ANNEX 75

EBC
Energy in Buildings and Communities Programme

International Energy Agency

The District as Action Level for Building Renovation Combining Energy Efficiency & Renewables

A Short Guide for Policymakers

Energy in Buildings and Communities Technology Collaboration Programme

May 2023

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The District as Action Level for Building Renovation Combining Energy Efficiency & Renewables: Making use of the Potentials

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Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Cooperation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international cooperation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA coordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes (TCPs). The mission of the IEA Energy in Buildings and Communities (IEA EBC) TCP is to support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. (Until 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.)

The high priority research themes in the EBC Strategic Plan 2019-2024 are based on research drivers, national programmes within the EBC participating countries, the Future Buildings Forum (FBF) Think Tank Workshop held in Singapore in October 2017 and a Strategy Planning Workshop held at the EBC Executive Committee Meeting in November 2017. The research themes represent a collective input of the Executive Committee members and Operating Agents to exploit technological and other opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy technologies, systems and processes. Future EBC collaborative research and innovation work should have its focus on these themes.

At the Strategy Planning Workshop in 2017, some 40 research themes were developed. From those 40 themes, 10 themes of special high priority have been extracted, taking into consideration a score that was given to each theme at the workshop. The 10 high priority themes can be separated in two types namely 'Objectives' and 'Means'. These two groups are distinguished for a better understanding of the different themes.

Objectives - The strategic objectives of the EBC TCP are as follows:

- reinforcing the technical and economic basis for refurbishment of existing buildings, including financing, engagement of stakeholders and promotion of co-benefits;
- improvement of planning, construction and management processes to reduce the performance gap between design stage assessments and real-world operation;
- the creation of 'low tech', robust and affordable technologies;
- the further development of energy efficient cooling in hot and humid, or dry climates, avoiding mechanical cooling if possible;
- the creation of holistic solution sets for district level systems taking into account energy grids, overall performance, business models, engagement of stakeholders, and transport energy system implications.

Means - The strategic objectives of the EBC TCP will be achieved by the means listed below:

- the creation of tools for supporting design and construction through to operations and maintenance, including building energy standards and life cycle analysis (LCA);
- benefitting from 'living labs' to provide experience of and overcome barriers to adoption of energy efficiency measures;
- improving smart control of building services technical installations, including occupant and operator interfaces;
- addressing data issues in buildings, including non-intrusive and secure data collection;
- the development of building information modelling (BIM) as a game changer, from design and construction through to operations and maintenance.

The themes in both groups can be the subject for new Annexes, but what distinguishes them is that the 'objectives' themes are final goals or solutions (or part of) for an energy efficient built environment, while the 'means' themes are instruments or enablers to reach such a goal. These themes are explained in more detail in the EBC Strategic Plan 2019-2024.

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the

following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (☼):

Annex 1: Load Energy Determination of Buildings (*)
Annex 2: Ekistics and Advanced Community Energy Systems (*)
Annex 3: Energy Conservation in Residential Buildings (*)
Annex 4: Glasgow Commercial Building Monitoring (*)
Annex 5: Air Infiltration and Ventilation Centre
Annex 6: Energy Systems and Design of Communities (*)
Annex 7: Local Government Energy Planning (*)
Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
Annex 9: Minimum Ventilation Rates (*)
Annex 10: Building HVAC System Simulation (*)
Annex 11: Energy Auditing (*)
Annex 12: Windows and Fenestration (*)
Annex 13: Energy Management in Hospitals (*)
Annex 14: Condensation and Energy (*)
Annex 15: Energy Efficiency in Schools (*)
Annex 16: BEMS 1- User Interfaces and System Integration (*)
Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
Annex 18: Demand Controlled Ventilation Systems (*)
Annex 19: Low Slope Roof Systems (*)
Annex 20: Air Flow Patterns within Buildings (*)
Annex 21: Thermal Modelling (*)
Annex 22: Energy Efficient Communities (*)
Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
Annex 25: Real time HVAC Simulation (*)
Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
Annex 28: Low Energy Cooling Systems (*)
Annex 29: ☼ Daylight in Buildings (*)
Annex 30: Bringing Simulation to Application (*)
Annex 31: Energy-Related Environmental Impact of Buildings (*)
Annex 32: Integral Building Envelope Performance Assessment (*)
Annex 33: Advanced Local Energy Planning (*)
Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
Annex 36: Retrofitting of Educational Buildings (*)
Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
Annex 38: ☼ Solar Sustainable Housing (*)
Annex 39: High Performance Insulation Systems (*)
Annex 40: Building Commissioning to Improve Energy Performance (*)
Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
Annex 43: ☼ Testing and Validation of Building Energy Simulation Tools (*)
Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
Annex 45: Energy Efficient Electric Lighting for Buildings (*)
Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
Annex 48: Heat Pumping and Reversible Air Conditioning (*)
Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
Annex 51: Energy Efficient Communities (*)
Annex 52: ☼ Towards Net Zero Energy Solar Buildings (*)
Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)
Annexe 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)

Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost (RAP-RETRO) (*)
Annex 56: Cost Effective Energy and CO2 Emissions Optimisation in Building Renovation (*)
Annex 57: Evaluation of Embodied Energy and CO2 Equivalent Emissions for Building Construction (*)
Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)
Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)
Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)
Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (*)
Annex 62: Ventilative Cooling (*)
Annex 63: Implementation of Energy Strategies in Communities (*)
Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles (*)
Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems (*)
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Annex 67: Energy Flexible Buildings (*)
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Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings
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Annex 73: Towards Net Zero Energy Resilient Public Communities
Annex 74: Competition and Living Lab Platform
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Annex 87: Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems
Annex 88: Evaluation and Demonstration of Actual Energy Efficiency of Heat Pump Systems in Buildings

Working Group - Energy Efficiency in Educational Buildings (*)
Working Group - Indicators of Energy Efficiency in Cold Climate Buildings (*)
Working Group - Annex 36 Extension: The Energy Concept Adviser (*)
Working Group - HVAC Energy Calculation Methodologies for Non-residential Buildings (*)
Working Group - Cities and Communities (*)
Working Group - Building Energy Codes
(*) – completed working groups

Summary

Urgent actions must be taken to decarbonise the building stock and meet the targets established in the Paris Agreement. Renovating the existing building stock to a zero-carbon level is a key priority to meet the decarbonisation goals. Apart from energy efficiency measures on the building envelopes, a switch to renewable energy-based heating and cooling systems is urgently required. Furthermore, in addition to building renovation at the individual building level, building renovation at the district level offers a promising perspective as a strategy to promote the much-needed acceleration of the decarbonisation of the building sector.

With this background, the IEA EBC Annex 75 - Cost-effective Building Renovation at District Level Combining Energy Efficiency & Renewables[1] aimed to clarify the cost-effectiveness of various building renovation approaches combining energy efficiency and renewable energy measures at the district level. The objective was to provide guidance to balance and enable an innovative and optimal mix of measures to decarbonise the existing residential buildings at the district level. Taking advantage of the potential synergies between energy efficiency measures and measures that promote the use of renewable energy, the aim was to show the possible combinations of technologies and the contexts in which they are most viable. It also aimed to show which business models can support the processes and which policies and processes organisations can help modernise and accelerate building renovation processes.

In this context, a comprehensive and detailed Guidebook (Meyer et al., 2023) was prepared to provide target group-oriented recommendations for policymakers and investors/decision-makers. As a supplement to this Guidebook, two complementary versions offer more straightforward guidelines oriented to each target audience, with a summary of the main recommendations.

This document provides guidance for policymakers only. A similar document is also available with guidance to investors and decision-makers.

All project documents are available on the IEA EBC Annex 75 website (https://annex75.iea-ebc.org/publications). On this website, a document with the terminology used in all the reports produced within this project and the definitions of the terms used (Hidalgo-Betanzos et al., 2023) is also available.

[1] https://annex75.iea-ebc.org/about

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Overview of Fields of Action

The guidelines presented in this document give recommendations for policymakers on upscaling building renovation to a district level, considering both energy efficiency and renewable energy measures towards the decarbonisation of the building sector.

The guidelines advise policymakers based on the most relevant outcomes of the work carried out in IEA EBC "Annex 75 - Cost-effective Building Renovation at District Level Combining Energy Efficiency & Renewables". The present document gives a brief thematic overview of the issues related to building renovation at the district level. It provides key recommendations for policymakers for six specific fields of action.

In addition, general derivations and overall recommendations are also provided.

