ANNEX 75

EBC
Energy in Building and Communities Programme

International Energy Agency

Business Models for cost-effective building renovation at district level combining energy efficiency & renewables

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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 Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international co-operation 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 co-ordinates 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 (*)
Annex 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 CO_2 Emissions Optimization in Building Renovation (*)
Annex 57: Evaluation of Embodied Energy and CO_2 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 (*)
Annex 66: Definition and Simulation of Occupant Behavior in Buildings (*)
Annex 67: Energy Flexible Buildings (*)
Annex 68: Indoor Air Quality Design and Control in Low Energy Residential Buildings (*)
Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings
Annex 70: Energy Epidemiology: Analysis of Real Building Energy Use at Scale
Annex 71: Building Energy Performance Assessment Based on In-situ Measurements
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Annex 74: Competition and Living Lab Platform
Annex 75: Cost-effective Building Renovation at District Level Combining Energy Efficiency and Renewables
Annex 76: ☼ Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO_2 Emissions
Annex 77: ☼ Integrated Solutions for Daylight and Electric Lighting
Annex 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications
Annex 79: Occupant-Centric Building Design and Operation
Annex 80: Resilient Cooling
Annex 81: Data-Driven Smart Buildings
Annex 82: Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems
Annex 83: Positive Energy Districts
Annex 84: Demand Management of Buildings in Thermal Networks
Annex 85: Indirect Evaporative Cooling
Annex 86: Energy Efficient Indoor Air Quality Management in Residential Buildings
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

Executive summary

Introduction

IEA EBC Annex 75 aims to investigate cost-effective strategies for reducing carbon emissions and energy use in city buildings at the district level, combining energy efficiency and renewable energy measures. Nevertheless, identifying the technical solutions is not enough to apply large-scale renovation strategies and achieve the projected building stock decarbonisation. Some of the main barriers to renovation involve the renovation cost and access to finance, as well as complexity, awareness, stakeholders' management, and fragmentation of the supply chain. In this context, IEA EBC Annex 75 Sub-task D2 worked on promoting cost-effective building renovation at the district level combining energy efficiency and renewable energy systems, by focusing on the business models (BM) that can make the implementation possible. Business models, which describe the rationale of how an organization creates, delivers, and captures value, are relevant to the implementation and acceleration of renovations and provide a tool to overcome barriers such as split incentives and financial complications, which is a priority for policymakers. The main elements addressed are related to the customers and the value that is offered to them, as well as the activities and partnerships that create this value and the revenue.

In developing and implementing business models, stakeholders are essential, as they constitute or influence the above-mentioned business model elements. Renovation is both a highly multi and inter-disciplinary field and it involves a considerable number of stakeholders. A 'stakeholder' is any person or entity with an interest or concern in the value proposition. In the building market, we can identify three categories of actors: 1) policy actors, such as municipalities or cities, federal/national government bodies, public agencies or institutes; 2) community or demand actors, such as building owners, housing associations or companies, private housing actors or real estate companies, public or social housing actors, residents or neighbourhood associations; and 3) market actors, such as planning and construction parties, urban planners and architects, suppliers of products or technologies, distribution system operators, energy supply companies, financing intermediaries.

Each category has distinct roles and influences in the development of the built environment, which also vary from district to district and from case to case due to the heterogeneity of possible pre-conditions. As part of the built environment, these actors determine the development and implementation of district renovations. Moreover, interaction is essential to develop the technical solutions and the business models required for the renovation implementation. In that respect, we need information and structure that support the stakeholder dialogue, which is the process that enables communication and interaction between the stakeholders. The motives and means of organising stakeholder dialogue differ in varying contexts. This report elaborates on a rather holistic understanding of stakeholders as actors with potential interests or concerns within the narrow or broader context of a business model for building renovation.

The present report aims to identify the key characteristics of business models important for upscaling business from the building to the district level. Understanding those characteristics and gaining insights about the opportunities the BMs offer for the different stakeholders will support the implementation of the renovation and the stakeholder dialogue. The methods implemented in the study included desk research and quantitative analysis of semi-structured interviews.

Findings

The first part of the analysis concluded with a catalogue of business model archetypes for energy renovation and a catalogue of business models for energy supply. The business model archetypes for building renovation are characterised by 1) the way the renovation is managed, 2) the role of the beneficiary/building owner, 3) the involvement of intermediaries and project managers, and 4) the return of the renovation savings. The present study compiled a catalogue of business models for energy-efficiency renovation by identifying four archetypes that summarize the current approaches. The four archetypes are the following: Atomised, Market intermediation, One-stop-shop, and Energy Service Company (ESCO).

As with any general classification, there are variants in all business models, and the conceptual dividing line from one to another might sometimes be difficult to define. For example, One-Stop-Shops can extend their services from construction to post-construction monitoring if requested, or sub-contract the consultancy phase to a trusted actor. Moreover, the simplification required to define archetypes must be considered. However, the archetypes distinctly highlight the difference in the process organisation and the integration of the solutions and financing.

Concerning energy supply, there is a large variety of business models. Six business model archetypes were identified, which can be split into several types and even sub-types. For the energy supply, three kinds of business model approaches can be defined: demand response (DR) and energy management systems (EMS); electrical and thermal storage (ETS); solar PV businesses (PV). Sub-categories within the three main approaches can be defined as BM archetypes.

Reviewing existing business model archetypes, stakeholders showed that no specific business model combines energy supply and energy-efficient district renovation. Some building renovation projects already apply RES, such as PV panels on the buildings' roofs. The scale is small and is not always combined as a business model. Even though this fragmentation in the business model hinders the implementation, new players can create business models that offer combined values at the district scale.

In addition, the analysis of success stories further highlighted the elements of the business models that were applied to district renovation. In all the success stories analysed, the main value propositions were the improvement of thermal comfort and the reduction of energy use and environmental impact. Additional value propositions were related to improving the overall living quality and the district's quality. The customer segment was the building owner and the building user, as tenants and energy consumers. In most cases, part of the investment came through public money, either as direct financing or subsidies to homeowners or other frameworks. In large renovation projects, the atomised market model is not common regarding the archetypes. This model could be more applicable in the case of maintenance, with the objective of single measures.

In projects focusing on the connection, modernization and expansion of district heating, the decision-maker was a policy actor, mainly the municipality, in collaboration with the energy supplier that would carry out the intervention. The building owners, such as housing associations, were involved in the connection implementation process. When combined with building renovation, the financing was arranged separately. Thus, the district heating interventions generally are not part of the renovation business model process. Separate entities execute them and do not share a business model. Some building-level measures that comply with the district heating, such as low-temperature radiators, are included in the buildings' energy efficiency renovation packages. As concluding remarks on the success stories of business models and financing, the role of public bodies can be highlighted, such as regional bodies, municipalities, and their affiliated housing associations, in the decision-making and funding of larger projects.

IEA EBC Annex 75 expert workshops and interviews confirmed that demand actors, such as homeowners and housing associations, had been identified as the business models' main decision-makers and customer

segments. Additionally, policy actors have a big influence on decision-making, particularly for district-scale implementation, and thus, they need to be addressed by the business models. To combine actors to upscale and combine EE+RES, policy actors have found that structures such as revolving funds, energy cooperatives, and initiatives that can offer a guarantee with public money can support the process to unburden the households of the initial renovation cost. Setting up a network and good practical examples are important for the combined business model development. Subsidies help a lot, but these must not only be available for individual measures (heating conversion) but for the entire process. Financial intermediaries point to a strong direction from national governments to provide the framework for innovative financial structures. Most importantly, funding is needed to support and moderate the process, particularly considering that, at the district level, these are long-term processes.

Even though no specific business models for energy supply are applied to the renovation of districts, some of their characteristics can support the development of business models for district renovation that combine energy efficiency and RES. The analysis of existing business models, success stories and the stakeholders' views on opportunities to upscale energy-efficient renovation to districts has highlighted the following aspects to consider when developing the business models.

Value proposition: The business model should offer an integral approach beyond the energy efficiency the technical solution achieves. Additional value propositions should be related to improving the overall living quality and the district's quality. Improved thermal comfort and lower energy costs for tenants can be combined with improved appearance and attractiveness of the area, resulting in the increased value of the properties.

As the complexity of multiple interventions on the district scale increases, the business model must offer one main point of contact as part of the service, such as in the case of one-stop-shops. The service should include technical advice for energy efficiency renovation and integration of RES, coordination of the solution providers and the construction, financial arrangements, such as subsidies and loan applications, and EPCs.

Partnerships: To upscale renovation to districts and integrate renewable energy, it is clear that both renovation and energy supply actors need to collaborate and offer a combined value proposition. Communication and financial intermediaries also need to be considered because such services can be part of the value proposition.

The role of energy network providers is significant. With the integration of RES, districts are becoming energy producers and their place in the energy infrastructure needs to be considered. Policy partners need to be involved to support the communication and build trust between the beneficiaries and the market actors. Moreover, they need to guarantee a long-term commitment and connect this business model and respective interventions to the larger district development and energy transition plan.

Financing: With the increasing complexity of the energy supply in building clusters, the partition of Energy Service Companies (ESCOs) of the total market should steadily increase. The streamlined financing could provide multiple benefits, such as improved quality and value and smart project management. The public sector is in a position to balance various local objectives, including cheaper local energy for the public, private and residential customers (contributing to alleviating fuel poverty), local job creation, local wealth retention, low-carbon power generation and/or local air pollution reduction. By quantifying these objectives through economic modelling, it is possible to create additional value for new financial models.

Communication: Communication among the stakeholders and particularly the dialogue with the residents to build trust and awareness is key for the upscaling of energy renovations and combination with renewable energy supply. It should underline the common societal goal for decarbonisation but also understand the individual district's needs. Ecologic conscience is well developed these days but still cannot be built on as a trigger for high and uncertain investments. The intrinsic motivation from affected actors is usually quite low. A good approach is to address the energy and sustainability benefits in a regular renovation cycle. Transparency and clear communication about costs and benefits are necessary.

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Abbreviations

Abbreviations	Meaning
BM	Business Model
CHP	Combined-Heat-and-Power
CO_2	Carbon dioxide
DER	Distributed Energy Resources
DH(C)-network	District Heating (Cooling) network
DR	Demand Response
DRP	Demand Response Provider
DSO	Distribution Network Operators
EE	Energy Efficiency
EMS	Energy Management Systems
EPC	Energy Performance Contract
EPP	Energy Planning Process
ESC	Energy Service Contract
ESCO	Energy Service Company
ESG	Energy, Social and Governance
ETS	Electrical and Thermal Storage
EU	European Union
FERC	Energy Regulatory Commission (US)
GHG	Green House Gases
HVAC	Heating Ventilation Air Conditioning
ICT	Information and Communications Technology
ISO	Independent System Operators
LCC	Life-Cycle Costing
M&V	Measurement and Verification
NECP	National Energy and Climate Plan
NNK	Netto Null Kollektiv (Net Zero Collective)
OSS	One-Stop-Shops (OSS)
PE	Primary Energy
PV	PV panels
PV/T	PV / Solar Thermal Collector hybrid panel
RE	Renewable Energy
RES	Renewable Energy Supply
RTO	Regional Transmission Operators
SO	System Operator
SPE	Special Purpose Entity
SPV	Special Purpose Vehicle
STC	Solar Thermal Collectors

TSO	Transmission System Operators
USC	Utility-Sponsored Community
V2G	Vehicle-to-Grid
VPP	Virtual Power Plant

Definitions[1]

Various IEA EBC Annex 75 reports use a common language for communication between local authorities, professionals, researchers, inhabitants and, in general, all stakeholders and international partners.

Each term is defined in the context and scope of IEA EBC Annex 75, namely building renovations at the district level, and combines definitions from the European legal framework, common definitions of English dictionaries, related projects, research papers, and other professional publications. The concepts are sorted alphabetically.

Actors: The persons and entities active during the planning and implementation of energy renovation processes in buildings and districts.

Assembly of homeowners/ homeowner association: An organisation managed by the persons and entities that own parts of a building or district that aims at building maintenance and/or improving the overall conditions and livelihood of the building and its environment.

Asset manager: A person or company that manages assets to achieve a specific investment goal as set out by their clients. In the context of IEA EBC Annex 75, this refers to asset managers that invest in energy efficiency with a long-term perspective related to building renovation or operation. This permits an additional financing mechanism, so building owners may obtain additional funding, outsourcing the energy management to third-party regulated asset managers. (Sesana et al., 2019) (EFAMA, 2018) (Kamelgarn and Hovorka, 2013).

Building inspection: An official visit to a building to check the building's energy performance on-site. These visits are often based on the main parameters included in the Energy Performance Certificate (EPC) of the building. The detailed level of the verification may differ by country and include other building aspects such as the structure, construction pathologies, building accessibility and indoor health conditions.

Building manager: A person or company that manages buildings, keeping owners, landlords and tenants informed about the current situation of the building, calculating the future needs and assisting during the decision-making process. They are also known as property managers, real estate managers or facility managers, when respectively properties, real estate or facilities are managed.

Building renovation: An improvement of the building envelope or the energy system of a building, at least to restore its functionality, and usually to improve its energy performance. Within IEA EBC Annex 75, building renovation is understood to refer to energy efficiency measures in buildings, particularly on building envelopes, as well as renewable energy measures in buildings, in particular for heating or cooling purposes, whether through a decentralised energy system of a building or a connection to a centralised district heating/cooling system.

[1] A comprehensive list of all IEA EBC Annex 75 definitions can be found here: (Hidalgo-Betanzos et al., 2023) - https://annex75.iea-ebc.org/publications

Building renovation passport: An electronic or paper document outlining a long-term (up to 10 or 20 years) step-by-step renovation roadmap and repository or logbook for a specific building. Depending on the country or regional definition, this passport may include the most relevant building information such as original design files, building plans, as-built files, environmental files, energy consumption and production, executed maintenance, energy audits and user-friendly information on effects and benefits of an energy renovation – for example in terms of reduced heating bills, improved comfort, and CO_2 savings (BPIE, 2019).

Business model: A model that describes the value logic of an organisation in terms of how it creates and captures customer value, and which can be concisely represented by an interrelated set of elements that address the customer, contain a value proposition and address organisational architecture and economics dimensions (Fielt, 2014) (Seddon et al., 2004) (BPIE, 2016) (Laffont-Eloire et al., 2019).

Carbon emissions: Shorthand expression used by IEA EBC to represent all greenhouse gas emissions to the atmosphere (this means carbon dioxide, methane, certain refrigerants, and so on) from the combustion of fossil fuels and non-combustion sources such as refrigerant leakage. It should be quantified in terms of 'CO_2 equivalent emissions'.

Community organisation: A local institution integrated by people, commerce, companies, and any other agents located within a district or urban area that aims at making desired improvements to a community's social health, well-being, and overall functioning.

Cooperative: An autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (WECF, 2017). In this sense, an energy cooperative can be, for example, a private, non-profit company whose purpose is to deliver renewable energy or renovation services to its customers or members.

Cost-optimal level: The energy performance level which leads to the lowest cost during the estimated economic life cycle of a building (European Commission, 2010).

Customer confidence: The feeling or belief, in IEA EBC Annex 75 report, related to the building renovation project, that customers can have faith in the proposed values or rely on the ability of the service providers such as the suppliers, intermediate agents, One-Stop-Shops, ESCOs, etc.

Customer segments: Groups of customers that have common interests, characteristics or needs. Segmentation aims to identify the most relevant groups and their priorities as a tool to improve the stakeholders' dialogue and business model.

Customer value: The (expected) satisfaction the customer experiences by taking a given action relative to the cost of that action. Key customer values for building renovation are, for example, less of a burden on the client, lower life-cycle costs, guaranteed quality or energy performance agreements (Haavik et al, 2012) (Mlecnik et al. 2013) (Mahapatra et al. 2013) (Van Holm et al. 2016).

Debt financing: A financing mechanism for building renovations based on the expense of private savings or through mortgages or loans. Debt financing typically needs to be compatible with restrictions associated with the existing mortgage on the properties (Bertoldi et al., 2021).

Deep renovation: A renovation which transforms a building or building unit into a nearly zero-energy building (until 2030) or a zero-emission building (after 2030), according to the latest European Commission proposal (European Commission, 2021). The previous EU legal framework didn't define deep renovations in detail, but they were typical of more than 60% energy savings. (European Commission, DG Energy, 2014) (BPIE – Deep renovation, 2021).

Demanding actors: The stakeholder category that typically includes the client or beneficiary of building renovation or renewable energy projects. It can be a private owner or an assembly of homeowners. In this work, housing associations, housing cooperatives and housing companies are also considered as part of this category, as they own buildings to be renovated. Depending on the situation, such demand organisations can be private or social, public, semi-public, or mixed.

District: A group of buildings in an area of a town or city that has limited borders chosen for purposes of, for example, building renovation projects, energy system planning, or others. This area can be defined by building owners, local government, urban planners, or project developers, e.g. along realities of social interactions, the proximity of buildings or infrastructural preconditions in certain territorial units within a municipality. IEA EBC Annex 75 focuses on residential buildings, both single and multi-family houses, but districts with other buildings with similar characteristics, such as schools or simple office buildings without complex HVAC systems, can also be included in the district.

District heating or District cooling: A centralised system with the distribution of thermal energy in the form of steam, hot water, or chilled liquids, from a central production source through a network to multiple buildings or sites, for use in space heating or cooling, domestic hot water, or other services.

Economic aid: A funding programme offered by local, national, and other public authorities and, in some cases, also semi-private institutions, to help improve the energy efficiency, health or other conditions in residential buildings.

Energy audit: A systematic assessment of the energy needs and efficiency of a building or set of buildings. The international norm EN 16247-1: 2012 defines the procedure to analyse energy use and energy consumption within a defined energy audit scope to identify, quantify and report on the opportunities for improved energy performance. There are three main types: Walk-Through Audit (basic), Energy diagnosis (medium) and Investment Grade Audit (detailed) (Energuide BE, 2020).

Energy bill (utility bill): As a part of utility bills, the energy bills comprise the costs of the energy services supplied for building owners and tenants, such as heating, cooling, hot water, electricity, gas and others. These bills generally include the tariff standing charge, the energy use during the billing period, and energy tax and distribution costs.

Energy carrier: A substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes. An energy carrier is a transmitter of energy that includes electricity and heat, as well as solid, liquid, and gaseous fuels. The energy carriers occupy intermediate steps in the energy-supply chain between primary sources and end-user applications (IPCC, 2007).

Energy Performance Certificate: An official energy-efficiency evaluation of a building or part of a building aiming at informing building owners, occupiers, and property actors on the energy performance of their buildings so that they can compare and assess different buildings and make informed decisions. Energy Performance Certificates are often accompanied by advice and practical information on how to improve the energy efficiency of buildings and their performance class (BPIE – Glossary of Terms, 2021).

Energy Performance Contract: Agreement between the homeowner or renter and a lender to provide financing for a building energy efficiency renovation. The energy performance contracts can be tied to real energy savings, in which case the lender assumes part of the risk, or to a flat rate, in which case both parties share financial risks. This agreement usually requires the involvement of a retail energy supplier (European Commission, DG Energy, 2014).

Energy performance of a building: The calculated or measured amount of energy needed to meet the energy need associated with the typical or standard use of the building services.

Energy poverty: A set of conditions where individuals or households are not able to adequately heat or provide other required energy services in their homes at an affordable cost. (Pye et al., 2015). There are three main components: low household income; high/growing energy prices; and inefficient energy performance of buildings concerning thermal insulation, heating systems and equipment (Thomson and Bouzarovski, 2019) (EU Energy Poverty Observatory, 2020).

Energy Service Company (ESCO): A company that offers long-term services to cater to all the building renovation project needs using Energy Performance Contracts (EPCs) as a financing mechanism based on ongoing energy performance guarantees. These EPCs are based on a long-term relationship with the customer, which can include renovation project design, retrofitting works, energy systems and renewable energy systems monitoring, operation and maintenance, fuel supplies, security management, savings justifications, and utility bills management. ESCOs might offer all the project services in-house or outsource some of them (Brown et al., 2019).

Energy solution providers: Stakeholder category identifying actors that provide renewable energy systems and services to the demanding actors. They can be, for example, Distribution System Operators (DSOs), Transmission System Operators (TSOs), energy supply or renewable energy companies, energy service providers, heat grid operators, aggregators, energy monitoring providers, energy cooperatives, and so on.

Energy source: Source from which useful energy can be extracted or recovered either directly or by means of a conversion or transformation process.

Energy tariffs: The way energy providers charge building users or renters for their effective energy use, such as electricity, gas, heating, cooling, hot water, and so on. Tariffs can be fixed or variable. A fixed-rate tariff sets a cost of energy for a certain amount of time, typically one year or more, while variable tariffs can go up or down according to the market or establish categories defined by other parameters.

Equity: A type of financing mechanism for building renovations that introduces a third-party lender who prefinances the renovation and receives a cut from the project's revenues, tying repayment to a monthly rate which gives access to energy savings.

