area for future research is the balance between voluntary and coercive approaches to governing the transition to energy-efficient and zero-carbon buildings. Here, the political feasibility needs to be considered as well, especially since building policy is generally considered a national competence, even though it has global effects through the impact on the climate.

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Data availability All data sources used are referred to and are publicly available on the internet.

Declarations

Conflict of interest The authors declare no competing interests.

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