Detailed background information and recommendations based on the international research project can be found in the extensive Guidebook (Meyer et al., 2023) and several topic-specific IEA EBC Annex 75 reports.[2]

This document is structured as follows:

1. Establishing the District as Action Level for Building Renovation
2. Techno-Economic Potentials of Upscaling Building Renovation to the District Level
3. Business Models Supporting Upscaling of Building Renovation to the District Level
4. Local Policy Instruments for Upscaling Building Renovation to the District Level
5. Supporting Building Renovation at District Scale through Process Organization & Stakeholder Dialogue
6. District-Oriented Mobilisation for Building Renovation
7. General Derivations & Overall Recommendations
8. Conclusions

[2] See https://annex75.iea-ebc.org/publications

1. Establishing the District as Action Level for Building Renovation

Changing the scope of policy action for building renovations from individual buildings to groups of buildings in districts (district approach) holds several technological, economic, organisational and mobilisation potentials. These potentials can be economies of scale, integrated approaches to building renovation that allows considering additional issues and plans for infrastructure and urban development, communication synergies within a district, or the use of district solutions for heating or cooling supply systems that allow the integration of renewable energy sources that could not be accessed through decentralised systems.

In addition, other reasons for promoting district solutions are the opportunity to overcome space or noise restrictions possibly related to decentralised systems in some of the buildings within a district, increased flexibility, the possibility to increase resilience through multiple energy systems, the opportunity to apply particularly innovative systems associated with fewer emissions, and the possibility of greater engagement among building owners when acting collectively.

Furthermore, there are indications that synergies between energy efficiency measures and renewable energy are greater for district systems than for decentralised systems when environmental heat is used through heat pumps. Although complexity grows by "zooming out" from the individual building level, the district level allows a more tailored perspective and approach compared to a broader scope, such as the city level.

However, the district, as the action level, can be associated with various challenges, depending on its concrete characteristics. Districts can have complex stakeholder structures with different interests and tasks. This can be a limitation for the potential synergies. Especially at the beginning, significant efforts in planning, coordination and communication are necessary to make use of the potential of district projects. Also, from a techno-economic perspective, building renovation projects at the district level are associated with high upfront costs and potential risks due to a dependency on a set number of customers for profitability. Furthermore, district approaches are overall not necessarily more cost-effective than decentralised solutions.

If policymakers want district projects to be implemented to make use of the stated additional benefits, a political commitment and associated policy measures are necessary because the market by itself is unlikely to deliver decarbonisation through district solutions to a large extent. Accordingly, there is an opportunity for policymakers to have an impact on advancing building renovation by coordinating different stakeholders and creating the right framework conditions for upscaling building renovation to the district level, making use of synergies between energy efficiency measures and renewable energy.

The following table provides, in this context, operational recommendations dedicated explicitly to local-level policymakers.

OPERATIONAL RECOMMENDATIONS
Make use of the techno-economic, as well as the organisational potentials and synergies of upscaling building renovation to the district level, such as a wider scope of action, expertise, and communication through addressing and including more actors
Ensure that harnessing synergies between energy efficiency measures and renewable energy measures is encouraged through various policy instruments
Address complex transformation issues like decarbonisation at the district rather than at the building level to be able to integrate interdependencies with other policy issues and goals in the policy action
Take advantage of the tailored perspective at the district level (e.g., compared to the city level) that allows for better direct involvement of the people and local actors in the energy transition
Support or bear the additional (especially initial) efforts of coordination, communication and planning that comes with an upscaling to the district level
Foster an integrated approach to urban development, energy planning and cooperative action of city departments and investors and decision-makers that promote a balance of interests right from the start

2. Techno-Economic Potentials of Upscaling Building Renovation at the District Level

Upscaling building renovation at the district level involves multiple interdependent investments, energy consumption decisions and the selection of different technology options and their combinations. These decisions are often fragmented and mainly made by private actors. However, policymakers need to consider general techno-economic potentials and their interdependencies with a district's framework conditions and policy goals. This understanding helps to be an enabler of innovative approaches to building renovation through integrated planning and overarching strategies, stakeholder dialogue and extensive mobilisation.

Based on the work carried out in IEA EBC Annex 75, and specifically on the report on barriers and drivers for energy-efficient renovation at the district level (Johansson et al., 2023), the most important key recommendations for policymakers are listed below.