Feed-in tariff (FIT): To promote renewable energy generation, some support schemes define fixed electricity prices paid to renewable energy producers for each unit of energy produced and injected into the electricity grid. The payment of the FIT is guaranteed for a certain period that is often related to the economic life of the respective renewable energy project (usually between 15-25 years). Another possibility is to calculate a fixed maximum number of full-load hours of renewable energy electricity production for which the FIT will be paid. FIT is usually paid by the electricity grid, system, or market operators, often in the context of Power Purchasing Agreements (PPA) (Energypedia UG Nonprofit, nd).

Financial incentives: Financial instruments provided by public authorities and/or private institutions that address financial and investment gaps. Particularly, building renovations can be expensive and owners may not have the means to finance energy efficiency and renewable energy measures.

Financial intermediary: The actor or body acting as an intermediary between the supply and demand of financial products (European Commission, DG Energy, 2014).

Financing: The act of obtaining or furnishing the money required for purposes related to building renovations, such as building energy-efficient measures, renewable energies implementations or other decarbonisation measures. Energy-efficient building renovations can be expensive, and owners may not have the means to finance them. Financial instruments provided by public authorities and/or private institutions can help solve this issue and address financial and investment gaps.

Funding: The money provided, especially by an organisation or government, for purposes related to building renovations, such as energy-efficient measures or renewable energy implementations (European Commission, DG Energy, 2015).

Grant: A type of funding given by local, regional and/or national public authorities (and, in some cases, also semi-private institutions) that the recipient does not have to repay for special purposes or requirements of energy efficiency measures and renewable energies implementation.

Housing association: An association that owns, lets and manages rented housing, usually under special conditions, for people that cannot reach the market or rented housing due to vulnerability or other socio-economic situations.

Intermediaries: Stakeholders that act as a third party and interact or connect between supply and demand, for example, between demanding actors and energy and renovation solution providers. Intermediaries may have more experience and expertise compared to the homeowner, therefore being able to deliver a more comprehensively/thoroughly researched solution.

Investors: Stakeholders that act as clients or beneficiaries of building renovation or renewable energy projects. There is a wide range of demand organisations which can be private or social, public, semi-public, or mixed, depending on the situation. For instance, private owners or assemblies of homeowners are typically in this category, as well as investment funds, housing associations, housing cooperatives and housing companies, as they may be owners of buildings to be renovated.

Land use: It refers to the socio-economic purpose of the land. Land areas can be used for residential, industrial, agricultural, forestry, recreational, transport and other purposes. Often, the same land is used for several purposes at the same time; for example, the construction can be used for commercial, recreational or residential purposes (European Commission - EUROSTAT, 2020).

Landlord: The person, institution or agent who rents a housing or building owned by them.

Local policy: Policy developed, controlled, or enforced by local public bodies to promote building renovation in number and depth. Local policy is made by the locally elected council and is implemented by the municipal administration. A wide range of persons and entities can act within the local policy framework, such as district developers, urban planners, municipality departments and regional institutions.

Nearly zero-energy building (nZEB): A building with a very high energy performance, where the nearly zero or very low amount of energy required should be covered to a significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby (European Commission, 2010).

Non-renewable energy: Energy taken from a source depleted by extraction (e.g., fossil fuels).

One-Stop-Shop (OSS): An office that offers a single point of contact catering to all building renovation project needs, not only as an intermediate agent but aiming to provide energy efficiency or renewable energy with an integrated solution. A typical set of services offered by the OSS includes preliminary evaluation, energy audit and scenario analysis, design, arrangement of third-party financing, procurement, outsourced manufacturing and installation, and performance testing to verify the system in operation (Haavik et al., 2012; Styczynska and Zubel, 2019).

Policy instrument: A new regulation, support scheme, communication programme or organisational service defined by policymakers. Within IEA EBC Annex 75, policy instruments intend to increase the building renovation rate (number of renovations undertaken due to economic and organisational & mobilisation potentials) and/or renovation depth (higher energy efficiency and more renewables due to the technological potentials). The instruments often serve specific purposes within a policy strategy, including multi-level actions and multi-actor governance (Rosenow et al., 2016; BPIE, 2018). For example, EU Regulations (European Commission, 2012) identify policy instruments such as (article 7): energy efficiency obligations; energy or CO_2 taxes; grants; loans; on-bill finance; tax rebates, regulations; voluntary agreements; standards and norms (that aim at improving the energy efficiency of products and services); and energy labelling schemes.

Prosumer: Individuals who consume and produce value, either for self-consumption or consumption by others, and can receive implicit or explicit incentives from organizations involved in the exchange (Lang et al., 2021).

Public actors: Stakeholder category for identifying policy actors on various levels and scales (municipality; county council, provincial/ regional government; federal/ national governmental body, other), as well as public agencies, such as innovation or energy agencies and public services.

Renewable energy: Energy from sources that are not depleted by extraction, such as wind power, solar power, hydroelectric power, ocean energy, geothermal energy, heat from the ambient air, surface water or the ground, or biomass and biofuels. These alternatives to fossil fuels contribute to reducing greenhouse gas emissions, diversifying the energy supply and reducing dependence on unreliable and volatile fossil fuel markets, particularly oil and gas.

Renovation: Construction activities related to interventions onto existing buildings or connected infrastructure. These interventions range from simple repairs and maintenance to adaptive conversion, transformation, and reuse. In the framework of IEA EBC Annex 75, renovation can refer to both renewal/retrofit of building envelopes and energy system changes.

Renovation solution providers: Stakeholder category that identifies actors providing renovation systems and services to demand actors. They typically include planning actors, such as urban planners, architects, landscape designers, or more general design teams, contracting and service parties, such as main contractors and subcontractors, facility managers, installers and suppliers, or more general integrated project teams and one-stop-shops, that unburden the demand actors from A to Z.

Revenue stream: The way an organisation generates revenue from value propositions successfully offered to customers within a building renovation process.

Revolving energy efficiency fund: A type of equity (financing mechanism) that offers a low but stable return on investment with good Energy, Social and Governance (ESG) ratings and binds reinvestment of the steady revenues into pre-set options. Fund equity can also be crowdsourced (Webber et al., 2015).

Social housing: A type of housing particularly oriented to vulnerable people who cannot afford the market cost of rent due to vulnerability or other socio-economic situations. It can also refer to the institutions that manage these homes and associations that own, let, and manage social housing. Social housing associations, institutions or councils can become key partners in scaling up building renovations due to their market presence as landlords of a considerable number of dwellings. Social housing might be offered by not-for-profit or market actors.

Special purpose vehicle: A subsidiary company that is formed to undertake a specific business purpose or activity. SPVs are commonly utilised in certain structured finance applications and support specific transactions, including public-private partnerships and project finance (Sainati et al., 2020).

Stakeholders: The persons, homeowners, companies, public institutions and in general every agent with an interest or concern in an ongoing or future project. The stakeholders in renovation projects can be a wide and diverse list of agents, including decision-making actors and also other involved participants that can influence the success or failure of the renovation process.

Stakeholder dialogue: The process whereby a lead actor, usually a local administration, facilitates communication and interaction with stakeholders, particularly also building owners, in a certain community area/neighbourhood/district to get them going in the direction that is politically favoured i.e., climate neutrality, energy efficiency, enhanced use of renewables. This dialogue can be implemented through various formats of information and communication and can be based either on regulations (if applicable) or on persuasion and commitment.

Subsidy: A financial incentive given by authorities to partly or fully offset the costs related to building renovation or renewable energy implementation over a lengthy period.

Tax incentive: A reduction in taxes for building owners or landlords oriented to encourage a certain level of building energy efficiency, renovations, the installation of renewable energies or other energy-efficiency measures.

Trust: A firm belief of customers and stakeholders in the reliability and truth of the building renovation project, in authorities, in other building owners for developing joint projects, or in the ability of the service providers such as the suppliers, intermediate agents, One-Stop-Shops, ESCOs, etc.

Value proposition: The way the organisation or organisations leading the building renovation project seek to solve the customer problems and satisfy their needs according to their values.

1. Introduction

1.1 General Context

To decarbonise the built environment, renovation strategies at the building level need to combine energy efficiency upgrades and renewable energy, in line with the EU's framework "Clean Energy for All Europeans package", which highlights the need to increase the energy efficiency of buildings through renovation while leading the uptake of renewable energy (European Commission, 2019). Combining energy efficiency and renewable energy sources addresses both energy supply and demand in the built environment. While building retrofitting is an appropriate strategy to reduce demand, using renewable energy aims to decarbonise the energy supply system.

These renovations, however, often need to be deployed at the district or city scale to make a more meaningful impact. Therefore, IEA EBC Annex 75 aims to investigate cost-effective strategies for reducing carbon emissions and energy use in city buildings at the district level, combining energy efficiency and renewable energy measures. The Annex defines a methodology to identify which strategies are most energy-saving and cost-effective (Bolliger et al., 2023), with the objective of guiding policymakers, companies working in the energy transition field, and building owners for cost-effectively transforming the city's energy use in the existing building stock towards low-emission and low-energy solutions.

Nevertheless, identifying the technical solutions is not enough to apply large-scale renovation strategies and achieve the projected building stock decarbonisation. The renovation rate in Europe remains well below the targeted annual 3% (Artola et al., 2016; Laffont-Eloire et al., 2019). Some of the main barriers to renovation involve the renovation costs and access to finance, as well as complexity, lack of awareness, stakeholders' management and fragmentation of the supply chain (Artola et al., 2016; BPIE, 2011).

Given the limitations due to available financial resources and the large number of investments needed to transform the cities' energy use in buildings, identifying cost-effective strategies and policies is important for accelerating the necessary transition towards low-emission and low-energy districts. To this end, business models are relevant to the implementation and acceleration of renovations. A well-designed business model also provides a tool to overcome barriers such as split incentives and financial complications, which is a priority for policymakers.

1.2 Elements of a business model

A business model describes the rationale of how an organization creates, delivers, and captures value (Bystedt et al., 2016). Seddon et al. (2004) define "business model" as the outline of essential details of a firm's value proposition for its various stakeholders and its activity system to create and deliver it. In other words, a business model is the abstraction of a strategy focused on the system of activities through which a firm makes economic value. The value proposition is the total sum of benefits promised by the firm. If payment is associated with the value proposition, the firm becomes a vendor, and the stakeholder who performs the payment becomes a customer.

The main elements addressed are related to the customers, the value offered to them, the activities that create this value, and the revenue. Multiple studies compare, summarise and integrate the elements a business model should contain (Pekuri et al., 2013). Osterwalder et al. (2009) identify nine main blocks that compose the business model:

- **Customer Segments**: who the organization's customers are.
- **Value Propositions**: how the organization seeks to solve customer problems and satisfy customer needs.
- **Channels**: how the organization delivers customer value propositions through communication, distribution, and sales.
- **Customer Relationships**: how the organization establishes and maintains relationships with each customer segment.
- **Cost Structure**: the costs the organisation incurs from value propositions successfully offered to customers.
- **Revenue Streams**: how the organisation generates revenue from value propositions successfully offered to customers.
- **Key Resources**: the assets required to provide and deliver the elements above.
- **Key Activities**: the activities required to offer and deliver the elements above.
- **Key Partnerships**: the activities outsourced to offer and deliver the elements above.

1.3 Stakeholders' categorisation

In developing and implementing business models, stakeholders are essential, as they constitute or influence the above-mentioned business model elements. Renovation is both a highly multi and inter-disciplinary field, and it involves a considerable number of stakeholders (Kamari et al., 2017).

In the context of the built environment and the need for decarbonisation, renovation actions also represent a new and powerful source of business for the various stakeholders involved in the whole process (Moschetti & Brattebø, 2016).

A 'stakeholder' is any person or entity with an interest or concern in the value proposition. In the building market, we can identify three categories of actors (Avelino & Wittmayer, 2016). Those categories, as shown in **Figure 1,** are:

- **Policy**, such as municipalities or cities, federal/ national government bodies, public agencies, or institutes.
- **Community**, such as building owners, housing associations or companies, private housing actors or real estate companies, public or social housing actors, semi-public or mixed, residents or neighbourhood associations.
- **Market**, such as planning and construction parties, urban planners and architects, suppliers of products or technologies, distribution system operators, energy supply companies, and financing intermediaries.

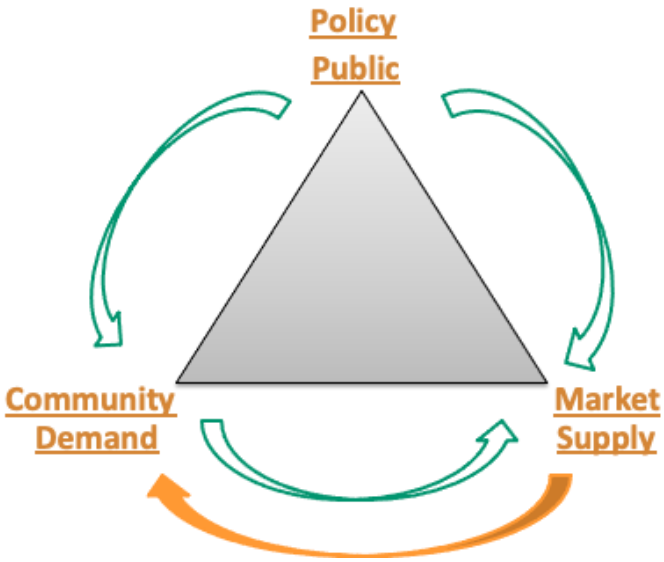

Figure 1. Three categories of actors (adapted from: Avelino & Wittmayer, 2016).

Each category has distinct roles and influences on the development of the built environment, which also vary from district to district and from case to case due to the heterogeneity of possible preconditions. As part of the built environment, those actors determine the development and implementation of district renovations. Moreover, interaction is essential to develop the technical solutions and the business models required for the renovation implementation.

In that respect, we need information and structure that support the stakeholder dialogue, which is the process that enables communication and interaction between stakeholders. The motives and means in the organisation of stakeholder dialogue differ in varying contexts. This report elaborates on a rather holistic understanding of stakeholders as actors with potential interests or concerns within the narrow or wider context of a business model for energy renovation. Looking at practical guidance for energy renovation for a certain target group, a stronger focus on mobilisation of energy renovation through stakeholder dialogue is purposeful and applied, e.g., in the IEA EBC Annex 75 report 'The District as Action Level for Building Renovation Combining Energy Efficiency & Renewables: Making use of the Potentials – A Guide for Policy and Decision Makers' (Meyer et al., 2023). From this perspective, stakeholder dialogue is organised by policy and decision-makers and addresses potential investors (mainly home and infrastructure owners and operators) with the aim of mobilising investments in energy renovation at the district level.

1.4 Objective and outline of the report

IEA EBC Annex 75 Sub-task D2 focuses on promoting cost-effective renovation at the district level combining energy efficiency and renewable energy systems, by focusing on the business models (BM) that can make this implementation possible. The research on BMs is still limited within the construction and building sector, as pointed out in (Abuzeinab & Arif, 2014). Furthermore, retrofitting for energy efficiency combined with renewable energy at a district scale is a complex process that includes different decision-making mechanisms by different stakeholders, which need to be identified before designing a business model applicable to such retrofitting actions.

The present report aims to identify the key characteristics of business models that are important to upscale business from building to the district level. Understanding those characteristics and gaining insights about the opportunities the BMs offer for the different stakeholders will support the implementation of the renovation and the stakeholder dialogue.

To this end, the main research questions addressed in the work of IEA EBC Annex 75, Sub-task D2 are the following:

Q 1: *Are the current practices in BM for renovation and energy supply applicable to district renovation?*

Q 2: *Who are the main stakeholders and what is their role in the BM for district renovation to combine energy efficiency and Renewable Energy Supply (RES)?*

Q 3: *Which business model's characteristics are important to upscale district renovation to combine energy efficiency and RES?*

To answer those questions, the present study consists of the following components.

1. **Identification of business model archetypes**: An overview of existing practices is needed as a first step to understanding the role of business models in the renovation. This part of the study builds upon existing literature to gain insights into the current distributed energy business model landscape (**Chapter 2 and Chapter 3**).

2. **Key considerations in combining renovation and energy supply business models:** After the overview of business model archetypes, some key considerations that can support the development of district demand and/or supply of energy-efficient renovations and/or renewable energy solutions are discussed, targeting various stakeholders (**Chapter 4**). Those considerations are based on the analysis of success stories and the opportunities and barriers discussed in the BM archetypes in the previous chapters.

3. **Stakeholders' views**: Based on the findings of the previous chapters, relevant stakeholders in different countries offer their insights during in-depth, semi-structured interviews. The information, processed through qualitative analysis, aims at confirming and further elaborating on the key consideration about the upscaling of renovation at the district scale (**Chapter 5**).

4. **Conclusion and guidelines on the main characteristics of business models**: Literature review, identification of archetypes and key considerations, and analysis of the stakeholder views resulted in an overview of the BM elements that are important to upscale district renovation to combine energy efficiency and RES, and guidelines tor develop the BM and support stakeholder dialogue (**Chapter 6**).

2. Business models for renovation

2.1 Introduction

Building renovation has always been an important activity in the construction industry, as it forms part of the building's life cycle. In recent years, due to widespread awareness of an escalating environmental emergency, efforts to increase the energy performance of the building stock have intensified. These efforts have resulted in regulatory measures and policies aimed at increasing the rate of energy retrofitting of existing buildings (DIRECTIVE, 2010/31/EU, 2012/27/EU). In 2019, the EU completed a comprehensive update of its energy policy framework to facilitate the transition from fossil fuels, deliver on the EU's Paris Agreement commitments and provide an important contribution to the EU's long-term strategy to achieve carbon neutrality by 2050. This new 'energy rulebook' is called the 'Clean Energy for all Europeans package' and consists of eight legislative acts. Among others, the Energy Performance of Buildings Directive (DIRECTIVE, 2018/844/EU) updates and amends many provisions from Directive 2010/31/EU. The recast renewable energy directive entered into force in December 2018 to show global leadership in renewable energy. The governance regulation includes drafting 10-year national energy and climate plans (NECPs) for each Member State (European Commission, 2019).

Building industry practitioners have recognised a large market potential opened by these policies. As a result, different business models (BM) for energy retrofits have been proposed and implemented. The business model's implementation is instrumental in making the renovation feasible and cost-effective. These business models range from the traditional 'atomised' and market intermediation models (Brown, 2018) to the emerging and more innovative One-Stop-Shop (Laffont-Eloire et al., 2019) and Energy Service Companies (ESCOs) models (Moschetti & Brattebø, 2016).

The existing business models and examples gathered in this report are sourced from European projects, IEA EBC Annex 75 workshops, and literature. The study analyses literature sources that provide reviews of related business models, such as (Brown, 2018; Burger & Luke, 2017; Gouldson et al., 2015; Haavik et al., 2014; Laffont-Eloire et al., 2019; Mlecnik et al., 2019; Moschetti & Brattebø, 2016; Teece, 2010).

The resulting business model overview is presented as a catalogue organised based on business model archetypes. The scope of each archetype is explained, and examples of their application are provided. Furthermore, financing mechanisms are discussed, as they are essential to the business model. Finally, the assessment of each archetype highlights barriers and opportunities for their implementation at the district level.

2.1.1 Financing mechanisms

Financing mechanisms for the renovation (without considering policy instruments, such as grants or subsidies) organize how investment sources generate revenue flows to cover cost structures. We usually distinguish between two sources of investment: debt and equity. When financing a project, debt is money lent to investors. Institutions or individuals become creditors and receive a principal or interest on the debt, which will be repaid regularly. Equity financing is the process of raising capital by selling shares in a company. Institutions or individuals become shareholders.

Debt: savings and mortgages

Traditional financing mechanisms for building energy renovations tap into debt through mortgages or private savings. Central or local governments support homeowners through subsidies, usually aimed at individual technologies, or dedicated development funds e.g., policy tools aimed at using public budgets to ease lending conditions. Private debt can be difficult to obtain for many homeowners. In contexts with high social-economic vulnerability or affected by energy poverty, the financing will likely require singular solutions with a higher share of public financing, adapted to each owner's situation.

Equity: funds and Energy Performance Contracts

Financing integral building energy renovation through debt has not been a successful strategy so far, judging from the slow pace of renovation rates. An emerging strategy is to replace financing for this type of project from debt (savings) to equity (shares). The essential aspect of the shift from debt to equity financing is the introduction of a third-party lender who pre-finances the renovation and receives a share of the project's revenues, tying repayment to a monthly rate which gives access to energy savings.

This financing mechanism allows expanding the value proposition (service) from just homeowners/occupiers to including renters as well. Misaligned incentives between building owners and building occupants have been recognised as one of the barriers to building energy renovations. Solving this barrier gives companies and organisations a competitive advantage in the retrofit market. This also helps address energy poverty, enabling households to overcome high upfront costs (European Commission, 2020; Turai et al., 2021).

The repayment is structured in regular (usually monthly) instalments charged to the beneficiary of the service. Choosing between repayment options depends on who the lender is. The lender needs to earn a reasonable rate of return over a pre-determined period, generally 20 to 30 years.

As these are long-term agreements and tenancy or ownership might change over the lifetime of the upgrade, one option for ensuring that the beneficiary pays for the efficiency improvement is to tie the agreements to the property instead of to the individual, a concept called building-linked financing. The contract is transferred to the new user if the property gets sold or rented to a new customer.

There are multiple ways to structure the monthly repayment to the lender, such as the following:

- Through an extra levy on property tax. This agreement usually requires the involvement of a governmental agency or regulatory body.
- Through an energy performance contract (EPC). EPCs can be tied to real energy savings, in which case the lender assumes part of the risk, or to a flat rate, in which case both parties share financial risks. This agreement usually requires the involvement of a retail energy supplier.

The equity for pre-financing building energy retrofits can be engaged from capital markets through dedicated investment funds. These funds are often called 'green funds', 'energy efficiency funds', etc. Actively managed funds can capture savings from investments in energy efficiency and other forms of sustainable development projects and reinvest them, through a special purpose vehicle (SPV), in similarly low-carbon investments. This is then called a 'revolving energy efficiency fund' (Gouldson et al., 2015). This type of equity offers a low but stable return on investment with good energy, social and governance (ESG) ratings. Equity for the funds can also be crowdsourced.

Any of these financing mechanisms can be applied, alone or in combination, to the revenue stream element of the business models analysed below.

2.1.2 Aspects of the business model archetype characterisation

The Business model archetypes for renovation are characterised by how the renovation is managed, the role of the beneficiary/building owner, the involvement of intermediaries and project managers, and the return of the renovation savings.

- The **building owner** is related to community actors, as discussed in section 1.2, and it can include a range of diverse types of stakeholders. What they have in common, however, is that they own or manage the building and, in many cases, will have to invest in the renovation. They are often the ones who initiate the renovation and benefit from the result, both financially through savings in energy costs and in terms of living quality through the increased comfort the renovated building offers. Their role in managing the renovation execution differs in different BM models.
- **Intermediaries and project managers** are actors from the supply side, and they would be the ones defining the business model. The extent of their role varies from consultants to general contractors and financing intermediaries. Figure 2 shows the range and complexity of services and actor constellations related to home renovations. This complexity reveals a potential for BMs and BM combinations that enable a smoother renovation process with all its services for the building owner as an investor.

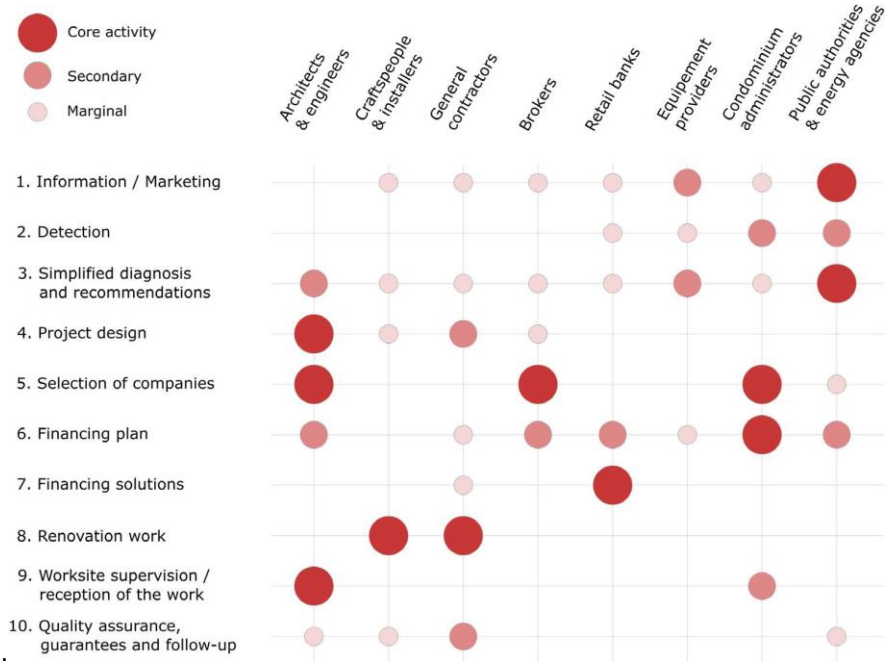

Figure 2. Current market offer along the customer journey for home energy renovation (source: Milin; & Bullier, 2021, fig 1, page 819).

- **Financing and revenue streams**. The financing of the renovation through different mechanisms, as explained in section 2.1.1, is needed to cover the initial investment of the renovation. How this is organised determines to a large extent the BM, in terms of key partnerships that are needed and the key activities.
- **Renovation phases and tasks.** The renovation process consists of different phases and core tasks per phase, as indicated in Table 1. The renovation tasks focus on the renovation work of Figure 2 that the construction market actors primarily offer. According to the combination of tasks the BM offers, the value proposition changes, while the execution of the tasks determines the key partnerships and key activities.

Table 1. Key Activities during project phases that are typically offered in renovation business models (Adapted from Konstantinou et al., 2021).

Phase		Core tasks included				
1	Pre-project	Setting objectives and criteria	Diagnosis of the existing condition	Definition of client requirements	Initial cost estimate	Selection of design team
2	Concept design	Identification of renovation measures	Decision on industrialised components design concept	Assessment and optimization	Preparation of permit applications	
3	Final design	Detailed design for the industrialised renovation	Survey of the existing building	Engineering of the components	Tender and products specification	
4	Execution and handover	Manufacturing	Transport	Mounting	Site Construction	Construction quality control
5	Post-construction	Building operation optimisation	Monitoring	Post occupancy		

2.2 Renovation business model archetypes

According to the characteristics discussed above, the different examples of business models for building renovation found in the literature can be categorised into four main archetypes, as seen in **Figure 3**. The figure also shows a simplified scheme of the revenue streams for the four BM archetypes. **Table 2** provides a detailed description of the archetypes, organised according to the business model canvas.

As in any general classification, there are variants on all the business models, and the conceptual separation line from one to another might sometimes be difficult to define. For example, the atomised and market intermediation models also result in improved comfort, next to energy savings. However, it is not as often part of the value as in the other, more integral business models. If requested, one-Stop-Shops (OSS) can extend their services from construction to post-construction monitoring or sub-contract the consultancy phase to a trusted actor. Moreover, the simplification required to define archetypes must be considered. Looking at **Figure 3**, “atomized” seems to be the simplest model, while “one-stop-shop” and “ESCO” would be more complex. In reality, it only looks “simple” because the plethora of other actors required in this model that need to be managed by the homeowner is part of a different model.

Nevertheless, the classification of the archetypes is still essential for the objective of the present study, which is to analyse current practices to provide insight into the characteristics of business models that combine energy renovation and renewable energy at a district scale. In the following sections, each business model archetype is described, including:

- **Scope**: definition and applicability.
- **Examples**: from literature and/or projects.
- **Assessment**: weaknesses and barriers of the instrument from the point of view of achieving large-scale, fast implementation of energy retrofits.

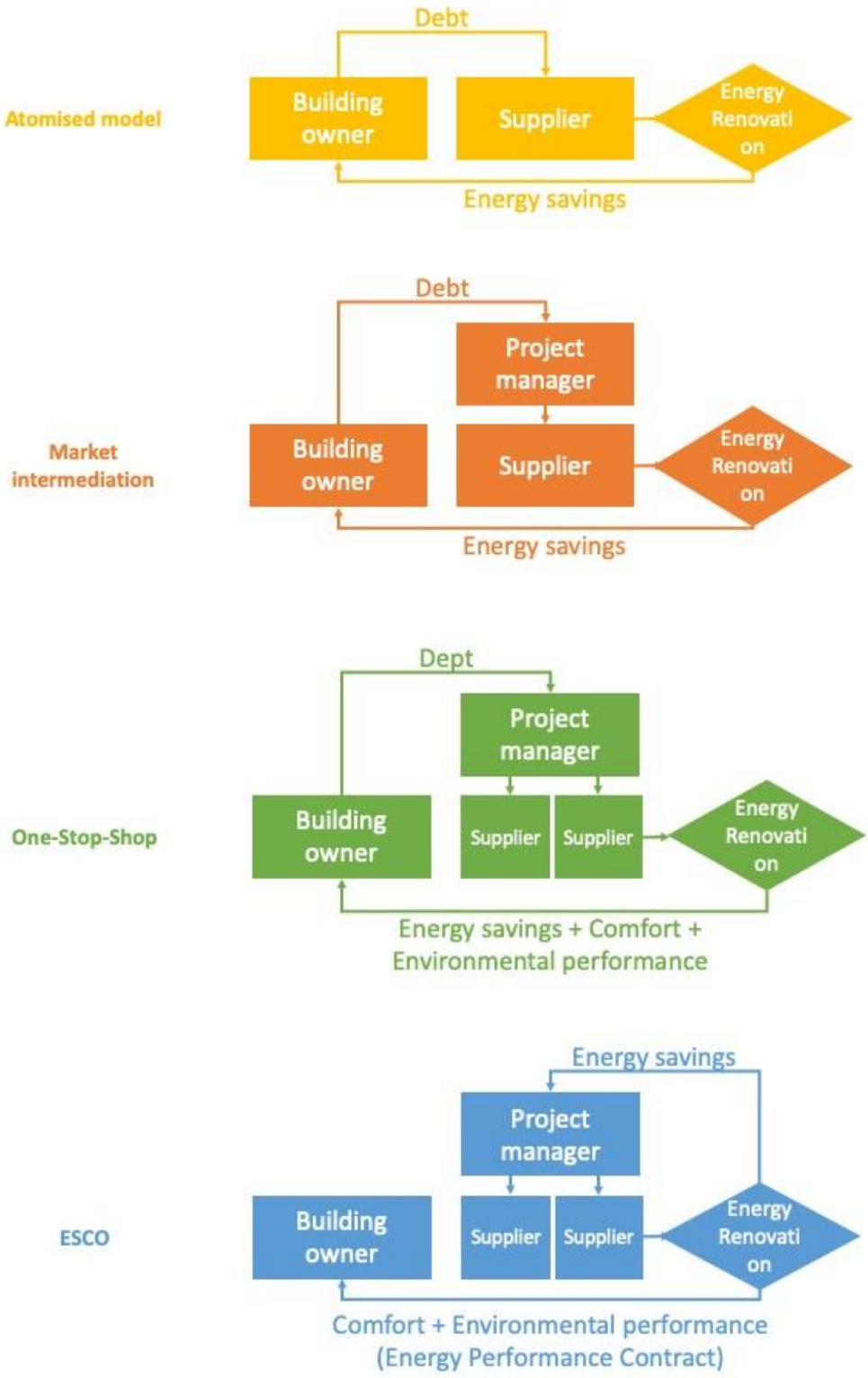

Figure 3: Revenue Streams for the four BM archetypes. In any of the models, 'Debt' can be replaced with 'Equity' through the introduction of an extra step involving a third-party lender (by the authors).

Table 2: Overview of business model archetypes for building energy retrofits.

BM archetype	Customer segment	Value Proposition	Channels & Customer Relationships	Cost Structure	Revenue Streams	Key Resources
Atomised market	Homeowner/occupier. Housing association or company. Private housing actor or real estate company. Public or social housing actor.	**Single measure**. Emphasis on specific solutions, energy, and cost savings.	**Supplier** offers dedicated personal assistance and builds trust and confidence with the homeowner. Single sale.	All typical business and project costs (marketing and promotion, administration, salaries, materials/products, demolition and construction costs…).	Homeowner pays for the entire cost structure, and payback through energy savings. Potential extra revenue from the sale of self-generated energy.	Staff and skills. Building. Construction materials/products and tools.
Market intermediary		**Single measure**. Emphasis on specific solutions for energy and cost savings. Expert advice and reduced time investment for homeowners.	**Project manager** offers dedicated personal assistance, builds trust and confidence with homeowners, bridges contact, and builds collaboration between customers, suppliers, and craftsmen. Single sale.			
One-stop-shop		**Multiple measures.** Emphasis on integrated solutions for energy and cost savings, comfort, and environmental performance.	**Single point of contact** offers dedicated personal assistance, builds trust and confidence with homeowners, bridges contact and builds collaboration between customers and several supply chains, suppliers, and craftsmen. Single sale with follow-up.	Above average business and project costs due to longer & more complex planning phases and highly energy-efficient components (marketing and promotion, administration, salaries, materials/products, demolition and construction costs…).		
ESCO (Energy Service Company)	Homeowner/occupier/renter. Housing association or company. Private housing actor or real estate company. Public or social housing actor.	**Multiple measures**. Emphasis on energy services (e.g., Indoor temperature, hot water volume…), cost savings, comfort, and environmental performance.	**Single point of contact** offers dedicated personal assistance, builds trust and confidence with the homeowner, bridges contact and builds collaboration between customer and several supply chains, suppliers, and craftsmen. Ongoing service during the operational phase (energy performance guarantee) is compensated through Energy Performance Contract.		Organisation pays upfront (lender), charges the homeowner with a monthly rate based on historic energy consumption, and captures energy savings and potential extra revenue from the sale of self-generated energy.	Staff and skills. Building. Construction materials/products and tools. Digital monitoring infrastructure.

2.2.1 Atomised market model

This model describes a product supplier delivering its product with a pitch that focuses on a main, clear advantage. In the case of building renovation, the product can be an envelope or an energy system solution. For example, façade insulation, windows (or a combination of these), heat pumps, ventilation systems, and so on. The product's main advantage is usually cost savings and sometimes improved comfort over the system's current state or environmental performance or simply the renewal of defective/malfunctioning products.

Homeowners usually contact product suppliers directly if they already have a clear idea of what they want. In the atomised market model, the supplier offers advice only related to its product. For example, a heat pump supplier might advise on a heating distribution system but probably not on a façade system. Trust and reliability are essential for the sale but bind the parties for a relatively short time, e.g., two to six months.

The homeowner pays for the entire cost structure, typically in one instalment. The initial investment is recovered through energy savings over a long period, usually 5 to 10 years. However, the payback time can vary considerably based on current and future energy prices, the energy efficiency of the building before and after the intervention, subsidies, maintenance costs, and so on. Providers of this market model can generally deliver the whole value proposition consisting of a preliminary evaluation, design, manufacturing, and installation. Some services are offered for an extra fee on the final invoice or outsourced to trusted third parties, typically design and installation.

In the case of multi-property landlords and larger housing companies, the process can differ, depending on the scale of the property, and the existence of managers or consultants that can evaluate the possibilities and assess the owners. In most cases, the BM can be simplified, due to the lower number of owners, and the decision-making is often faster and based on reliable economic and energetic calculations.

Examples

This model does not necessarily preclude innovation. Market competition in the building energy efficiency sector has sprouted diverse, highly dynamic ideas. These producers also have the advantage of streamlined, relatively short supply chains and multiple years of practical experience. Because of this, many producers can quickly adopt innovative technologies such as digital tools and robotic manufacturing, achieving concrete results in a short time. Below are some examples of companies in the Netherlands that offer EE upgrades:

- WEBO[2]: Prefabricated load-bearing façade panels made on wooden frames with BIM-supported, automated robotic technology. Fully circular building process. Founded in 1922.
- RCPANELS[3]: Prefabricated insulating façade panel. Installed within one day thanks to 'file2factory' process. Residents don't have to leave the house. Any appearance: robots create complex brickworks. Delivers energy-neutral homes in cooperation with third parties delivering installations.
- Factory Zero[4]: 'plug-and-play' system for modular heat pump and electric boiler installation. It can be installed from the outside, with minimal intrusion in apartments.

Assessment:

- The atomised model relies on individual funding and initiative (single sales), therefore, achieving large-scale implementation and corresponding economies of scale is a slow process.
- Solves one problem at a time in an uncoordinated, one-sided way so that sub-optimal consumption patterns and technical solutions can be 'locked-in' and block further progress, e.g., lowering carbon emissions from a building life cycle perspective.

[2] https://www.webo.nl/en/, last accessed on March 18th, 2020.

[3] https://rcpanels.nl/, last accessed on March 18th, 2020.

[4] https://factoryzero.nl/, last accessed on March 18th, 2020.

- There are requirements for manufacturing and assembly lines and quality assurance of the different retrofitted components.

2.2.2 Market intermediation model

This model is similar to the atomised model, except that an intermediary instead of the homeowner manages the process around the building retrofit. The intermediary might have more experience and expertise than the homeowner so that they can deliver a more comprehensively/thoroughly researched solution. This can result in extra energy savings costs, increased comfort or aesthetic value, or less time the homeowner invests.

The intermediary typically takes care of preliminary evaluation, design and procurement while interfacing with a small number of suppliers and construction crews for manufacturing and installation. Optionally, they can also arrange third-party financing.

In the market intermediation model, again, the revenue stream consists of a single payment in one or more instalments. The extra investment in salary costs for the intermediary might be recovered through a more economically efficient solution, hours offset from the homeowner's otherwise productive time or it can be decided that it won't be recovered and instead result in a more robust or comfortable solution, compared to the homeowner choosing a provider and managing the process by themself.

Examples

The market intermediation model is usually offered by architecture, engineering, and planning professionals.

- Alliantie+[5]: Originated from an idea of the Eindhoven consultancy and architectural firm BouwhulpGroep. In the role of researcher, architect, and consultant, they have retrofitted nearly 500,000 Dutch homes in the past 40 years and have developed a diverse range of renovation products for all types of homes based on this knowledge. Their approach is personal and dedicated, home by home.
- EIT Climate-KIC's Green Light District project[6], in the city centre of Amsterdam, aims at generating a platform to scale up bottom-up initiatives by residents, entrepreneurs, and institutions in the field of the energy transition, starting with the retrofit of historic buildings.
- INDU-ZERO[7]: 'Designing a factory for energy renovations'. Funded by the European Regional Development Fund (ERDF) 2014-2020 INTERREG VB NEW and led by Provincie Overijssel (The Netherlands), INDU-ZERO aims to develop a blueprint for a fully automated factory to produce standard renovation packages at an industrial scale (at least 15,000 per year). In addition, sites are to be selected and businesses sought that will build and operate the factory. The components will be put together in a way that is as circular and biobased as possible. The aim is to offer the total package of measures for half the current price. This model aims to integrate the single supplier of an atomised model with the range of measures offered by an intermediary model and can thus be seen as a hybrid model.

Assessment

- This model suffers from the same limitations regarding process optimisation and economies of scale as the atomised market model. It relies on implementing individual solutions; customers are served one at a time, and widespread implementation is slow.
- Compared to the atomised model, project time per customer can be increased because of additional interfaces between multiple actors.
- If the intermediary is perceived as more neutral compared to a supplier, the customer might need to spend less time comparing options. If the intermediary builds trusted relationships with a set of service providers, a project can, at least in theory, be completed in less time compared to the atomised model.

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[5] http://www.alliantieplus.com/, last accessed on March 18th, 2020.

[6] https://benelux.climate-kic.org/news/green-light-district-making-the-oldest-area-of-amsterdam-more-sustainable/, last accessed on March 18th, 2020.

[7] https://northsearegion.eu/indu-zero/about-the-project/ and https://www.sir.nl/media/afbeeldingen/selection-of-3-renovation-packages.pdf, last accessed on March 18th, 2020.

- Intermediary models that do not offer integrated solutions but single energy-saving measures lock in inefficiencies until at least the next renovation cycle.
- Intermediaries, such as consultants, do not have the option of using innovative technologies because they do not control manufacturing or supply chains. They can only offer solutions that are already on the market.
- Furthermore, because their services add to the final bill, intermediaries might be drawn to propose cheaper and, therefore, sometimes less efficient solutions to avoid losing customers due to high overall project costs.

2.2.3 One-stop-shop

The one-stop-shop model is similar to the market intermediation model in that it offers a single point of contact catering to all of the project's needs, but it differs in the value proposition, services provided, and third parties involved.

The value proposition aims at providing energy efficiency with an integrated solution. At the same time, a strong focus is on increasing comfort and well-being for occupants and other customer values. To achieve this, the One-Stop-Shop needs to design and promote sets of most energy-efficient measures, also considering non-energy benefits, such as cost, health, and environmental impact. Depending on the customer segments, specific sets of customer values and solutions can be put forward.

A typical set of services offered by the One-Stop-Shop is preliminary evaluation, energy audit and scenario analysis, design, arrangement of third-party financing, procurement, outsourced manufacturing and installation, and performance testing to verify the system in operation. The performance test can include a satisfaction survey with building occupants and comparing real energy consumption against modelled consumption.

Therefore, the relationship with the customer does not end with the installation; it typically does not extend beyond the first year of operation. The initial investment costs of identifying and designing integrated solutions are markedly higher compared to single interventions, not only because of multiple components but also for extra time and personnel costs during the auditing and scenario analysis phases. On the other hand, savings might be obtained in operation and maintenance if standardised sets of solutions and related maintenance plans are offered. Third-party financing is part of the marketing and sales package offered by the One-Stop-Shop.