OPERATIONAL RECOMMENDATIONS

Create an in-depth and accessible database and source of information for analysing the starting conditions of building renovation projects at the district level as a basis for informed and integrated decision-making while guaranteeing the security and privacy of data, especially personal sensitive data
Explore local renewable energy potentials, including those that can only be accessed at the district scale, to facilitate the development of related projects
Be transparent about the potential effects of specific local preconditions, such as energy and building materials prices, as well as regulatory frameworks and user behaviour
Take into account synergies between energy efficiency measures and the use of renewable energy when developing or supporting projects for building renovation at the district level
Maintain regulations and incentives concerning energy efficiency measures in buildings within the scope of district solutions based on renewable energy since synergies between energy efficiency and the use of renewables can be as high at the district level as at the decentralised level
Analyse each case individually according to an integrated approach that not only reflects the techno-economic assessments but also considers socio-economic effects, overarching policy and urban development goals and plans
Plan any district intervention in such a way that it integrates well with the external energy system
Take into account that if an existing thermal grid is in good shape in the district, it is usually more cost-effective to continue using it
Explore or encourage the reduction of temperature in the heat grids while ensuring the necessary hygienic conditions

Inform and encourage the use of energy efficiency measures in building envelopes whenever renovations are required anyway
Develop and align district solutions with city-wide, regional, or national strategies. Do not hinder the implementation and development of cost-effective decarbonisation technologies through overarching frameworks and strategies
Promote and support training programs for the skilled workforce to implement building renovation
Promote and support standardisation and prefab solutions
Analyse situations individually according to the recommendations mentioned above since it is not possible to generalise about the cost-effectiveness of heating or cooling supply solutions, whether centralised or decentralised

3. Business Models Supporting Upscaling of Building Renovation to the District Level

Business models can support the upscaling process of building renovation to a district scale. Upscaling building renovation to the district level can lead to new levels and scopes of building stock renovation, energy supply strategies, and change cost scenarios, which is important to consider in developing business models.

Naturally, business models are primarily relevant to investors. However, policymakers are crucial in setting up a framework and coordinating the different single actors to allow business models to be established and profitable. Understanding the different stakeholders' decision-making contexts and needs helps to create policy and legal frameworks that best meet practical demands and realities.

Based on the work of IEA EBC Annex 75, specifically on the report on business models (Konstantinou et al., 2023), the most important key recommendations for policymakers are listed below.

OPERATIONAL RECOMMENDATIONS

Setup of a comprehensive Energy Master Plan and a city-wide decarbonisation strategy, including building renovation, which guarantees energy security and gives guidance to private actors (e.g., investors and decision-makers)

Create a national policy framework (e.g., through regulation, financial incentives, and subsidies) and local action plans (e.g., for communication and organisation in districts) to promote large-scale renovations and allow new business models to evolve in this regard

Take the role of careful coordination between stakeholders, including master planners, energy planners, building designers and potential investors and decision-makers, and enable an easier linking of practical, concrete business activities to overarching goals and strategies

Create effective governance models with clear roles and actions that must consider new business models but not neglect local specificities regarding the labour market and business structure. Encouraging upscaling of building renovation must be accompanied by co-developed information and training campaigns for a skilled workforce, as well as potential investors and decision-makers

Facilitate partnerships between energy companies, prosumers, building renovation solutions suppliers and integrated home renovation services that can coordinate the translation from overarching plans to specific actions in districts

4. Local Policy Instruments for Upscaling Building Renovation to the District Level

Municipalities have a key role in advancing building renovation at the district level and can assume various functions: As initiators, they can provide an initial impetus for building renovation projects at the district level. Municipalities can also develop concepts and municipal energy planning for setting the cornerstones for future district projects. From a strategic planning view, the municipality is a potential decision-maker, legislator or regulator. It is also up to local policymakers to connect existing concepts, procedures, strategies and tools related to district-level renovation efforts with each other.

Municipalities also have an important role to play as role models, for example, in the form of model renovations and pilot projects, but also by selecting the tender with the most attractive project from an energy/environmental perspective.

Municipalities can be facilitators to obtain funding, information hubs, and communicators. They can provide advice and organisational support to enable district projects. They can assume functions as mediators, coordinators, motivators, or funding institutions. Among various government institutions, they have the best knowledge about local conditions and are best positioned to interact with citizens and stakeholders at the local level. For example, they can also be producers or suppliers of heat or cooling through public companies they own.