The extra costs can be recovered by the homeowner/occupier through 1) energy savings and, especially, 2) when the value proposition includes extra revenue from locally generated energy, for example, from photovoltaic modules. The extra costs might also be recovered by agreements with local public actors who want to achieve a higher renovation in specific target areas.

Because the focus is on specific customer values per customer segment rather than solely on cost savings, homeowners tend to trust this kind of business model providers more compared to the intermediary or the atomised model. Support by local authorities and non-profit organisations can also improve the feeling of trust in these organisations. This allows the one-stop-shop provider to invest more time in cultivating trusted relationships with its suppliers. These suppliers, in return, can invest in improving the quality of their offer thanks to a stable supply chain of projects. One-stop-shops, in this sense, might make energy renovation more financially attractive for landlords as well, together with homeowners/occupiers.

Examples:

- COHERENO (Collaboration for housing nearly zero-energy renovation): The IEE-funded project Collaboration for Housing Nearly Zero-Energy Renovation (COHERENO) aims to assist in creating a volume market, specifically for single-family owner-occupied houses. The project shows how barriers to effective cooperation can be eliminated and better services for different customer segments can be developed. Based on the learnings from the processes in the COHERENO project, a "checklist" for creating a one-stop-shop model was proposed (Straub, 2016).
- EuroPACE[8]: A Horizon 2020 programme inspired by the success of a financing model called PACE (Property Assessed Clean Energy loan), launched in California in 2008. PACE financing covers up to 100% of a project's costs and is repaid as a special assessment added to a property tax bill over a term of up to 20 years. Typically, investors lend money for deep retrofits upfront and then get repaid regularly through an additional charge added to the property. EuroPACE sets up a platform to identify and select which energy efficiency improvements to make, assists in finding contractors, and delivers transparent, easy and secure long-term financing (Styczyńska & Zubel, 2019).
- BIKBouw[9]: Integrated and sustainable solutions for new construction, renovation, and major maintenance. Outside installation and maintenance, new models for operation and management, resident participation, and communication, and monitoring before, during and after the renovation. Based on 2nd Skin®, a unique concept developed as an EIT Climate-KIC project initiated by TU Delft, BIK construction, Sto Isoned, Itho Daalderop and Kingspan.
- ReCO2ST[10]: Residential Retrofit assessment platform and demonstrations for near zero energy and CO2 emissions with optimum cost, health, comfort, and environmental quality. A European Union's Horizon 2020 project led by Aalborg University, Denmark. Follows a 'least cost' concept. Offers a straightforward 3-step approach to renovations, resulting in major savings and heightened standards of living, at a near-zero energy coefficient: 1. Interactive Renovation Assessment Tool (RAT) for renovation scenarios, 2. Integrated Project Delivery (IPD) tool for planning package installation, 3. Deployed as a customisable Retrofit-Kit.
- RenoZEB[11]: Accelerating nearly-zero energy renovation for buildings and neighbourhoods. RenoZEB aims to unlock the nearly Zero Energy Building (nZEB) renovation market by increasing property value through a new systemic approach to retrofitting. An EU Horizon 2020 project led by Solintel (Spain). Focuses on drivers of change for the Real Estate Industry through the creation of post-renovated property value schemes. Cost-effective and non-intrusive prefabricated multi-functional modular "plug and play" façade systems for large-scale deep nZEB rehabilitation schemes combined with the transformation of buildings into Active Energy through ICT, smart control, and monitoring.
- REZBUILD[12]: 'Towards an innovative and collaborative renovation ecosystem for Europe'. Defines and designs guidelines and proposes specifications for new EE procedures for residential buildings interconnecting with final consumers. Focus on circularity by developing key sustainable construction principles for renovations, such as the reduction of demolition waste by recovering, reusing, and recycling materials, dust-minimising techniques, or careful clean-up. Additionally, the selection of products will consider environmental labels in the field of eco-design, low carbon footprint, EE labels or renewable raw materials.

[8] https://www.europace2020.eu/, last accessed on March 18th, 2020.

[9] http://bikbouw.nl/, last accessed on March 18th, 2020.

[10] EeB PPP Project review 2019, available at http://www.ectp.org/fileadmin/user_upload/documents/E2B/0_EeB_PPP_Project-Reviews_Roadmaps/EeB_PPP_Project_Review_2019.pdf, last accessed March 18th, 2020.

[11] https://renozeb.eu/, last accessed May 11th, 2022.

[12] https://rezbuildproject.eu/, last accessed May 11th, 2022.

Assessment:

- The model's main advantage is having one contact person for the whole process, unburdening the homeowner, and involving the right experts and suppliers.
- Complex but ecologically optimised solutions have clear economic disadvantages compared to traditionally simple but wasteful solutions. 1) Externalities, like carbon emissions or extraction of non-renewable resources, are currently not being (properly) priced into the cost structure of products and systems. 2) Integral building energy retrofits rely on large amounts of time invested by expert professionals in complex planning and design tasks. Therefore, One-Stop-Shops with high levels of ambition usually need public funding or dedicated 'sandbox' regulation to offer customers an attractive financial investment.
- Most One-Stop-Shops do not offer energy performance guarantees but focus on organising the renovation without a long-term commitment.

2.2.4 Energy Service Company (ESCO)

Energy Service Companies offer a similar service to the One-Stop-Shops, but their value proposition is based on ongoing energy performance guarantees instead of a fixed level of ambition (for example, energy label A). ESCOs have varied structures and might offer all project services in-house or outsource them. They differ from all other business models addressed so far in keeping a long-term relationship with the customer, including monitoring, operation, and maintenance. The EU Directive on Energy Efficiency (DIRECTIVE, 2012/27/EU) encourages the possibility of concluding long-term energy performance contracts that provide long-term energy savings.

ESCOs primarily use Energy Performance Contracts (EPCs) as a financing mechanism. Energy Performance Contracts have also gained popularity in the last few years, even though they cover a fraction of residential buildings (only large multifamily or social housing). EPCs offer the option of performance guarantees which can reduce risks associated with complex projects. Given that they enable funding of energy renovations from energy cost savings, they are successful at tackling upfront cost barriers for consumers (Bertoldi et al., 2021).

The EPC applies to the public and private sectors (Polzin et al., 2016). They are based on the principle that ESCOs are requested to guarantee and verify energy savings during the contract period (Shang et al., 2017).

Emerging energy supply retail channels are, for example, energy communities consisting of residents, companies, social organizations, and municipalities setting up cooperatives to develop and implement local Energy Action Plans. Communities benefit socially and economically from new energy production and energy savings in their region through reduced fossil fuel emissions, strengthening the local economy, and improved social cohesion.

Examples:

- Energiesprong[13] is a whole house renovation and new build standard and funding approach. It works with independent market development interdisciplinary teams and targets primarily (social) housing associations. Tenants pay an energy service plan which is equivalent to their previous energy supplier bill. Financing is guaranteed because the total cost of living stays the same over 30 years and includes the budget for maintenance and repairs. Mass customisation, process automation, and cooperation with regulators to tune policies and with banks to create financial arrangements are key. Energiesprong originated in the Netherlands in 2013 as a government-funded innovation programme (Brown et al., 2018).
- Examples of energy communities[14]:
  - ECCO[15] is a European Interreg NEW project that gathers the combined experience of 9 existing energy communities in North-West Europe to engage 50 new communities.

[13] https://energiesprong.org, last accessed March 18th, 2020.

[14] https://www.communitypower.eu/, last accessed March 18th, 2020.

[15] https://www.nweurope.eu/projects/project-search/ecco-creating-new-local-energy-community-co-operatives/

- REScoop[16] 20-20-20 is an initiative launched by the Federation of groups and cooperatives of citizens for renewable energy in Europe with the support of the Intelligent Energy Europe Program (European Commission). Twelve organisations in seven countries have joined forces to increase the number of successful citizen-led renewable energy projects across Europe.
- The IEE (Intelligent Energy Europe)[17] action towards 100% RES rural communities (100-RES-COMMUNITIES) aims at experimenting with and spreading the model of joint Sustainable Energy Action Plans (SEAPS) development and implementation in rural territories and towns in 10 European countries.
- CrowdFundRES[18] aims to contribute to accelerating renewable energy growth in Europe by unleashing the potential of crowdfunding for financing renewable energy projects. The project brings together active citizens, crowdfunding platforms, cooperatives, municipalities, and project developers, helping them work together for a future with more renewable energy.
- The Citizenergy[19] portal has been made possible by the European Union. The Citizenergy project, which began in 2014, helps individuals directly contribute to a sustainable energy future by providing information on opportunities to get involved in renewable energies across Europe.

Assessment

- Energy Performance Contracts offered through ESCOs are a financing mechanism which empowers citizens to shape their own energy-efficient homes through long-term loans tied to energy savings. These loans can be made more affordable and attractive with the involvement of central or local governments or even unusual actors like pension funds or healthcare providers. This will help tilt the scale of undecided citizens to undergo a building energy retrofit.
- There are however some barriers to the wider implementation of EPCs for housing renovation, such as the following:
  - Long-contract and old ownership structures (over 20 years, whereas many may be reluctant to sign a contract over 10 years).
  - Lack of trust, where prices and revenue flows are not transparent.
  - Company large initial investment (financing costs).
  - Collective contract management.
  - Expensive civil works.
  - Individualization of systems as freedom for families.

2.3 Conclusions and recommendations

The present catalogue of business models for energy-efficiency renovation identified four archetypes that summarize the current approaches. The information was gathered by reviewing current literature and illustrated by examples found in renovation practice and research projects.

Table 3 summarizes the characteristics of each archetype.

[16] https://www.rescoop.eu/

[17] http://www.100-res-communities.eu/

[18] http://www.crowdfundres.eu/

[19] https://citizenergy.eu/

Table 3. Summary of the business model archetypes, highlighting the barriers they pose to upscale renovation to the district and opportunities to overcome those barriers.

BM archetype	Value Proposition	Financing mechanism	Barriers	Opportunities to overcome barriers
Atomised market	**Single measure** Emphasis on energy cost savings.	Homeowner pays for the entire cost structure, payback through energy savings. Access to finance through debt.	- Relies on individual funding and initiative. - Fragmented and uncoordinated renovation process.	- Awareness raising. - Financial incentives for renovation.
Market intermediation	**Single measure** Emphasis on energy cost savings. Expert advice and reduced time investment for the homeowner.		- Relies on individual funding and initiative. - Additional interfaces can add to cost and time. - Fewer opportunities for innovation and integrated solutions	- Awareness raising. - Financial incentives for renovation. - Intermediary builds trusted relationships with suppliers, to provide integrated solutions. - Addresses market fragmentation.
One-stop-shop	**Multiple measures** Emphasis on energy cost savings, comfort, and environmental performance.	Homeowner pays for the entire cost structure, through their own debt. Payback through energy savings, and potential extra revenue from the sale of self-generated energy. One-stop-shop interface is also adequate for equity financing.	- Lack of awareness of the integrated service benefits. - High investment costs, due to complex and expensive solutions, and expert consultations.	- Awareness raising and coordinated renovation projects. - Development of integrated, modular, scalable solutions. - Addresses market fragmentation.
ESCO (Energy Service Company)	**Multiple measures** Emphasis on energy services (e.g., indoor temperature, hot water volume…), cost savings, comfort, and environmental performance.	Organisation pays upfront (lender), charges the homeowner with a monthly rate based on historic energy consumption, and captures energy savings and potential extra revenue from the sale of self-generated energy.	- Complex financial structure. - Long-term loans are tied to energy savings.	- Financial attractiveness for homeowners. - Addresses market fragmentation. - Enables long-term planning.

Recommendations

Based on the BM catalogue described in this chapter, a stakeholder round table was conducted to get an overview of existing stakeholder structures and to reflect on barriers to upscale energy renovation to the district level and how they can be overcome.

The main barriers identified are 1) the separation between energy supply and building performance and 2) the conflict between energy production/supply and energy savings. To this end, combining renovation and energy supply business models, and their respective stakeholders, is needed. An example of achieving that would be offering a performance guarantee from both the technical solution supplier and the energy supply.

Regarding the financial burden, which is a major hindering parameter, it can be linked to the building instead of the owner. Models like the ESCO with equity funding can facilitate that, while also using policy instruments, such as subsidies, to provide part of the investment and reduce the long-term financial risks. Applying such models requires long-term planning and a legal framework that allows it.

Different financial interfaces are needed for various types of owners, as individual owners have different financial power than landlords. Moreover, effective process management is needed to address the complexity of stakeholder communication.

Final remarks

- Ecologic conscience is well developed but still not triggered for high and uncertain investments. A good approach would be to address the energy and sustainability benefits in a regular renovation cycle of the building. The same approach can be upscaled to synchronize renovation cycles within a district to allow for the combination of EE and RES at a district scale.
- In general, but especially at the district level, renovation is connected to extensive processes driven by outside-standing actors like researchers. The intrinsic motivation from affected actors is usually quite low.
- The legal framework needs more incentives to invest more money in CO_2 reductive measures, such as a CO_2 tax.
- Concessions from the municipality - e.g., higher building density if certain standards are reached - can accelerate energy-efficient renovations.
- There is a rising demand for green finance products. Funds are investing in buildings with certain ecologic standards or defined renovation schedules to reach these standards. Maybe whole districts could also be interesting for such investments.

3. Business models for energy supply

3.1 Introduction

Energy supply for the buildings stands in for the supply of both electric and thermal energy. Most of the energy use of buildings is related to space heating (and cooling). Therefore, the needed thermal energy can be extracted directly from a district heating and cooling (DH(C)) network or provided by a heat pump (HP) or even directly converted using electric heaters/coolers. Energy supply companies are responsible for supplying buildings and districts with their needs in terms of electric and thermal energy, with many countries relying mainly on electricity to meet their needs in the residential sector (Eurostat, 2021).

In IEA EBC Annex 75, which aims to upscale energy efficiency renovations and integrate renewable energy sources, both electrical and thermal energy are relevant. They both can be produced from renewable energy sources, and their supply influences the buildings' demand. However, the processes and operations of the energy supply companies differ per type of energy, and different parameters influence the decision-making. For this purpose, this chapter investigates business model archetypes for both district thermal energy and electricity market. The aim is to identify current practices in business models and synergies within business models of the companies of energy supply.

3.1.1 Heating (and cooling)

In recent years the understanding of the role of utilities has changed dramatically. In the early 1980s, utilities were comparably simple heating and cooling supply schemes in existing or newly built building clusters (utility services or energy supply contracting), which included supply components on the supply side and never considered refurbishing the user side. The supply schemes usually had a highly efficient supply technology such as combined heat and power (CHP), gas, oil or coal-fired or biomass supply boilers for hot water or steam and electricity. Thus, *customer value creation is based on a network logic that aims to link producers and consumers with complementary needs in an infrastructure-like network* (Sandoff & Williamsson, 2016). These efficient technologies were backed up by "normal" heating boilers (hot water/steam). The power was usually fed into the power grid (no direct retail to end users), while the heating was distributed by hot water (or steam, mainly in the US) grids to the end users. End users paid a heating price per kWh consumed and a heating load price covering investment costs (at least partially). The end users have been responsible for the demand side: the house station is often equipped with a heat exchanger or a hot water exchanger, a domestic hot water station and a control system including a heating meter for the measurement of the consumed heating energy.

Most business models for districts involve the public sector to some degree, and in many cases, the public sector has partial or full ownership of the project. The degree to which the public sector is involved is determined in part by how much it may wish to steer a district energy project towards a variety of local objectives, resulting in the following categories:

- The "WHOLLY PUBLIC" business model is the most common globally. In its role as a local authority or public utility, the public sector has full ownership of the system, which allows it to have complete control of the project and makes it possible to deliver broader social objectives, such as environmental outcomes and the alleviation of fuel poverty through tariff control.
- Business models that focus on "HYBRID PUBLIC AND PRIVATE" energy supply have a rate of return that will attract the private sector. However, the public sector is still willing to invest in the project and retain some control. These models can include the following:

    - A public and private joint venture where investment is provided by both parties that are creating a district energy company, or where the public and private sector finance different assets in the district energy system (e.g., production of heat/cooling versus transmission and distribution).
    - A concession contract where the public sector is involved in the design and development of a project, which is then developed, financed, and operated by the private sector, and the city usually has the option to buy back the project in the future.
    - A community-owned not-for-profit or cooperative business model where a municipality can establish a district energy system as a mutual, community-owned not-for-profit or cooperative. In this model, the local authority takes on a lot of risks initially in development and if it underwrites any finance to the project.
- "PRIVATE" business models are pursued where there is a high rate of return for the private sector and require limited public sector support. They are developed as wholly privately owned Special Purpose Vehicles but may benefit from guaranteed demand from the public sector or a subsidy or local incentives. Few cases are developing "private" models as the majority district energy model.

3.1.2 Electricity market

The electric energy system contains the physical infrastructure (generation, transport, distribution and use together with their components) and an organised electricity market based on different marketplaces. The market consists mainly of the following actors (Erbach, 2016):

- Electricity generator: generates electricity and sells it to the energy suppliers.
- Electricity suppliers: purchase the electricity from the generators and sell it to consumers.
- Consumers: who use electricity and pay monthly fees to suppliers.
- Transmission System Operators (TSO): responsible for transporting electricity for long distances and ensuring grid stability and reliability by real-time dispatch.
- Distribution Network Operators (DSO): who are responsible for delivering electricity to the consumers and measuring consumption.
- Regulators: who set the market rules and oversee the functioning of the market.

A large part of the world's electric energy supply is either based on fossil fuels like coal, gas, and oil or nuclear energy. The production, transmission, and distribution of electricity account for the largest share of the world's anthropogenic carbon emissions, while emission-free nuclear energy poses serious security risks and hazardous waste problems. Therefore, the role of renewable energies as the most important instrument to mitigate climate change and reduce the negative effects of energy production is increasing. Even though utilities (with national or transnational activities) still have a dominant position, they are confronted with disruptions in their current way of doing business and face the challenge of developing new business models for electricity generation from distributed and highly intermittent renewable sources.

The electrical energy sector is undergoing a continuous transformation process where a fundamental shift of energy supply towards renewable, carbon-neutral energy is taking place, together with decentralisation and digitalisation. The classical structure of the electrical energy industry that emerged after the liberalization of European electricity and gas markets (**Figure 4**), including established business models, is subject to disruptive and massive changes.

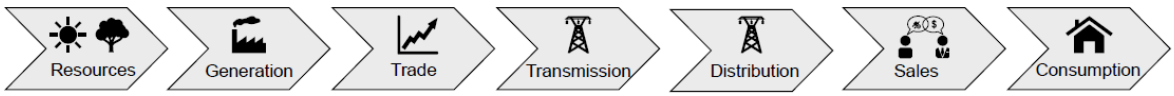


Figure 4. The classical value chain of the energy industry (source: Giehl et al., 2020).

The transformation of today's electric power sector to a more sustainable energy production based on renewable energies will change the industry's structure (Richter, 2012). In this transformation toward a smart energy system interaction between sectors and technologies, the main stakeholders, as listed above (energy service providers; utilities), will face new challenges in their traditional way of doing business. Therefore, adapting their business models to remain competitive is seen as an important step. Business model literature reveals that there exist basically two possibilities:

- Ownership of renewable energy assets (Frantzis et al., 2008).
- Utilities need to develop from commodity providers to energy service providers. According to this idea, utilities should evolve into comprehensive energy-solutions providers for residential and commercial customers to create new sources of revenue (Klose et al., 2010; Valocchi et al., 2014).

3.1.3 Aspects of the business model archetype characterisation

Based on the above discussion, this chapter identifies business model archetypes for district heat and electricity supply, as they have been seen in the literature.

In the energy sector, the following characteristics of the business models for energy supply are worth noting:

- **Servitisation (energy-as-a-service)**. In the energy transition context, servitisation is correlated with energy services and the reduction of the end-users energy consumption. The variations of energy services range from basic services, such as information and analysis provided, to more advanced services, such as energy management, project design, implementation, maintenance, evaluation and energy and equipment supply, savings guarantees, etc.
- **Financing and Ownership**. Since Renewable Energy sources (RES) ownership, individual or collective, may influence the grid capacity and thus the grid stability and energy supply security, owners' decisions may contribute to increasing or decreasing grid balance.
- **Public interest**. The public sector may wish to steer a district heating (or cooling) energy project towards a variety of local objectives (Sharp et al., 2020). By quantifying these objectives through economic modelling, it is possible to create additional value outside of the standard financial modelling.
- C**ustomer's role**. It is central to reducing the cost of the energy supply. In RE-dominated energy production, the ownership of the RES and the proximity between production and consumption sites play a critical role in determining the used BM.
- **Decentralisation**. Energy systems can be designed by different decentralisation levels. Nowadays, due to the smaller production capacity of RES and their distributed nature, a new decentralised energy market has been established and requires other revenue models than the classical ones of centralised energy production.
- **Energy tariff structure**. Today utilities' revenues are usually based on a fixed price per energy. This means that the more energy is consumed, the better it is for the utility. This is why the current revenue model creates a disincentive for utilities to engage in energy efficiency or third-party-owned decentralised power generation because demand decreases and revenues reduce. It is often argued that the current revenue model is the greatest obstacle between the current utility structure and a modernised energy delivery system based on renewable sources (Duncan, 2010). Here, a decoupling of the relationship between sales volume and revenues is needed; dynamic pricing (see flexibility below) should orientate on the wholesale prices for energy (time-of-use tariffs, off/peak prices, etc.), flat rate tariffs should be

coupled to incentives to reduce energy consumption, and new construction structures would need to be more customer oriented.

- **Infrastructure** includes key resources to create a value proposition. Cooperations or joint ventures between utilities and independent developers are needed to build up portfolios and in-house competencies to extend the revenue model. In this respect, utility-side renewable energy business models are more attractive to utilities in terms of risk and return expectations than customer-side renewable energy business models. Thus, utilities mainly favour large-scale projects when considering risk-return expectations and transaction costs. Hence, customer-side renewable energy business models are not expected to advance in scale in the near future (Richter, 2012).
- **Flexibility** is the ability of energy supply systems to use their existent resources to manage net load variation and generation outages over various time horizons when intermittent RE sources, such as wind and solar energy are present in the system. Flexibility can be stimulated either from consumption or from the generation side by coupling them with timing service. The decentralised electricity and/or heat generation is thus not just developing renewable energy sources but also finding ways of local balancing of production and consumption.
- **Management and control.** Stakeholders indicate the actors responsible for maintaining and keeping the energy supply hardware in optimal operating conditions. Many factors affect management (consisting of operation, control, and governance), among others, the proximity of the technology to the consumption site, the contract, the partnership, and the legal form. The management activities are key activities that also aim to optimize electric grid balance and trading service, provide maintenance to the co-owned infrastructure, and handle the fluctuation of renewable energy production and grid balance.

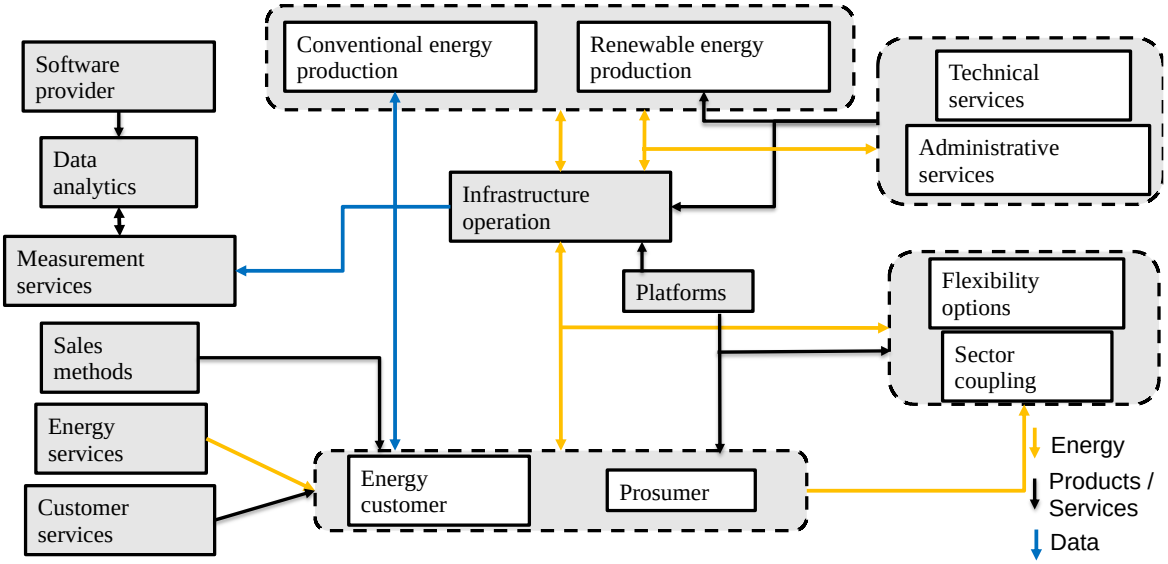


Figure 5. Overview of the components that characterise the energy supply BM. Next to the delivery and production of energy, services and data can also be part of the value provided (adapted from Giehl et al., 2020).

3.2 District energy business model archetype

With the increasing complexity of energy supply in building clusters, the share of Energy Service Companies (ESCOs) of the total market is steadily growing. Today ESCOs and a few innovative utility companies can provide highly complex energy services, including generation, distribution, storage, selling, and M&V com-

bined with demand-side measures like renovation of buildings, distribution grids and other demand-side activities. The business scheme here usually is the energy supply (or service) contracting (ESC) which delivers demand and supply side measures for a fixed investment cost-based price per kW and a price for the consumed kWh of energy. The ownership of all investments, except those in buildings, remains for the duration of the contract (5-20 years) with the ESCO/utility.

In recent years, energy savings performance contracting has been developed into a business model that can tap energy efficiency potentials in buildings (HVAC and thermal envelope) and provide complex supply, distribution and storage concepts with CHP, PV, biomass, and heat pumps. Examples of such projects can be found in Liu et al. (2020).

The revenue is based on the energy savings and other life cycle cost savings provided by the energy service company. The business model is a scheme in which the overall objective, design, and execution of the community energy plan (CEP) in a building cluster is fragmented into a set of services and remuneration streams among different parties.

Table 4 illustrates the main business model canvas for DH supply companies. Different types of this BM depend on the district network ownership, as mentioned in section 3.1.1.

Table 4. Business model canvas for district heating supply companies.

<table>
<tr><th>Key Partners</th><th>Key Activities</th><th>Value Proposition</th><th>Customer Relationship</th><th>Customer Segments</th></tr>
<tr><td rowspan="3">Energy supply components suppliers

Construction contractors

Marketing company

Transportation company</td><td>Development, optimization, and testing.
Designing, planning, and assembling.
Certification/Standardization.
Marketing.
Training.
Transportation/shipment.</td><td rowspan="3">Overall superior performance.
Increased resilience.
Increased insulation properties.
Inclusion of solar energy gain and storage.
Environmentally friendly.
Affordability.
Reduced operational cost.</td><td>Direct assistance from manufacturers.
Provision of training and instructions.
Maintenance.</td><td>Building owners

Facility managers

Municipalities

Construction companies

Developers

Building managers

Architects and Designers

Engineers

Etc.</td></tr>
<tr><td>Key Resources</td><td>Channels</td></tr>
<tr><td>Services and components.
Technology.
Personnel.
Facility and equipment.
Initial investment.</td><td>Municipal planning office.
Municipal energy providers.</td></tr>
<tr><td colspan="2">Cost Structure</td><td colspan="3">Revenue Streams</td></tr>
<tr><td colspan="2">Fixed: salaries, facility, equipment.
Variable: cost of materials and components, energy costs, savings.
Others.</td><td colspan="3">Economies of scale.
Maintenance inspections.
De-risked investment.</td></tr>
</table>

3.3 Electricity supply business model archetypes

For the business models for electricity supply companies, the same line of thought as for the business models for renovations is followed. Description of the most common business models for energy supply has been done following the BMC (Business Models Canvas) principle. There is a large variety of business models for the electricity supply. Three main approaches of the business models can be defined:

- Demand response (DR) and energy management systems (EMS).
- Electrical and thermal storage (ETS).
- Solar PV businesses (PV).

Following the characteristics defined in the previous section, the most predominant archetypes of business models for the energy supply are presented and discussed below. Four distinct themes that outline the value creation drivers for the energy supply business models have been identified:

- "Going Green BMs" are the ones where new ways of performing economic transactions have been adopted. Accounting for the content element, fossil fuel energy is replaced in these BMs with renewable energy resources. Thus, they are mostly technology-driven BMs, nowadays with a strong predominance in the solar PV businesses, resulting in a pattern category named "Going Green".
- "Building energy communities BMs" is the second pattern category where new organizations based on the co-participation form are addressed in the structure element. In contrast, the governance element is based on shared resources and governance.
- "Lock-in-oriented BMs" refer to the ability of the firm to attract, maintain and improve customer and partner association with the business model.
- "Complementarities-oriented BMs" refer to a bundle of goods together instead of providing each of the goods separately.
- "Efficiency-oriented BMs" are the ones where measures are taken to achieve increased transaction efficiencies.

Table 5 provides an overview of the different business model archetypes with sub-types. The following sections 3.3.1 until 3.3.5 describe the archetypes, following the logic of the previous Chapter 2. A comprehensive overview of the BM elements per archetype is also provided according to:

- **Scope**: definition and applicability.
- **Examples and sub-types**: from literature and/or projects.
- **Assessment**: weaknesses and barriers of the instrument from the point of view of achieving large-scale, fast implementation of energy retrofits.

Table 5. Overview of business model archetypes for electricity supply.

Business Model Archetype	Sub-type
Going green	Utility-side renewable energy model
	Prosumer model
Building energy communities	Utility-Sponsored Community (USC) model
	Special Purpose Entity (SPE) model
	Energy cooperative model
	Local white-label model

Business Model Archetype	Sub-type
Lock-in-oriented	BM that offers energy functionalities
	Energy service agreement
	Third-party model
Complementarities-oriented energy supply	Optimising grid operations
	Combining value propositions
	Acting locally
Efficiency-oriented energy	Scaling-up
	Running platforms

3.3.1 Going green models

The main innovation of this type of business model is in the content of the business model rather than in the structure or the governance, therefore they are technology-oriented business models with an emphasis on replacing the energy fossil fuel with renewable energy resources. Two archetypes of business models are presented below:

Utility-side renewable energy model

- Fossil fuel resource is replaced with renewable energy.
- The organisational structure of the business model remains the same as the typical energy supply.
- Renewable resources are integrated vertically.
- Key resources: small numbers and large-scale plants owned by the utility side.
- Value proposition - new product: green energy offered as a commodity that is embedded in a centralised network and distributed to the end-user.
- Energy utilities adopt renewable energy and extend their value proposition by adding new renewable energy sources to satisfy customers' demand for renewable energy (Richter, 2013).

Prosumer model

- Prosumers have both roles, the producer, and the consumer.
- Resources: mainly small PV (or thermal collectors or hybrid PV/T) systems (thus technology-driven BM) which are owned and hosted by the customer.
- Value proposition: generated electricity fed into the grid according to regulated feed-in tariff rates or is self-consumed. The customer creates value through small-scale owned distributed generation.
- Customers are driven by governmental incentives, such as income tax reductions during the first years and the feed-in tariff. The incentives secure income and eliminate price risks.
- Key partners:
  - Energy utility has a passive and limited role in providing interconnection and net metering.
  - Installer firm plays a key role in customer adoption of solar-based systems. Installers are local firms, which depend on the network of producers and wholesalers to obtain technical knowledge on these new systems, therefore facing challenges, such as diminishing feed-in tariffs for PV, declining adaptation rates and decreasing installation profitability.

Assessment

- The focus of these business models is technological, particularly on RES.
- The business models contradict each other. Either the utility or the prosumer is in a key role. This leads to conflicts over which business model to apply.
- The prosumer business model is often driven by incentives. There is a big interest in providing incentives by different levels of government (state, municipality, local initiatives) for various reasons.

- The PV market has matured in the past decade, while the heat market is still in a lower development stage.
- Regulations are often hindering the exploitation of the full potential of prosumer business models.

Table 6. Details of Going-green business model archetype for energy supply

Archetype	BM Type	Customer segment	Value Proposition	Channels & Customer Relationships	Cost Structure	Revenue Streams	Key Resources
Going green	Utility-side renewable energy BM	Individual homeowners	Green energy (electricity/heat) extension of the classical value proposition based on fossil fuel resources.	Centralised network	Classical cost structure	Classical revenue stream	Small number of large-scale RE plants owned by the energy utility.
	Prosumer BM	Individual homeowners	Small-scale energy (electricity and/or heat) generated in small-scale owned systems; electricity fed in the grid according to regulated feed-in tariff rates or is self-consumed.		Driven by governmental incentives, such as income tax reductions during the first years and the feed-in tariff.	Feed-in-tariffs ensure secure income and eliminate price risks.	Small PV systems. Partial replacement of fossil fuel-based energy supply.

3.3.2 Building energy communities models

In this archetype, the deployment of **energy communities** allows multiple participants to invest and/or benefit directly from the energy produced by a shared system. Participants benefit by owning or leasing a portion of the system or by purchasing kWh of renewable energy, either electricity or heat. The range of power of the installations within this pattern is from a few kW to a few MW and the installation is administered by a third party or an energy utility.

Depending on the business model, the customer can finance the project as a shareholder or by a loan and thus will have a different decision capacity depending on a share-based community or a cooperative community. The characteristic of these BMs is that they may range from *open and participatory* to *closed and institutional* according to the key partners who run, influence and are involved in developing the energy community. Energy communities have a diversity of outcomes and benefits that differ e.g., locally, nationally, etc., and that can be transferred to different forms depending on local contexts. These energy communities can be social enterprises funded by public institutions or initiated by a public-private partnership, an energy utility, or a locally owned cooperative. Equity and distribution of cost and benefits are critical factors in these BMs together with the strong involvement of local people in project development. This leads to increased project acceptance, facilitation of the development of local renewable energy projects and promotion of positive beliefs and actions about renewable energy where the entrepreneurial venture is linked to many others. Developing these BMs includes many social and economic benefits since creating energy communities creates local income, maintains local control, and contributes to load stability through load management systems. Furthermore, the projects often have lower capital costs and faster local authority approval. Energy utilities are key partners in some BMs within this pattern. Given the large scale of the projects, capital intensity and social function of energy projects, the presence of local public authority and the political nature of the system

is a prominent issue. The local authority and its political framework may play an important role in managing the financial risk.

Utility-Sponsored Community (USC) model

One of these business models is the **Utility-Sponsored Community (USC) business model**, which is developed by utilities in the form of community solar/wind with a size range from 2 MW to 20 MW. Thus, it is also a technology-based BM. The solar-based ones target new market segments, including multi-family homes and residential rooftops that are not suitable for hosting on-site PV systems. USCs maintain an energy utility relationship with the consumers, satisfy consumers' demand for renewables and diversify utilities' energy resources. Energy utilities may retain their customers as no significant changes in the customer's behaviour and practices are required. It has potential advantages for the utility, including economies of scale, reduced line loss, and reduced transmission and distribution costs. Novelty is addressed by grouping customers in communities and allowing them to invest and own shares. Furthermore, the location of assets is closer to the consumption points in comparison with the traditional centralised BM. However, the control and governance of the activities are handled by energy utilities.

Special Purpose Entity (SPE) model

The second kind of energy community business model is the Special Purpose Entity (SPE), based on investor-owned companies with strong policy incentives. The members have to raise the capital, negotiate contracts with owners and the site host, set up legal and financial processes for sharing benefits and manage the operation of the business. Private investors generate renewable electricity in a community form, and the governance of the business model is under the members themselves.

Energy cooperative model

The energy cooperative model is the third type identified within the building energy community pattern. Business activities are conducted along the energy value chain, including generation, distribution, and trading. This BM is only partly technology-driven since it combines technological and social change where social factors, such as participation, trust, and conflict management, are essential. Citizens are customers and key partners and participate in the governance and finance part of the capital to generate local and green electricity/heat. Citizens' motivation to engage in an energy cooperative is based on the desire to influence local policy or the ownership model of these companies, which are based on democratic principles rather than on share-proportional voting schemes.

Local white-label model

The fourth type is the **local white-label business model** that applies to an organization that does not hold a supply license and usually works on a local scale. It is often based on intermediating and encouraging energy community generations to supply electricity to local people through a partnership with a licensed supplier. The local white label has the potential to link local suppliers with local customers, thus allocating the cost of local generation to local customers.

Assessment

- Local energy communities' business models have a long history starting in the 1970s in response to the energy crisis. These were often ideologically supported and thus Utility-sponsored BMs are often seen with sceptics among customers.
- The energy cooperative business model was very successful, and in some cases, the government changed procurement processes to make it ineffective (e.g., in Germany with the "Ausschreibungsverfahren" for RES projects).
- New players in the market face high entry hurdles.

Table 7. Details of Building energy community business model archetype for energy supply.

Archetype	BM Type	Customer segment	Value Proposition	Channels & Customer Relationships	Cost Structure	Revenue Streams	Key Resources
Building energy communities	Utility-Sponsored Community (USC)	Citizens impacted by the solar/wind project local entrepreneurs and investors	Energy community associated with a wind or solar project.			Through a fixed solar rate or a shared investment return.	Solar or wind larger project
	Special Purpose Entity (SPE)	Individual homeowners	Renewable electricity generated by private investors in a community form.		Electricity generation in the community form	Through participation mainly in solar energy projects.	Large-scale RE projects - mostly solar based
	Energy cooperative model	Citizens	For the investor type - a market-oriented BM - RE assets do not serve members' needs directly. For the hybrid type - electricity/heat purchase and needs beyond return on investments. For the prosumer type - RE exclusively satisfies members' needs directly.	Possible with own network for distribution		- Investor type - the generated electricity feed-in the grid; members are investors motivated by return on investment. - Hybrid type - energy sales beyond the return on investments. - Prosumer type - no revenue generation.	RE assets
	Local white label	Citizens who do not trust big utilities, are looking for renewable energy, and prefer consuming local electricity	Intermediating and encouraging energy community generations to supply electricity to local people through a partnership with a licensed supplier.				Local RE assets/ projects

3.3.3 Lock-in-oriented business models

A part of many BM is “loyalty”, where customers are retained, and their loyalty is assured by providing value beyond the actual product or service itself. The goal is to increase loyalty by creating an emotional connection or simply rewarding it with special offers. In these business models, customers are voluntarily bound to the company, which protects future revenue, e.g., through incentive-based programmes. The so-called “lock-in effect” raises customer loyalty to the next level by locking customers into a vendor’s world of products and services. Thus, switching to another energy service provider is not possible without exposing yourself to substantial additional costs.

The main lock-in mechanisms identified are learning effects, economies of scale, economies of scope, network externalities, informational increasing returns, technological interrelatedness, collective action, institutional learning effects and the differentiation of power.

Klitkou et al. (2015) show that the lock-in mechanisms have reinforced very different path dependencies. Therefore, the characteristics of existing energy supply chains set the preconditions for developing new transition pathways. The mandatory socio-technical BM is not just fossil-based but can also include developed specialised companies in the exploitation of renewable sources. “This implies a need to distinguish between lock-in mechanisms favouring the old fossil-based regime, well-established (mature) renewable energy niches, or new pathways” (Klitkou et al., 2015).

Table 8. Details of lock-in-oriented business model archetype for energy supply

BM Archetype	Type	Customer segment	Value Proposition	Channels & Customer Relationships	Cost Structure	Revenue Streams	Key Resources
Lock-in-oriented	BM that offers energy functionalities	Citizens ESCOs Local authorities	Energy service providers offer energy efficiency measures or renewable energy systems through a solution not based on product ownership transfer.	Passive customers; deal with one representative of an alliance of service providers.	Financial partners are crucial, based on the combination of products and services.	Whole package based on energy functionalities.	Alliances between manufacturers, installers, and insurance firms.
	Energy service agreement	Citizens Local authorities	Provide energy services that reduce energy consumption using more efficient energy systems.	Close and long-term relationships with customers of local authorities.	Time-consuming investment procedures and a long payback period.	Long payback periods, and limited revenue streams.	Energy production equipment with more efficiency.

BM Archetype	Type	Customer segment	Value Proposition	Channels & Customer Relationships	Cost Structure	Revenue Streams	Key Resources
	Third-party BM	Citizens ESCOs Local authorities	Customers pay a fixed price per kWh for direct use of the solar system. Immediate reduction of up to 10-20%, a predictable cost of electricity over 20 years and a lower upfront cost.	Customers are involved in a leasing contract and pay a fixed amount per month for the usage of the PV system.	Installation and maintenance of solar-based rooftops systems; learning and scale effect enable the third parties to lower the transaction cost associated with incentives, grid connection, permits and installations.	Stimulating demand by aggressive sales and downstream partnerships and vertical integration of the value chain to minimize cost. Customers pay a fixed price per kWh for direct use of the PV system for a long period (around 20 years), depending on the power purchase agreement. Long-term contracts.	Large number of small solar systems installed on the roofs of the customers' houses.

Energy functionalities-oriented models

The energy service providers offer energy efficiency measures or renewable energy systems through a solution not based on product ownership transfer. The consumers' roles are passive and similar to the conventional roles. At the same time, the financial partners are crucial, based on the combination of products and services, thus on alliances between manufacturers, installers, and insurance firms.

Energy service agreement

Energy service companies provide energy services that reduce energy use by using more efficient energy systems. ESCOs, assume most of the financial and technical risk, provide bespoke and holistic energy services and create environmental and social benefits.