In addition, local authorities already have the task of carrying out urban planning and authorising or monitoring construction and renovation projects. Thus, there are numerous opportunities to link ongoing local processes to new activities to encourage building renovation at the district scale. There is a significant opportunity for local authorities to advance district projects by being involved from the outset and by providing support through their commitment.

Municipalities have a vast set of policy instruments at their hand. How many and how impactful they are, depends highly on the overarching regulatory and legal framework. A central task for municipalities is to find out how to use existing instruments for district-level renovations, how to develop them further and when to use them.

The following key recommendations can support policymakers at a municipal level to develop and use their instruments for upscaling building renovation through district projects and to make use of synergies between energy efficiency measures and renewables. Detailed information about this topic can be found in the related IEA EBC Annex 75 report on policy instruments (Mlecnik et al., 2023).

OPERATIONAL RECOMMENDATIONS

Support building renovation at the district level, specifically supporting combinations of energy efficiency measures and renewables

Map building renovation efforts at a district scale and establish multi-level-processes that result in instruments and policy decisions at many institutional and geographical levels

Raise awareness of the role of the municipal level in such processes. Engage a myriad of actors in the use and development of instruments through good stakeholder dialogue
Scan existing instruments for their potential use in building renovation efforts. If not already established, create a municipal energy plan and municipal renovation goals, and expand them to city-wide decarbonisation plans
Ensure energy efficiency measures are combined with district heating
Define recommendations for district heating companies to cover additional territory, as energy efficiency measures reduce overall consumption
Create financial incentives for connecting to district heating and ensure that efficiency measures in building envelopes remain attractive after the connection
Ensure honest communication, recognising that district heating is not always the most cost-effective solution, and its main advantages may be of another kind
Make use of large renewable energy sources, if suitable and possible
Enforce mandatory installation of heating solutions with renewable energy sources
Use urban planning tools where possible. If there are regulatory restrictions, try to lobby for changes in laws at higher levels to be able to tackle building renovation issues
Strengthen strategies and planning procedures, and, in particular, encourage the development of Integrated District Renovation Plans to combine both energy efficiency measures and renewable energy measures at the district level
Define holistic & integrated approaches linking energy efficiency to urban design
Design municipal subsidies, loans, and tax benefits to target district renovations
Ensure appropriate incentives for landlords, but also correctly weigh tenants' needs
Offer comprehensive organisational and advisory support for districts interested in developing district projects
Do not stop engaging in a project after its realisation. The results of a monitoring system could directly influence current and future local-level decisions and plans
Communicate about the progress being made
Spread information about successful building renovation examples at the district level

5. Supporting Building Renovation at District Scale through Process Organization & Stakeholder Dialogue

The benefits of positive stakeholder involvement are clear. Engaging diverse interested parties may present an organisational challenge but provides benefits essential to successful implementation and acceptance. Developing a workable strategy to integrate stakeholders within a project's development should therefore be seen as a fundamental part of the overall planning process.

In such a process, policymakers, especially at a local level, are essential to establish dialogue and communication between different stakeholders.

This is particularly important for district-level building renovation projects that combine energy efficiency and renewable energy measures. Sharing common heating/cooling systems or engaging in coordinated activities to increase the efficiency of building envelopes requires a high level of trust between the concerned building owners and also with other building owners and other stakeholders involved in the process. This is because these activities involve high costs and uncertainties regarding future energy markets, the renovations are associated with interventions in the personal living environment, and the reliability of a heating/cooling system or another type of energy system is of key importance to building owners and tenants.

The following table provides, in this context, operational recommendations dedicated explicitly to local-level policymakers.

OPERATIONAL RECOMMENDATIONS
Make stakeholder dialogue a core objective of your local policy, as it is an essential part of public participation
Identify and address all relevant stakeholders involved in processes of change in your municipality (urban development, building renovation at the district level)
Be clear and honest about the changes, the process and the goals, and address citizens' fears (costs, gentrification) to overcome them
Organise a continuous process of a stakeholder dialogue with the administration, including building owners/investors and energy suppliers as an open table

6. District-Oriented Mobilisation for Building Renovation

To bring energy efficiency measures and renewable energy into the districts, it is essential to get building owners, owner-occupiers and tenants on board. They are crucial investment decision-makers or have a crucial role in determining the acceptance of such projects. Therefore, they are the key players in accepting and implementing renovation measures and transforming related policies into action.