Third-party model

The third-party BM is often linked to solar-based technologies and is often cited in the literature as the third-party PV business model (Huijben & Verbong, 2013). Third parties control and own the PV system, bearing the financial risk and reducing complexity for the consumers.

Assessment

- The application of this kind of BM is denominated as customer-side renewable energy delivering renewable electricity as a service and providing a customised solution that fits different customer requirements.
- The customer is engaged by hosting the generation system. The infrastructure consists of large numbers of small-scale generations close to the consumption points, and the benefits are shared between customers and energy utilities based on long-term contracts.

- The infrastructure is centred around the customer, the value proposition is heterogeneous and customised, and the revenue model is based on small-scale, expense-intensive sales generated from services.

3.3.4 Complementarities-oriented energy supply models

In the optimising grid operations pattern, Demand Response (DR) services are combined with the consumption and renewable generation devices to optimize energy system efficiency. In the combining value proposition pattern, renewable energy systems are sold with products from other sectors, like prefabricated homes or electric vehicles.

Optimising grid operations model

The sources of value creation are based on complementary services for load and generation management looking to optimize grid operations often related to the distributed renewable energy resources and/or the customer's consumption configurations. The core feature of this pattern is its association with timing, what is called "timing-based" activities. These activities aim to increase the flexibility of energy supply or demand through ICT infrastructure. It is a "coupled service" that couples timing as a service with supply valuables (e.g., large power plant) or/and with consumer-based valuables (large or small demand) (Helms et al., 2016). In this pattern, three BMs are presented: **demand-response, virtual power plant, and active management of distribution networks**.

Examples

The **demand response BM** looks for mechanisms to change end-users' usual consumption shapes. This modification is especially interesting when facing high wholesale prices or when system reliability is jeopardised (Albadi & El-Saadany, 2008). Changing the user's consumption shape can respond to electricity price changes over time. It also refers to induced lower electricity consumption use through incentive payments at peak demand.

Demand response value creation involves identifying, activating, connecting, and communicating with consumers. These activities usually focus on large-size small numbers of consumers (e.g., industrials), which entails lower transaction and intervention (consumer disruption) costs than handling small-size large-number consumers. To induce lower electricity consumption in the case of large-size consumers, incentive payments are largely used, while small-size consumers can be invited to modify their consumption shape by changes in the electricity prices over time or by other techniques.

Even if the demand-response BM focuses on actors that offer flexibility in energy consumption, the generated value propositions can be for different stakeholders, such as system operators, generation actors, distribution stakeholders, retailers, or load stakeholders. The **Demand Response Provider (DRP)** creates value for the System Operator (SO) by adjusting the demand profile to maintain the generation load balance and reduce peak hours. Moreover, energy consumption modification can impact the spot electricity price (Behrangrad, 2015).

The DRP can create value for generation stakeholders by creating a desirable load profile, which increases their operational efficiency. DRP can also offer services to transmission and distribution actors by reducing consumption in congested zones, thus helping delay or reduce infrastructure investment (Poudineh and Jamasb, 2014). Concerning the retailing stakeholders, the DRP uses its competencies to modify the consumption shape of a retailer to reduce its procurement costs. Lastly, DRP creates value for load stakeholders by shifting the electricity load when the kWh prices are high (Behrangrad, 2015).

The second example is the "**Virtual Power Plant**" (**VPP)**. Herein, the provider aggregates a combination of high numbers of small-scale generation units e.g., Combined Heat and Power (CHP) and renewable energy resources, to generate sufficient capacity, enabling producers to participate in the energy market and gain

fees from their flexibility, often complemented with consumption management. Prosumers shift part of the demand to lower price periods and sell the generated renewable energy when the electricity market prices are high or consume when the prices are low. The prosumer has a lower electricity bill, and the SO has higher available capacity during peak hours.

This concept is defined as a system in place to control a combination of distributed resources, in which DSOs can manage the electricity flow and generators take some degree of responsibility for system support through a connection agreement. The DSO is responsible for the distribution network operation. In this BM, the DSO provides voltage management services to renewable energy resources, and the generators profit from this service by maximising their connected capacity and generating electricity. The aggregator can also provide this service by aggregating and limiting commercial and industrial consumers' maximum power consumption during congestion periods. This BM includes ancillary service; even if habitual utilities have provided these services to maintain grid stability and security, new companies have emerged with an original MB that can be classified within the active management of the distribution network.

Combining value propositions model

In this pattern, the energy products and services that emerge from the energy industry are provided as add-on products/services to the original product and integrated within other products from different sectors. Two BMs have been identified within this pattern**: the vehicle-to-grid (V2G) or home BM and the cross-selling of PV systems BM**. These EBMs build original combinations between the mobility sector, the demand response services, and the construction sector with renewable energy systems. Some examples show that EV car manufacturers and distributors are interested in entering the electricity market by providing extended (electricity) services to their customers (car buyers or owners).

Examples

In the **vehicle-to-home** BM, the aggregation of the electric vehicle is embedded in the management of other loads in the home. In the "**vehicle-to-grid**" BM, a commercial intermediary manages and aggregates the battery loads of a large number of connected vehicles simultaneously to have sufficient tradable capacity. (e.g., Tesla in UK, Sonnen in Germany). The battery capacities of the cars are centrally controlled and used for grid services ("virtual super" battery).

In the **cross-selling of PV systems BM**, a product or service based on renewable energies, such as PV solar panels, is sold with prefabricated homes, providing more value than having each product be sold separately. The advantage of this combination is that the PVs are 10% cheaper than the market price as the inclusion of the PV systems in the mortgage of the established house selling process lowers the transaction cost of PV. Moreover, this solution is often more aesthetic as PV systems are better integrated than add-on solutions.

Acting locally model

In this BM, the complementary service of demand response is organised locally to create and capture the value of load balancing locally. DR value proposition is related to cheaper power use, matching local generation with local loads and systems benefits to infrastructure providers.

Examples

The **e-balance BM** aims to balance consumption and production intelligently and effectively to enhance the reliability and efficiency of the low/medium voltage energy grid levels; it acts as a platform based on ICT and citizens' behaviour. The value creation is enabled by automated DR that shifts the load from local consumers to periods when there are low energy prices, pooling local generation and employing smart meters to net off the local supply at a virtual meter point.

The **local pool and sleeve BM**, the local aggregator pools a group of local generations and then supplies the energy to a consumer or consumers.

Finally, the **Energy Hub BM** refers to a local energy system that mediates multi-energy carriers (electricity, thermal and chemical energies) that optimize energy management and integrate energy conversion and storage units. It primarily guarantees energy supply and demand match through internal flexibility and energy market participation.

Assessment

- The share of renewable energy resources and distributed generations connected to the grid is growing. This growth requires the distribution grid to be flexible or extended by reinforcement. While the latter is temporary and not cost-efficient, the former depends on the efficient use of the existing network and creating value from activating user flexibilities of both generators and consumers.
- In the future, active management of the distribution network is needed. This will incentivise the market actors to provide “grid-friendly” services (IEA Annex 82, 2022).
- The complementary-oriented business models try to foresee these complementary values already today. But not all “grid-friendly” services have a remuneration model in place yet.

3.3.5 Energy efficiency-oriented models

Two patterns are defined in which efficiency is the major source of value: scaling up and running platforms. In the former, the business logic lies behind the economies of scale and the implementation of distributed generation at customers’ sites. The latter discusses the online platforms that establish a direct link between the various parties of the energy market, such as the peer-to-peer energy trade and renewable crowdfunding.

Scaling-up

In this pattern, the firms generate economies of scale by aggregating supply, as in the case of the first business model type, the network model of a large company, which is taken from the heat supply sector. In the second type, economies of scale are achieved by aggregating demand, as in the collective buying of solar systems.

In the first business model type, **a network model of a large company**, the provider’s value creation enables a low-cost heat supply unit due to its several operation units. Economies of scale in the fuel supply (e.g., biofuel, wood chips, etc.) are the core of value creation. Customers, such as municipalities, can lease the required infrastructure, such as the heating plant and the distribution network to the provider, which is also operating the heat production. While the major benefit is cost efficiency, the supply of foreign fuel might have an impact on local and regional economics.

In **collective buying**, the organization provides a service of buying, installing, and maintaining the PV system on the customer sites, or it only arranges the installations. In both cases, the subscribers benefit from the availability of information, such as the selection of suppliers, price bargaining, insurance, etc. The efficiency improvement arises from the lower cost of demand aggregation, complexity mitigation from reducing technological risk and making information available to a large number of subscribers. The value creation is improved by joint value maximization and strong bargaining conditions.

In this pattern, the main tasks are outsourced to a third party who has the experience, the required knowledge and efficient resources. The service oriented-business model and the aggregation of demand or supply enable decentralised generations to create cost-efficient value. As a result, ownership, financing and controlling may be outsourced to a service provider, as in the case of heat generation or perhaps not as in the case of PV collective buying.

Running platforms models

The running platforms pattern enables new services in which the BM activities are organised in a more efficient and sustainable way, with a lower cost. Such platforms foster the emergence of new markets for energy trading, fundraising and load balancing. In these BMs, new parties are linked in peer-to-peer relationships. The flexibility of load can be enhanced by high transaction speed and real-time access to data. Consumers and small generation stakeholders have access to the energy market and can participate in demand response platforms. Herein renewable generation and demand response depend more on granular and decentralised resources.

The **peer-to-peer BM** consists of a software platform that plays an intermediate role between commercial consumers and the distributed generation, where consumers can choose their energy mix and compare the different tariffs. The direct link between consumers and generation constructs a more efficient way of satisfying demand without passing through the wholesale market.

Crowdfunding for renewable energy BM is described as an organizational innovation form used by people who are networked and pooled. The main purpose is to raise funds and finance renewable energy projects collectively, thus scaling up renewable energy projects and transforming the energy and financial regimes.

Lastly, the **electricity balancing service platform** BM is a matching platform between suppliers who cannot predict their renewable energy generation and consumers who participate in the energy demand side management and are vulnerable to real-time electricity price volatility. It aims to provide demand response service to electricity suppliers and reduce consumers' bills by optimising and managing household electricity.

Assessment

- BMs based on energy efficiency are focusing on delivering energy efficiency to the market, either by scaling effects or by exploiting new digital services.
- Digital and advanced technologies are increasingly transforming the electricity value chain, transforming the way electricity firms create, deliver and capture value. Efficiency gains are generated by making transactions more transparent and faster, simplifying the processes and increasing the availability of information.
- These models have a high potential for future optimization of the energy market. It is also possible to include a renovation business model in this offer.

3.4 Discussion and conclusions

This chapter investigated the dynamics of the energy sector, which is undergoing a continuous transformation process where a fundamental shift of energy supply towards renewable, carbon-neutral energy is taking place, together with decentralization and digitalisation. The classical structure of the electrical energy industry that emerged after the liberalization of European electricity and gas markets, including established business models, is subject to disruptive and massive changes.

This section discusses opportunities for coupling the sectors of housing, mobility, energy supply and waste heat.

Understanding the policy and regulatory interdependencies is critical to ensuring the sustainable development of these businesses:

- Five different archetypes of BM were identified that ensure a maximum impact.

- Uncertainties in the supportive measures for applying distributed energy resources (DER) make it difficult to develop new business models for the utilities.
- There are opportunities for new business models for energy supply applied to the renovation of districts.

3.4.1 Heat market

With an increasing number of requirements at the national level, such as primary or end energy targets for buildings, regulation to foster renewables, and partly and temporarily overloaded grids have added multiple complexities which cannot be handled by the utility model alone. In the EU, carbon footprint and primary energy (PE) targets for buildings are in place. In most cases, the latter PE targets can only be responded to positively by combining demand and supply side measures. This means that a building connected to a supply grid with a biomass boiler (low primary energy factor) can even reduce its efforts on the building insulation level to achieve the required PE target. However, this option is short-sighted, as these buildings will consume a lot of valuable biomass.

3.4.2 Electricity markets

Value streams in the electric power sector are embedded in the regulatory and policy frameworks that characterize the sector. State or national government-appointed regulatory commissions regulate the revenues of electricity distribution companies. Classical electricity supply utilities are suffering nowadays from a strong decrease in the number of energy utility customers. The quitting customers are served by new market actors operating with new business models centred on renewable energy and energy efficiency technologies.

The revenues – and thus the viability – of distributed energy resources businesses (DER) in distribution networks are, therefore, partially exposed to these regulatory frameworks. Similarly, in wholesale electricity markets, market rules are established by a central authority, Independent System Operators (ISOs) or Regional Transmission Operators (RTOs), all entities monitored and regulated by an Energy Regulatory Commission (FERC). New DER business models selling services in wholesale electricity markets must conform to the market rules and regulations established by these authorities. In addition, the electric power sector is subject to significant national and EU policy support, taking the form of subsidies or favourable rules for a variety of technologies, e.g., solar-based energy (electricity and heat) generation. Understanding these policy and regulatory interdependencies is critical to ensuring the sustainable development of these businesses. Lastly, an innovative activity currently being developed includes installing energy storage systems, which is a key activity to balance the intermittency of renewable energies. Based on these activities, innovative BMs are needed, which allow early-stage companies to make a place in the energy value chain. It became clear that several objectives that are to be fulfilled also entered the electricity market. Buildings are more commonly seen as micro-energy hubs with energy generated, stored, used, and saved in buildings and districts, as indicated by (Building Performance Institute Europe - BPIE), aiming at:

- Maximise energy efficiency of the buildings.
- Increased on-site or nearby RE production and self-consumption.
- Encourage energy storage capacities in buildings (or nearby).
- Incorporate demand-response capacity in the building stock.
- Decarbonise the heating and cooling energy for buildings.
- Empower end users via smart meters and controls.
- Make dynamic price signals available for all consumers.
- Foster business models aggregating micro-energy hubs.
- (Re)Build smart and interconnected districts (renovate/retrofit).
- Build infrastructure for the further market uptake of electric vehicles.

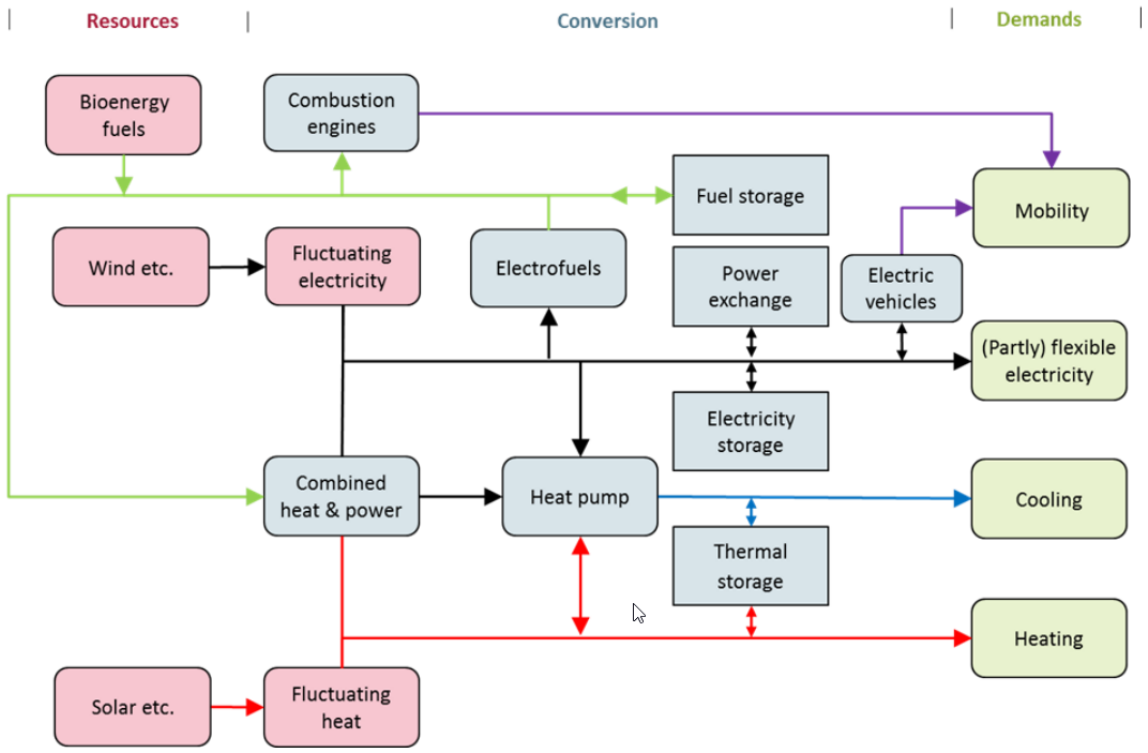


Figure 6 The principal interaction between sectors and technologies in a smart energy system, providing several business model opportunities (adapted from Paardekooper et al., 2018).

3.4.3 Energy planning process/sector coupling

With technologies (as depicted in **Figure 6**), renewable energy can provide heating, cooling, (flexible) electricity and mobility. An integrated energy planning process must be established to implement such a system. The Energy planning process (EPP) has to implement goals and constraints on different levels (national, municipal, neighbourhood) and phases. The measurement and verification depend on some criteria:

- Cost-effectiveness of community projects.
- Economic decision-making criteria:
  - Life-Cycle Costing (LCC) calculation for EPP.
  - Multiple benefits (bankable LCC at the building level).
  - Bankability and risk mitigation of multiple benefits.
  - Cost-effectiveness.
- Investment costs and capital expenditures.
- Determination of technical concept and investment costs:
  - Gathering accurate investment costs.
  - Developing detailed energy demand and supply scenarios by simulation.
  - Specific risks in the calculation of investment costs.
  - Optimization of investment cost.

With the increasing complexity of the energy supply in building clusters, the partition of Energy Service Companies (ESCO) of the total market is steadily increasing. Today ESCOs and a few innovative utilities can provide highly complex energy services, including generation, distribution, storage, selling, measurement & verification combined with demand-side measures like renovation of buildings, distribution grids and other demand-side activities. The business scheme here usually is the energy supply contracting which delivers demand and supply side measures for a fixed investment cost-based price per kW and a price for the consumed kWh of energy. The ownership of all investments, except those in buildings remains for the duration of the contract (5-20 years) with the ESCO/utility.

Energy savings performance contracts help policy actors meet energy efficiency, renewable energy, water conservation, and emissions reduction goals by streamlining contract funding for energy management projects. The streamlined financing could provide multiple benefits, such as increased quality and value and smart project management.

In recent years, energy savings performance contracting has been developed into a business model which is not only able to tap energy efficiency potentials in buildings (HVAC and thermal envelope) but also provide complex supply, distribution and storage concepts with CHP, PV, biomass and heat pumps. Here, the remuneration is based on the energy savings and other life cycle cost savings provided by the energy service company. The following value streams are also important to notice:

- Energy savings.
- Avoided maintenance and repair costs.
- Operation cost reduction.
- Insurance costs.
- Building comfort and Green Neighbourhood Value.
- Risks and De-Risking methods and tools.
- Key Risk Indicators (KRI) in general.
- KRI in EMP for building clusters, in particular.

The public sector is in a situation to balance a variety of local objectives, including cheaper local energy for public, private and/ or residential customers (e.g., the alleviation of fuel poverty); local job creation; local wealth retention; low-carbon power generation; and/or local air pollution reduction. By quantifying these objectives through economic modelling, it is possible to create additional value for new financial models, for example, the coupling of electric vehicles with electricity supply.

3.4.4 Energy Community

Community ownership is often considered a source of income that can be controlled locally. Therefore, these kinds of investments are more likely to be accepted socially because it helps develop local supply ownership and avoid value leakage out of the local economy. Especially renewable energy assets follow different strategies than traditional assets (high investment, low operational costs) and depend on key activities of the energy provider (capacity), and key partnerships within a network of suppliers and partners to make the BM work. Financing of RE technologies is a crucial factor for both micro-generation (where the costs are a barrier because of the long-term investment in the infrastructure assets and the success or failure of investment depends on the institutional support) or for large-scale renewable energy technologies (where the large up-front cost is often described as a barrier that prevents customers from having a clean energy resource and hence outsourcing financing to a third-party to remove this barrier.

Alternative financing sources for RE investments are the newly emerging energy cooperatives, where the financial risk can be mitigated due to local authority investment or collective fundraising for RE through crowd-funding platforms.

The development and implementation of EPP require a bundle of mandatory and optional services provided for the public owner of a building cluster. Also, remuneration or compensation schemes for these services need to be adapted. Each of the services is allocated to typical service providers.

Finally, the services are allocated in the “business as usual” and the energy service business model. However, the public owner of the energy supply systems (utilities) plays a major role in the successful application of implementation models for PEDs.

At the building level, energy supply, storage and distribution infrastructure make the EPP design and implementation a much more challenging and demanding task for utilities and energy service companies (ESCOs). In this context, the “business model” is used to provide a first draft of the structures of market-ready approaches for the EMP design and implementation.