However, these players constitute a highly diverse target group. The suitable measures to address them depend strongly on the housing market structure of the respective country, region, or district. In addition, the age of the building stock varies by country, region and district, which is a good indicator of its average efficiency, determining suitable measures as well.

Building renovation is a complex techno-economic and social process, especially when it combines energy efficiency and renewables and upscales them to the district level. Many aspects are hard to grasp for non-experts. Accordingly, diverse advisory support is needed to boost building renovation activity.

The following recommendations advise how non-professional end-users can be mobilised for broader action, improving the consultation landscape and creating networks among the many actors involved. These networks with a common knowledge base enable an end-user-friendly reference culture and a common language that helps dismantle barriers in complex renovation processes. To do this, policymakers can take action and use their structural role.

The following table provides operational recommendations dedicated explicitly to local-level policymakers. More detailed instruments and practical examples of incentivising, mobilisation and consultation instruments at a local level are also elaborated in the IEA EBC Annex 75 report on policy instruments (Mlecnik et al., 2023).

OPERATIONAL RECOMMENDATIONS
Support an interlinked "consultation chain" for building renovation to foster a local user-friendly "reference culture"
Provide neutral basic and low-threshold information on building renovation, available funding options and a general overarching framework
Organise and support situation and target group-oriented approaches to mobilising homeowners within the target district, such as through consultancy centres, local energy desks or pop-ups, outreach-counselling, or one-stop-shops
Offer advice and organisational support to building owners in districts to carry out district projects from the beginning to the implementation. For example, by initiating contacts between building owners, mandating a company to develop an Integrated District Renovation Plan, assisting building owners in finding a suitable legal structure among themselves and a contractor or another type of company for implementing a district project

Install or perpetuate local or regional networks of implementing and consulting building renovation actors as they are a link to practical knowledge and an interface to practical needs that can also be used to explain and communicate overarching strategies to the implementation level
Bundle activities for building renovation (including energy efficiency and renewable energy systems) under an umbrella brand for better communication and recognition value
Help to implement local or regional quality networks and standards by co-developing them with implementing actors in building renovation

7. General Derivations & Overall Recommendations

Some general derivations and overall recommendations can be made based on the work of IEA EBC Annex 75. These derivations and recommendations address especially high-level policymakers and call for an enabling environment for an integrated approach to foster the upscaling of building renovation to the district level, combining energy efficiency measures and renewables.

Although an integrated district-oriented approach for encouraging building renovation is best shaped and implemented locally, higher levels can incite action through agenda setting, funding and enabling legal frameworks.

Higher-level policymakers working together with local policymakers and supporting them in integrated and interconnected multi-level governance is essential to move towards climate neutrality fast enough to respect remaining carbon budgets compatible with the 1.5 °C target set in the Paris Agreement.

To achieve this, the following general derivations and overall recommendations can contribute to a framework for implementing the aforementioned practical guidance.

OVERALL RECOMMENDATIONS FOR HIGH-LEVEL POLICYMAKERS	
REGULATIONS STANDARDS AND PLANNING	Provide a legal framework to foster target-orientated building renovations at the district level. Adapt laws and regulations to stimulate building renovation at both the building and the district levels
	Deploy building codes with clear goals and standards aiming at zero-carbon building renovation and an overarching goal of zero-carbon districts
	Guide the deployment of district solutions combining energy efficiency measures and renewables through energy planning covering the entire city
	Create a certification system to set standards also at the cluster and district levels while maintaining high ambitions at the building level
	Promote a holistic approach combining building renovation, urban planning, energy grid development and carbon reduction goals so that overall quality of life can be achieved and residents' acceptance increased
	Support and develop incentives and regulations, as well as coordination and planning at overarching policy levels, and enable local authorities to assume an active role
	Guide local actors and decision-makers by defining a clear and practice-oriented decarbonisation path, developing clear definitions of zero-carbon standards involving a broad spectrum of practitioners