The “business as usual” value stream usually is based on a strict separation of responsibilities and risks between a set of service providers and the building cluster owner: concept designers, energy modellers, architects, designers for construction, energy supply and infrastructure, handcraft companies or general contractors are working on the EPP process step by step with several hands-overs**.**

Understanding the advanced EPP value stream provides a different mindset that focuses on the needs of the building owners and the community developer. A few cornerstones of the advanced value stream for PEDs are highly resilient community energy systems considering buildings, supply, distribution and storage as basic components which have to match together. The main aspects were identified as important to be able to define value streams as the basis for the successful implementation of decarbonisation projects.

3.4.5 Final remarks

- No specific business models for energy supply are applied to the renovation of districts.
- Energy poverty is still present in the EU, and this does not encourage the deployment of renewable energy sources while performing district renovations.
- Uncertainties in the supportive measures for applying DER make it challenging to develop new utility business models.
- EMP (heat planning) can be an essential instrument against uncertainty and allows for better synchronization of investment cycles. In addition, EMP can detect links between EE and RES measures.
- Since renewable energy business models are highly dependent on the regulatory framework, policymakers directly influence their future development.
- Supportive measures for energy-efficient district renovations also emphasise energy supply.

Table 9. Summary of BM archetypes for energy supply.

BM archetypes	Value Proposition	Financing mechanism	Barriers	Opportunities to overcome barriers
District heating	Economy of scale, exploiting various heat sources (including waste heat).	Incomprehensive tariff structure, usually high connection costs, obligations to connect to the existing network.	High investment costs. Too high temperatures to utilize low-temperature (waste) heat. Low heat energy costs (not reflecting external costs).	New generation of DH with low circulation temperatures. Incentives from policymakers. Inclusion of external costs (CO_2 tax). EPP including other sectors. Heat storage opportunities.
Going Green	Renewable electricity generation by various stakeholders.	The energy utilities adopt renewable energy and extend their value proposition by adding new renewable energy sources to sat-	Based on existing relationships with customers of local authorities, thus difficult to attract new customers.	Incentives from policymakers.

BM archetypes	Value Proposition	Financing mechanism	Barriers	Opportunities to overcome barriers
		isfy customers' demand for renewable energy.	More energy-efficient system is based on fossil fuel.	Inclusion of external costs (CO_2 tax). EPP including other sectors. Heat storage opportunities.
Building Energy Communities	Renewable electricity generated by private investors in a community form.	Allows multiple participants to invest and/or benefit directly from the energy produced by a shared system.		
Lock-in-oriented	BM that offers energy functionalities, e.g., provides energy services that reduce energy consumption using more efficient energy systems.	Customers pay a fixed price per kWh of the direct use of the solar system; immediate reduction of operational costs; a predictable cost of electricity over 20 years and a lower investment cost.		Combine RES and EE.
Complementarities-oriented energy supply	Active grid management of energy (balancing demand-supply mismatch).	Revenues from actively managing the grid.	Costs for grid balancing services are not established. Various stakeholders for grid management (consumers, producers, DSO, TSO).	Establish incentives for grid stability services (Annex 82). Add time to the value of energy (summer vs. winter). Convert energy supply to energy balance services (incl. storage).
Efficiency-oriented energy	Economies of scale	Cheaper production through economies of scale; digital services for distribution and sales.	Scaling up mechanisms. Early stage of digital technologies. Slow (and too big?) established market players (with little incentives to change).	Opportunities for new market participants. Active change management.

4. Comparing and combining renovation and energy supply

4.1 Introduction

The previous chapters 2 and 3 identified business model archetypes and drew some conclusions regarding the business models' opportunities for upscaling energy renovation to the district level. In this chapter, we try to evaluate the potential for combining renovation and energy supply business models. For that, we identified the stakeholder mapping, the identification of value creation, the combination of customer segments and the main drivers.

Furthermore, within the framework of IEA EBC Annex 75, a number of success stories were analysed. The success stories constitute good-practice examples of districts where energy-related interventions have been applied. The success stories screening and analysis aim to highlight technical potentials and innovative approaches and identify and describe lessons learned regarding applied methodologies, success factors and barriers. A detailed description of the success stories can be found in the respective IEA EBC Annex 75 Report (Domingo-Irigoyen et al., 2023). This report is mainly dedicated to analysing the aspects related to the applied business models. Here, the success stories provided insights into what a combination of renovation and decarbonisation of the energy supply can look like and how these were identified and implemented.

Based on the archetype investigation and the success story analysis, section 4.3 offers some insights into the key considerations for the business models and stakeholders' dialogue in district energy renovation. Those insights are further supported and elaborated in the next step of the methodology, where we collect the stakeholders' views on upscaling the renovations (Chapter 5).

4.2 Success stories analysis

Within the framework of IEA EBC Annex 75, a database of district renovations was collected to illustrate the development of cost-effective strategies to combine energy efficiency measures and renewable energy use in renovation at the district level, to investigate factors influencing the choice for a cost-effective strategy, and to gather related best-practice examples.

Following the definition proposed by Paiho et al. (2019), this study considers a "renovation at the district scale" as an intervention in different buildings located in the same area. It is assumed that there is a relation between the buildings, for example, that they could be served by the same district heating or be part of the same neighbourhood. The term "district" is used in this study without juridical or administrative purpose to accommodate the different national contexts analysed in the scope of the project.

Table 10 summarises 12 cases of district renovation gathered in the project. More detailed descriptions of each renovation project along with an interactive map showing their respective geographical location can be found in (Domingo-Irigoyen et al., 2023) and online (https://annex75.iea-ebc.org/success-stories). The projects form the basis for a multi-perspective analysis of similarities and differences between projects, which in the end, is used to derive the most important lessons learned. As seen from the table, most of the districts are strictly residential and only two are mixed (residential and schools/commercial/cultural). The buildings were constructed between the 1950s – 1980s and renovated during the last 10 years.

A holistic analysis of success stories was performed by (Rose et al., 2021). This report focuses on the analysis of the business models employed in the district renovations to relate to the archetypes identified in the previous chapters and highlight the key considerations.

Table 10. Brief summary of success stories in IEA EBC Annex 75.

	Country	Project	Nomenclature	City	Use	Year of construction	Year of renovation
1	Austria	Strubergasse	AT	Salzburg	Residential	1950-1965	2012-2018
2	Denmark	Kildeparken	DK	Aalborg	Residential	1970s	2014-2020
3	Italy	Quartiere Giardino	IT1	Modena	Residential	-	1970
4		Quartiere Sangallo	IT2	Varese	Residential	1960-1970	2015-2017
5		Vicenza	IT3	Valdastico	Mixed	-	2014
6		Campus Univ. IUAV	IT4	Venice	Educative	17th– 20th century	2017
7	Portugal	Rainha Dona Leonor	PT1	Porto	Residential	1953	2009-2014
8		Vila D´Este	PT2	V.N.Gaia	Residential	1984-1986	2009-2015
9		Boavista Neighbourhood	PT3	Lisbon	Mixed	1960	2013
10	Spain	Coronación district	ES1	Vitoria-Gasteiz	Mixed	1960-1970	2016-2021
11		Lourdes Neighbourhood	ES2	Tudela	Residential	1954-1972	2010-2012
12	Sweden	Linero	SE	Lund	Residential	1969-1972	2014-2021

4.2.1 Categorisation of success stories

During the collection of the success stories, a template was used, consisting of the key parameters needed for the analysis carried out across the different IEA EBC Annex 75 tasks. Namely, those key parameters were the following: the goal of the interventions, balance between energy efficiency and renewable energy sources, drivers (decisive aspects for the successful implementation), main barriers and influencing factors, and business models. The current report aims to identify the business models used during the renovations and focuses on specific sections of an information-gathering template provided to IEA EBC Annex 75 participants. The following sections provided information that enables the characterization of the BM elements, as presented in the overview of **Table 11** and, in more detail, in **Addendum 3**:

- "Description of the renovation concept" - non-technical aspects (e.g., stakeholder involvement, communication, etc.).
- "Decision and design process", aimed at investigating the context and the pre-design steps that led to the retained solution by assessing the general and organizational issues, stakeholders' roles and motivation, design approach, technical issues, financing issues, management issues, and policy framework conditions.
- "Lessons learned and interesting findings" to be transferred.

The information provided in the templates was not detailed enough to be able to outline the complete business model per case. However, they helped identify some of the main business model elements and the respective archetypes.

Table 11. Overview of business model characteristics in success stories.

		BM Archetype	Customer	Activities	Partners
1	AT	One-stop-shop Complete solutions	Housing association City of Salzburg Municipal Department	Thermal renovation. Connection to district heating. Produce electricity on sit with PV. Surplus electricity for mobility.	Municipality, neighbourhood actors, building owners, financial intermediaries, and advisors.
2	DK	Market intermediation	Housing association Energy consumers	Collaboration model for an energy partnership between housing organizations, municipality, and an energy company. Integration of the district in the existing energy supply network.	Architects and technical advisors. District Heating supplier.
3	IT1	Atomised model Specific measures delivered by the supplier	Energy consumers	Construction of a district heating network and connection to the existing buildings. Connecting the buildings to the network.	Public entities and private companies.
4	IT2	ESCO	Housing association Energy consumers	Buildings envelope thermal insulation, air-to-water heat pump, installation of PV systems grid-connected.	Regional governments, Public Financier, Housing association, ESCO Co-Financier.
5	IT3	Atomised model Specific measures delivered by the supplier	Municipality – public building user	Central biomass heating plant (wood chips); solar heating system to supplement the summer domestic hot water needs; maintenance of existing boilers; system management.	Policy actors: municipality, housing association and school administration, Design and consultant company.
6	IT4	Atomised model	IUVA – property owner	Trigeneration plant with natural gas composed of a cogeneration group; hot water district heating based on 90 °C supply temperature that serves the 5 neighbouring buildings.	Building owner, ESCO.
7	PT1	One-stop-shop	Existing tenants New private owners	Renovate the buildings due to their deep degradation state; adapt the living areas to modern living standards; improve indoor comfort; renovate outdoor areas such as playgrounds and circulation areas.	Social public housing, Developer.

				Exterior walls insulation, roof insulation, double glazing windows, daylighting improvement with bigger windows in the living room, energy-efficient heating and cooling systems, solar thermal system for DHW.	
8	PT2	Market intermediation	Homeowners	Roof insulation and cladding. Ventilation exhausts Exterior wall insulation and GRC cladding Replacement of windows, Shading.	Municipality, municipal energy agency, Homeowners association. Residents' association, Condominiums association, contractor, designer, University.
9	PT3	Market intermediation	Housing association	Thermal insulation (black cork agglomerate) on the envelope, PVC window frames with double glazing. Solar thermal energy panels implemented in the pool and sports complex.	Eco-Bairro. Housing Association, Tenants Association.
10	ES1	One-stop-shop	Homeowners and HOAs	Retrofitted (envelope), connection to the district heating, new biomass (wood chips) district heating network, integrated energy management system, and acquisition of electric vehicles. VIS manages, contracts, supervises, and finances the correct design and execution of the renovation work and subsidies.	Municipality, Regional Government, public company, HOA. ESCO and engineering company (design of DH network and boiler room adaptation).
11	ES2	One-stop-shop + ESCO	Homeowners' Associations	improving the energy efficiency of the building envelopes and district heating boilers and distribution pipes.	Municipality, Financial/ regulations facilitator, Building managers, Residents, district heating. Regional and European Government. Direct subsidies.
12	SE	One-stop-shop Comprehensive measures	Housing Association	Window replacement, roof insulation, south façade insulation. Optional balcony glazing, renovation of the ventilation system. Electricity production and improvement of district heating performance with additional stations and renewables.	Housing Association, Municipality.

Based on the information presented in **Table 11**, the success stories were reviewed to identify which archetype of the renovation business model was applied and how it fitted the project's scope and activities. The findings of the analysis regarding the BM archetypes for renovation are summarised below.

Atomised market model

The individual, “atomised” model was rarely encountered in the success stories, as most renovations consist of integrated solutions with multiple measures. However, it is possible to classify in this model the cases that the intervention referred only to the upgrade and connection to district heating, as there was one specific measure that was delivered by the supplier (IT1, IT3, IT4).

Market intermediation model

Regarding the success stories presented, this model was applied when a bigger consortium was involved in the process, also in the case of research projects. The result was comprehensive renovation solutions, aiming at high energy performance incorporating measures for both envelope and building services upgrades, renewable energy production on site (PT2, PT3), and connection to district heating (DK, PT1).

One-Stop-Shop

Several success stories are considered to adopt the one-stop-shop approach (AT, ES1, ES2, SE), offering a single point of contact with integrated services, such as audits, arrangement of third-party financing, residents' acceptance, and others, next to the technical solution design and implementation.

Energy service company

Energy Service Companies (ESCOs) offer a similar service to One-Stop-Shops, but their value proposition is based on ongoing energy performance guarantees. ESCOs primarily use Energy Performance Contracts (EPCs) as a financing mechanism and keep a long-term relationship with the customer, including monitoring, operation, and maintenance. A form of an ESCO business model was applied in two of the success stories (IT2, ES2).

4.2.2 Findings from the success stories’ analysis

In all the success stories analysed, the main value propositions were improving comfort, reducing energy use, and reducing environmental impact. Additional value propositions were related to improving the overall living quality and the district's quality. In some cases, the diversification of apartment sizes was also one of the renovation objectives (DK, PT1).

The customer segment was the building owner and the building user, as tenants and energy consumers. Depending on the context, the building owners were the housing associations (public or non-profit), homeowners’ associations (HOA) or public buildings users, such as the university or the municipality.

Regarding financing, in most cases, part of the investment came through public money, either as direct financing (AT, DK, IT1, IT3, PT1, PT2, SE) or in the form of subsidies to homeowners or other frameworks (IT4, PT3, ES1). In IT2, the financing was solved with a combination of one-third public money, while the buildings’ owner, “ALER- Varese”, assigned the remaining two-thirds to an ESCO. In PT1, the municipality initially supported the costs of renovating the existing buildings. At a later stage, a public tender was held by the municipality to find a private investor who would demolish the three apartment blocks and build “high-end social housing” buildings, as well as a private-owned residential building that would be put on the regular market. Finally, the ES2 project was financed through public grants and private loans to HOAs.

As mentioned above, the analysis of the success stories showed that in the case of big renovation projects, the atomised market model is not common. This model could be more applicable in the case of maintenance,

with the objective of single measures. Based on this observation, this study suggests that the atomised business model is not adequate for district renovation or has to be steered and managed to contribute to a coordinated district energy renovation.

In projects focusing on the district heating connection, upgrade, and expansion (IT3, IT1, IT4, DK), the decision-maker was a policy actor, mainly the municipality, in collaboration with the energy supplier who would deliver the intervention. The building owners, such as housing associations, were involved in the process of implementing the connection. In the IT4 case, the university led the decision-making as a large organisation and policy actor. When combined with renovation, the financing was arranged separately. Thus, the district heating interventions are generally not part of the renovation business model process. They are executed by separate entities and do not share a business model. Some measures at the building level that comply with the district heating, such as low-temperature radiators, are included in the buildings' energy efficiency renovation packages.

As concluding remarks on the success stories' business models and financing, we can highlight the role of public bodies, such as regional bodies, municipalities, and their affiliated housing associations, in the decision-making and funding of the larger projects.

Moreover, the success stories proved the need for comprehensive approaches to district-scale renovation, not only in the implementation of technical solutions but also in the business and financing model, as well as regarding process management.

4.3 Key considerations in combining renovation and energy supply business models

Based on the archetype investigation (section 4.1) and the success story analysis (section 4.2), this section collects insights into the key considerations for the business models and stakeholders' dialogue in district energy renovation. To evaluate the potential for combining renovation and energy supply business models, we identified the stakeholder mapping, the identification of value creation, the combination of customer segments and the resulting main drivers.

4.3.1 Stakeholders mapping

The nature of ***business model innovations*** involves broader sets of actors working together. Thus, developing a successful value proposition for users is difficult as there are multiple and sometimes conflicting end-user values, system needs and supplier/ financier needs. Because these business model innovations create new interfaces between users and the grid, they also open opportunities for creating new sources of value, such as reducing pressure on the electricity networks, price arbitrage, time-shifting consumption etc., but these can be small or intangible. There are often trade-offs between the sources of value and how that value is shared. For example, local balancing has the potential to reduce supplier imbalance costs and reduce the customers' bills, provide an uplift to the generator, and increase the supplier margin. The key challenges of developing successful business model propositions are balancing innovation, attractiveness, risk, adhering to regulations and meeting decarbonisation goals. Many of these business models depend on the growing local demand for RES, flexibility, and storage services. These models view value proposition development as a step-by-step process, focusing first on value propositions that would appeal to a larger group of users and then developing more innovative service solutions that could be delivered later. When establishing new BM for renovation and energy supply on a district scale, clusters of stakeholders and an innovation ecosystem are needed. The traditional view of such ecosystems is a collection of companies situated within some level of proximity, allowing for more collaboration, interaction, development of stronger ties and natural growth of collaborative strengths within the cluster (**Figure 7**).

Innovation clusters act as ecosystems that create an active flow of information and resources for ideas to transform into reality. Through these ecosystems, a process is started by which more innovators and entrepreneurs can develop and launch solutions to solve real-world problems faster. This process creates expertise in new areas, helps to diversify the economy, and allows businesses to meet their customers where they are. Additionally, an innovation ecosystem provides the means to create economic stability and resource sharing (Verdú & Tierno, 2019).

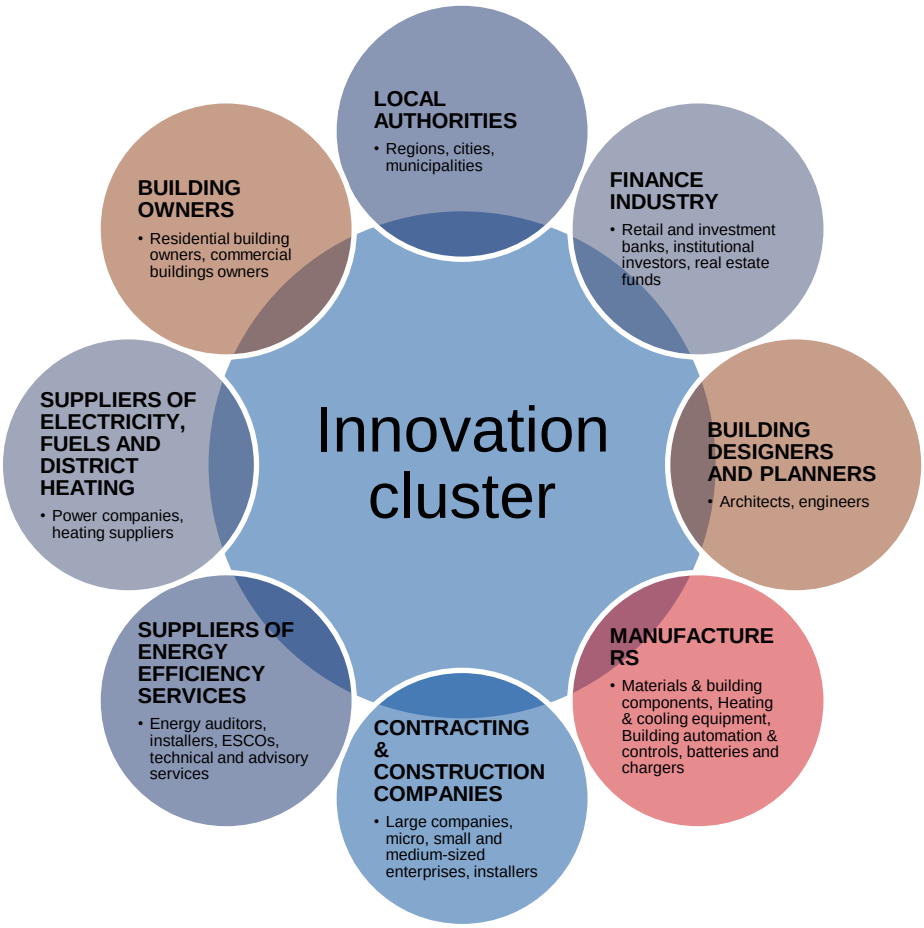


Figure 7: Illustration of a stakeholder mapping (by the authors).

4.3.2 Value creation

The energy market becomes more personalised to the residents. The consumers' behaviour, attitude, tastes and needs are critical factors for the BM operating in decentralised systems where multiple roles for the consumers are possible:

- Active producers and consumers who produce and self-consume green electricity and/or heat.
- Customers as financial investors in renewables.
- Service users demanding light, heat, etc. instead of an energy commodity.
- Local beneficiaries, project supporters/protestors/activists.
- Technology hosts.