	Take advantage of the time when regular maintenance of building elements or a district grid is required to improve their energy performance and synchronise related renovation activities within a district
	Tighten regulations requiring the use of renewable energy whenever a heating system is replaced or newly installed and ban, at some point, the use of fossil fuel-based heating and cooling systems at international, national, regional and local levels, while strongly supporting vulnerable groups during the transition periods/processes to maintain overall acceptance for decarbonisation
	Require the combination of energy efficiency measures and renewable energy measures in concessions for district heating systems or public tenders
	Ensure that also the peak capacity of large district heating systems is provided through renewable energy
ECONOMIC AND FINANCIAL INSTRUMENTS	Assure financial support to the energy transition to even out potential (initial) adverse socio-economic effects whenever necessary and prevent thereby that the technological district renovation solutions are being neglected due to high initial and coordination costs
	Ensure that financial support favours a combination of energy efficiency measures and renewable energy measures and that counter-productive incentives are avoided
	Provide financial support for the development of integrated district renovation plans that combine both energy efficiency measures and renewable energy measures
	Deploy financial measures and business models to promote ambitious building renovations, including funding for building renovations at the district level
	Provide incentives and subsidies for comprehensive and multi-measured building renovations that are not yet cost-effective
	Facilitate cross-sector business models and the cooperation of energy companies, renovation solution suppliers and housing companies by eliminating possible legal barriers
	Make financial guarantees and funds available not only for individual measures but for the entire process, ensuring the final performance of the renovation project at the building as well as the district level
	Deploy financial schemes for different target groups, especially low-income households, to unburden them from the upfront and following costs of the building renovation upscaling
INFORMATION AND CAPACITY-BUILDING	Offer integrated solutions and services by providing a single point of contact
	Develop collaborative platforms for different target groups, learning networks, and reliable and easy-to-use tools for professionals and end-users, assuring quality in procurement, design, and execution

	Create transparent and accessible databases by enhancing the collection of energy performance information through building inspections, energy audits, smart meter promotion and big data analysis
	Develop online energy maps as an information resource on connection possibilities to renewable energy sources, energy grids and heating/ cooling networks
	Support and promote capacity-building for the whole chain of the renovation process actors
	Raise awareness and ensure effective communication among the district renovation stakeholders from the early stages and throughout the entire process, especially involving residents
	Help to spread information about local examples, inspiring action
RESEARCH	Support R&D to unravel the needed process innovations at local and regional scales, particularly for developing integrated building renovation services for different target groups and at the district scale
	Provide funding to develop and test innovations related to improved renovation measures for reaching decarbonisation
	Explore innovative solutions in research projects beyond the existing legal structure, granting exemptions through sandbox projects

8. Conclusions

As a complement to the comprehensive Guidebook prepared based on the main results and conclusions of the IEA EBC Annex 75 project, this short guide for policymakers summarises the main recommendations addressed to this specific target group to promote the district as an action-level for cost-effective building renovation combining energy-efficiency measures and renewables.

Building renovation at the district level can offer several synergies and cost-effective solutions in addition to building renovation at the individual building level. But, complexity grows with upscaling, and tailored strategies, technology combinations, and policy frameworks are needed together with integrated thinking and cooperation between the different stakeholders.

A major conclusion is that at the district level, there are no "ready-made" or "one size fits all" solutions regarding cost-effectiveness, but several techno-economic potentials of district solutions exist, enabling the development of suitable and tailored solutions to each local context.

Finding a local optimum renovation strategy requires an integrated approach to district-specific building renovation based on cooperation, the balance of needs, in-depth knowledge, information, and regulatory frameworks.

The key factors for a successful building renovation at the district level are effective communication and stakeholder coordination. In particular, the involvement and collaboration of residents in defining the renovation proposal and throughout the entire process are crucial to the acceptance and understanding of the implemented solutions, contributing to a successful renovation project. Local authorities, in turn, can have a vital role in the renovation process as facilitators, mediators, coordinators, and motivators.

While the integrated and district-oriented approach to building renovation is shaped and implemented locally, the role of higher-level policymakers is crucial in establishing agendas, funding, and enabling legal frameworks. Higher-level policymakers working together with local policymakers and supporting them towards integrated and interconnected multi-level governance are essential to advancing our path towards carbon neutrality.

An entire framework needs to be created to make deep renovation the rule rather than the exception. It starts with adapting regulations and building codes to building renovation rather than only new buildings and to the district level as a complement to the single building level.

Policy measures are essential to implement building renovation at the district level because the market is unlikely to deliver district solutions to a large extent, especially as the benefits are often not clearly related to direct economic advantages but to public interests.

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