Decarbonisation, digitalisation, and decentralisation are interconnected processes and can significantly enhance the diffusion of low-carbon technologies and the ability of certain actors (such as Local Authorities) to participate and develop innovative business models at multiple scales (from household to system levels). For example, the distributed energy resources (DER) market has seen a significant increase over the past decade, with an increasing focus on integrating DER by connecting and utilising their flexibility, which has been

made possible through the growing levels of digitalisation of the energy system. The decentralisation, digitalisation and decarbonisation of energy services are leading to several value creations, including opening the electricity grid, expanding the type of energy services and role changes involving redefining the role of consumers and the introduction of new roles (such as aggregators and prosumers). The opening up of the electricity grid takes many forms, from opening the low voltage (LV) part of the grid to local community energy groups to DNOs providing forecasts of their flexibility needs in different areas 5 to 8 years ahead. Here, reducing energy demand through deep energy renovation can offer new values that energy supply-focused service companies still have to adapt to.

4.3.3 Cluster customer segments

Business models for renovation or energy supply and RES would potentially target different customer segments. Clustering those customers through innovation clusters provides possibilities for a combination of energy efficiency (renovation at the building level) and energy supply (decarbonisation and exploitation of local RES). From the analysis of the success stories, the customer segment was the building owner and the building user, as tenants and energy consumers. Depending on the specific context, the building owner came in the form of housing associations (public or non-profit), homeowners' associations (HOA) or public buildings users, such as the university of the municipality.

The value of an innovation ecosystem lies in the access to resources and the flow of information for the ecosystem's stakeholders. This information flow creates more investment opportunities for the right institutions to connect with the right ideas for their businesses and portfolios, at the right time, for the right reasons. Clusters (or cluster organizations) can be purposefully built and developed. The role of governments matters, either indirectly through taxation and industrial policies or directly through national cluster programs and direct funding schemes.

4.3.4 Main driver: renovation or energy supply

Renovation of individual residential buildings is nowadays subjected to the (compulsory) deployment of renewable energy technologies, meaning that all renovation processes have, as a result, an increase in the DER. However, this is not always the case for the deployments of DER in buildings that are not yet up to renovation.

In some success stories projects, those focusing on the district heating and upgrade and expansion (IT3, IT1, IT4, DK), the decision-maker was a policy actor, mainly the municipality, in collaboration with the energy supplier who would deliver the intervention. The building owners, such as housing associations, were involved in the process of implementing the connection. In the IT4 case, the university led the decision-making as a large organisation and policy actor. When combined with renovation, the financing was arranged separately. Thus, district heating interventions are generally not part of the renovation business model. Thus, this creates two almost parallel business models, one at a household business level, and one at a higher system level, where digital platforms aggregate multiple vectors and services at a large grid scale. The two BM need to be connected in a way the real (also digital) innovations of these business models are intervened with renovation BM. These two BM ought to be brought together through technical and market means – aggregation and market trading. For example, innovations include exploring the role of energy aggregators in managing the energy consumption of specific groups of users, creating a system focused on local energy and economic needs, and investing in the built environment to create local value through retrofits or solar PV. This will also help the creation and capture of social and environmental values, especially for users, through digital innovations.

Local energy markets (as shown in the Community Energy BM) are seen as most suitable for also integrating renovation-based business models. Thus, the local demand and supply system can be optimised. Local authorities can assist in setting up such clusters and build a framework for establishing innovation clusters where

all stakeholders are represented and where intermediaries (e.g., expert companies) collaborate with beneficiaries on the common goal of decarbonising the built environment. For a successful implementation, it is essential to start with an energy master planning that includes local constraints analysis, political goal setting, and setting up alternative solutions.

Energy poverty is central to many political agendas and thus must be addressed in the energy master planning process. For the energy renovation BM, this often involves using established interfaces and working with incumbent actors (i.e., the interface of the microgrid remains the existing energy supplier). In some cases, these business models can exist entirely separately from the energy system and cover diverse activities, such as energy generation and its onsite use by individual households.

Often such business models are put in place to deliver specific social values, such as alleviating fuel poverty and providing better energy comfort. In IT2, the financing was solved with a combination of one-third public money, while the buildings' owner "ALER- Varese", assigned the remaining two-thirds to an ESCO.

Business models at this level are usually built on the use of a specific technology and are focused on the delivery of benefits to users and generators. In most of the success stories, part of the investment came through public money, either as direct financing or in the form of subsidies to homeowners or other frameworks. In PT1, the municipality initially supported the costs of renovating the existing buildings as a measure against energy poverty. At a later stage, a public tender was launched by the municipality to find a private investor to demolish three apartment blocks and build "high standard social housing" buildings, as well as a privately owned residential building that would be put on the regular market.

5. Stakeholders' views on upscaling renovation to district scale

5.1 Introduction to stakeholders' interviews

After presenting an overview of business models employed in energy renovation and energy supply and discussing their potential, the current chapter analyses the stakeholders' views on the upscaling of renovation to the district scale to provide insights to elaborate the subtask research questions. These questions are answered by examining results from in-depth interviews carried out in the IEA EBC Annex 75 project framework.

Interviewers from multiple countries followed a guidance document (see **Addendum 1**) to question selected stakeholders in their own language during 1-1,5 hours. The interview results are analysed by the interviewee using an analysis template provided by IEA EBC Annex 75 subtask D. Deliverable leaders collected all anonymised analysis templates and analysed the results presented in this report.

The analysis covered the following aspects:

- Qualitative data assessment about the applicability of the identified BM in district renovation, as expressed in the stakeholders' views.
- Qualitative data about the common value propositions and customer segments found in district renovation, according to the viewpoint of actors and stakeholders on future adoption.
- Qualitative analysis of the financing structure in district renovation.
- Quantitative data about the main stakeholders and their role in district renovation.

The following subsections explain the study setup, including identifying the types of stakeholders, an overview of the interviewees, and the questions of the guidance document. Subsequently, the interviews are analysed, starting with a cumulative analysis of the different stakeholders' roles and influence and then a qualitative analysis of the stakeholders' views on the elements of the business models.

5.1.1 Identification of stakeholder types

As part of the IEA EBC Annex 75 project, various stakeholder groups were identified that could play an important role in developing district-level renovations, including energy efficiency and renewable energy systems. The following gives an overview of the key stakeholders identified by the IEA EBC Annex 75 experts that might hold valuable opinions regarding (local) policy development.

P. Public actors/ Policy actors: This category includes policy actors on various levels and scales (municipality; county council, provincial/ regional government; federal/ national governing body, other), as well as public agencies, such as innovation or energy agencies and public services.

C. Demanding actors/ Investors: This category typically includes the client or beneficiary of renovation or renewable energy projects. It can be a private owner or an assembly of homeowners. In this work, housing associations, housing cooperatives, and housing companies are considered as part of this category, as they own buildings to be renovated. Such demand organisations can be private or social, public, semi-public, or mixed, depending on the situation.

R. Renovation solution providers: These actors provide renovation systems and services to the demand actors. They typically include planning actors, such as urban planners, architects, landscape designers, or more general design teams, as well as contracting and service parties, such as main contractors and sub-contractors, facility managers, installers, suppliers or more general integrated project teams or one-stop-shops that unburden the demand actors from A to Z.

E. Energy solution providers: These actors provide renewable energy systems and services to the demand actors. They can be, for example, Distribution System Operators (DSOs), Transmission System Operators (TSOs), energy supply or renewable energy companies, energy service providers, heat grid operators, aggregators, energy monitoring providers, energy cooperatives, etc.

F. Financing intermediaries: These actors intervene to invest or finance project developments or works regarding the renovation of buildings, installation of renewable energy systems or more general redevelopment of districts. These actors can, for example, be banks, investment fund operators, real estate or project development companies, building portfolio managers, ESCOs, revolving fund operators, or other financing intermediaries.

I. Other intermediaries: These actors play a role in the more general market or policy development or development of citizen engagement and can sometimes influence project developments from their specific position. For example, federations, trade organizations, not-for-profit organizations and educational and research institutes can influence opinions and viewpoints. Within district projects, sometimes additional actors are foreseen to organize district communication, citizen engagement or feasible business models. For example, district interest organisations, communication agents, and other 'trusted' consultants play a role in district-level renovations and how citizens perceive the need for taking up energy efficiency measures or renewable energy systems.

5.1.2 In-depth interviews

Actors and stakeholders involved in success stories or case studies, innovators and other stakeholders who could give valuable input based on their experience regarding district approaches combining energy efficiency and renewable energy sources were approached with a request to retrieve and assess their viewpoints. From each category, relevant stakeholders for interviewing were identified by IEA EBC Annex 75 members based on their frontrunner experiences with district renovations, including energy efficiency and renewable energy systems. A standardised questionnaire with closed and open questions was developed to fit multiple IEA EBC Annex 75 reports (Johansson et al. (2023); Mlecnik et al. (2023) and this report). The questionnaire was provided to all interviewers as support for semi-structured interviews (see **Addendum 1**). As such in-depth interviews were carried out on multiple topics at the same time, checking the adoption and applicability of local policy instruments (Mlecnik et al., 2023), stakeholder involvement (Johansson et al., 2023) and business models (this report). In this report, the related results are used to describe and analyse stakeholder viewpoints on applicable business models' characteristics and to identify the role and influence of stakeholders. The actors that were interviewed are listed in **Table 12**. In total 39 stakeholders were interviewed from 8 countries covering all the above-mentioned stakeholder types.

Table 12. Interviewees in the framework of IEA EBC Annex 75 (with completed analysis).

Interview code/actor type	Interviewer	Interview date	Stakeholder description
AT-01 / C	AIT	15/03/2021	Representative social housing business group
AT-02 / I	SIR	07/06/2021	Regional planner housing institute (energy consultancy)

Interview code/actor type	Interviewer	Interview date	Stakeholder description
BE-01 / P	TU Delft	06/04/2021	Municipal project coordinator
BE-02 / R	TU Delft	23/04/2021	Director of an autonomous municipal company
CH-01 / C	ZHAW	11/02/2021	Building owner
CH-02 / P	ZHAW	10/03/2021	City representative
CH-03 / I	ZHAW	12/03/2021	Representative Green building council
CH-04 / P	INDP	20/04/2021	Employee of a city with >100'000 inhabitants
CH-05 / P	INDP	18/10/2021	Employee of a municipality with >10'000 inhabitants
CH-06 / P	INDP	07/10/2021	Employee of a municipality with >10'000 inhabitants
CH-07 / P	INDP	11/10/2021	Employee of a municipality with >10'000 inhabitants
CH-08 / I	INDP	18/10/2021	Director of a national energy programme
CH-09 / E	INDP	21/10/2021	Head of energy services in an energy company
DE-01 / R	DV	25/02/2021	Consulting and management company
DE-02 / I	DV	12/02/2021	Representative energy agency (macro-level)
DE-03 / C	DV	26/03/2021	Developer housing business group (region-owned)
DE-04 / C	DV	19/02/2021	Urban developer housing business group (city-owned)
DE-05 / R	BSU	08/01/2021	CEO of public-private NGO (renovation consultancy)
DE-06 / P	BSU	14/01/2021	Senior policy advisor local authority
DE-07 / P	BSU	13/01/2021	City civil servant (energy and climate consultancy)
DE-08 / P	BSU	15/01/2021	Deputy head office for building & construction (city architect)
DE-09 / P	BSU	01/02/2021	Senior civil servant (consultant sustainability)
ES-01 / P	UPV/EHU	09/03/2021	Representative municipal urban rehabilitation society
ES-02 / C	UPV/EHU	10/03/2021	Regional social housing provider (public institute)
ES-03 / I	UPV/EHU	05/03/2021	Representative regional energy agency
ES-04 / P	UPV/EHU	12/03/2021	Housing renovation grant manager regional government
ES-05 / C	UPV/EHU	08/04/2021	Representative public housing association (corporate)
ES-06 / E	UPV/EHU	14/04/2021	Representative energy, waste & water management company
NL-01 / R	TU Delft	03/11/2020	Non-profit service supplier living-cost neutral renovation
NL-02 / I	TU Delft	09/02/2021	Renewable energy cooperative
NL-03 / P	TU Delft	22/02/2021	Senior consultant regional authority
NL-04 / P	TU Delft	16/12/2020	Senior consultant municipality (energy and circular)
NL-05 / R	TU Delft	26/03/2021	One-stop-shop renovation provider
NL-06 / P	TU Delft	12/04/2021	Senior consultant municipality (sustainability)
NL-07 / F	TU Delft	19/04/2021	Revolving fund operator supporting municipalities
PT-01 / R	U Minho	29/06/2021	Civil engineer, project & real estate project manager
PT-02 / I	U Minho	05/08/2021	Qualified expert National Energy Certification System
SE-01 / P	Lund Univ.	24/11/2020	Representative municipality
SE-02 / C	Lund Univ.	19/04/2021	Representative public housing company

5.1.3 Questions for cumulative analysis

We asked the interviewees to score the role of different stakeholder types and their level of influence, reflecting on their interests and experiences. These data were captured using 4-value responses (Q1) and 5-point scale (Q2), as shown in Table 13. Blank answers were also accepted, meaning they did not know what to indicate. See also Addendum 1 and Addendum 2 for further details of the in-depth interview steps.

Table 13. Questions for the cumulative assessment of stakeholders' role and influence on district renovation projects.

Questions	Scale
Q1. Their role in this project was…	1. Deliverer 2. Technical advisor 3. Influencer 4. Decision maker
Q2. I think their level of influence in the project was…	1. Very low 2. Low 3. Medium 4. High 5. Very high

The interview data and the votes were collected using a supporting document to be filled in by interviewees identifying the above multiple-choice questions and were assembled and analysed in a spreadsheet as an analysis template (Addendum 2), and the information was processed in multiple ways to understand different viewpoints in the BM. To operate with the gathered votes, the values were transformed into scores and percentages (minimum score 1 as 0% and maximum score 4 or 5 as 100%). Also, the frequency or counting of each score was calculated to analyse both average values and score distribution or dispersion. The resulting data were visualised in the following ways:

- The frequencies and average scores for each stakeholder type regarding the two questions (project role and level of influence) were calculated.
- The frequencies of different scores on each stakeholder type and questions were plotted to obtain a visual comparison between stakeholders and detect closer relationships.
- The results were evaluated by stakeholder category, separating the actor votes as their participation in the BM, that is, as policy/public, community/demand or market/supply.

All the interviewees have been classified into the three main stakeholders' categories, identifying them as policy, community or market (see Section 1.3). In the first group, the policy side, apart from all the interviewed policy actors, also three intermediaries were included due to how they integrated into their project BM. The community, the beneficiaries, and one intermediary actor were counted in the second group. Finally, in the third group, the Market includes the renovation solution suppliers, the energy suppliers, the financial intermediaries and three intermediaries that performed as the supply side in their project BM.

5.1.4 Quantitative analysis of the stakeholders' views

The information about BM elements was subtracted from the relevant interview questions (as indicated in Table 14) and analysed by the interviewers as input in the respective fields of the analysis template (Appendix 2). Specifically, the interviewers indicated the main aspect and its description, as well as the interesting quotes, remarks and recommendations for upscaling and combining energy efficiency with renewable energy sources. See also Addendum 1 and Addendum 2 for further details of the in-depth interview steps.

Blank answers were not considered in the analysis, as they do not indicate the stakeholder view on the BM characteristic. As a result, the number of answers analysed per BM element varies and does not correspond to the total number of interviews (39). The sub-sections 5.3 present the results per BM element and indicate the number of corresponding answers.

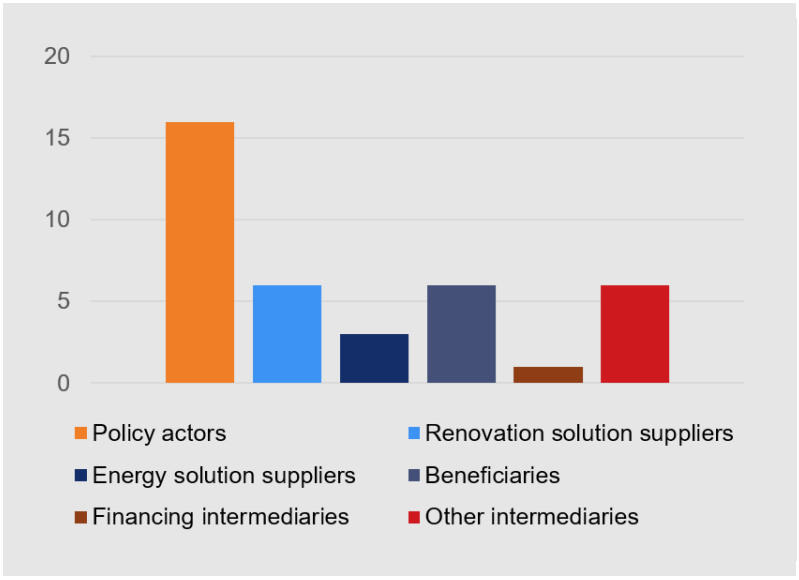
Table 14. Overview of the inputs for the interview analysis, according to the different BM elements (more details in Addendum 2, tab 4).

Business model elements	Consideration for the interviewer analysis	Corresponding interview questions as indicated in Addendum 1
BM archetype	What is the (nearest) BM archetype for the renovation (see Table 2)	Questions 2.8 and 2.9.
Customer segment	Who benefits/uses/pays for the renovation/RES? The main decision-maker is often the main customer segment.	Part I table.
Value Proposition	What is the value to the customer? How to solve problems and satisfy customer needs?	Question 2.1 and Part I table.
Key Partnerships	Which partners are in the business model? Such as a general contractor, a service company, etc.	Questions 2.7 and 2.10.
Customer Relationships & Channels	How is the value proposition delivered to customers? Communication, distribution, sales... How are relationships forged and sustained?	Questions 2.7, 2.11 and 2.10.
Cost Structure	What is the value proposition cost? Renovation and RES investment (context of Annex75) and other costs. Financing mechanisms, such as Dept or Equity, can fund the cost.	Question 2.2.
Revenue Streams	How does the organisation generate revenues? How is the investment paid back?	Questions 2.2, 2.4 and 2.7.
Key Activities & Resources	How is the value proposition achieved? The activities and resources required to offer and deliver the value.	

5.1.5 Number of responses

In this analysis, we also cross-reflect the perceptions of interviewees according to their participation in the BM as policy, community and market to assess commonalities and differences. The following graphs (**Figure 8, Figure 9, Figure 10**) and tables (**Table 15, Table 16**) illustrate the distribution of responses per stakeholder category and country. The stakeholder types are explained in 5.1.1, while the stakeholders' categories refer to the actor's categorisation described in section 1.3., based on Avelino and Wittmayer (2016).

a.



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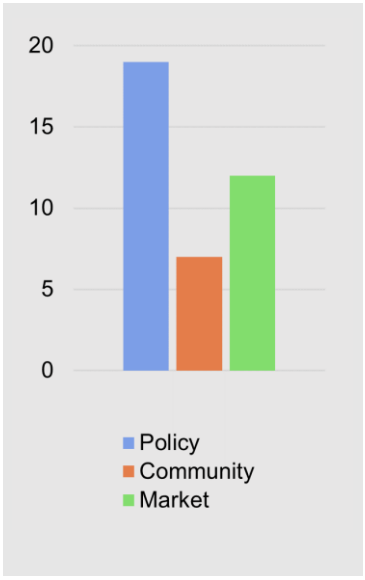

Figure 8. Number of interviews per stakeholder type (a) and per stakeholder category (b).

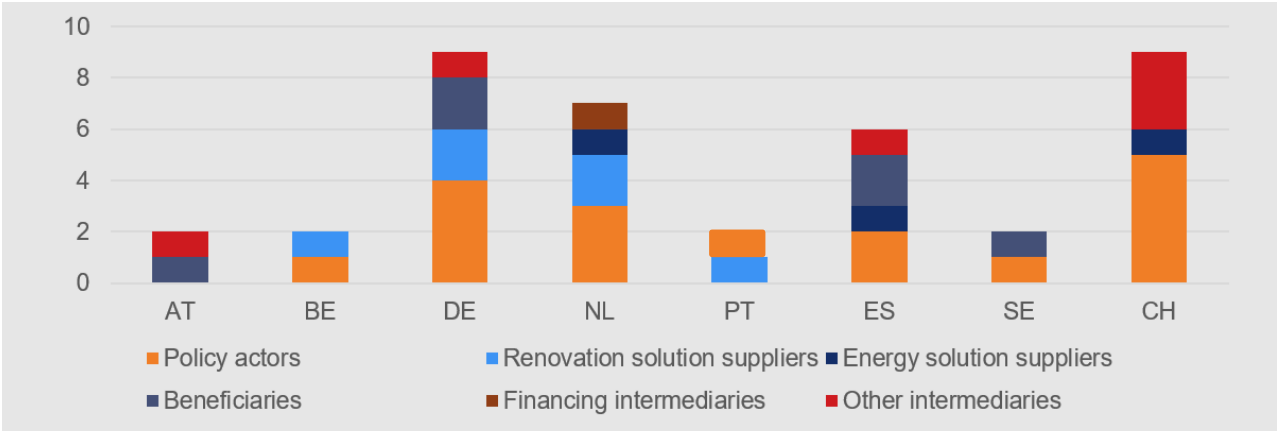

Figure 9. Number of interviews per country and stakeholder type.

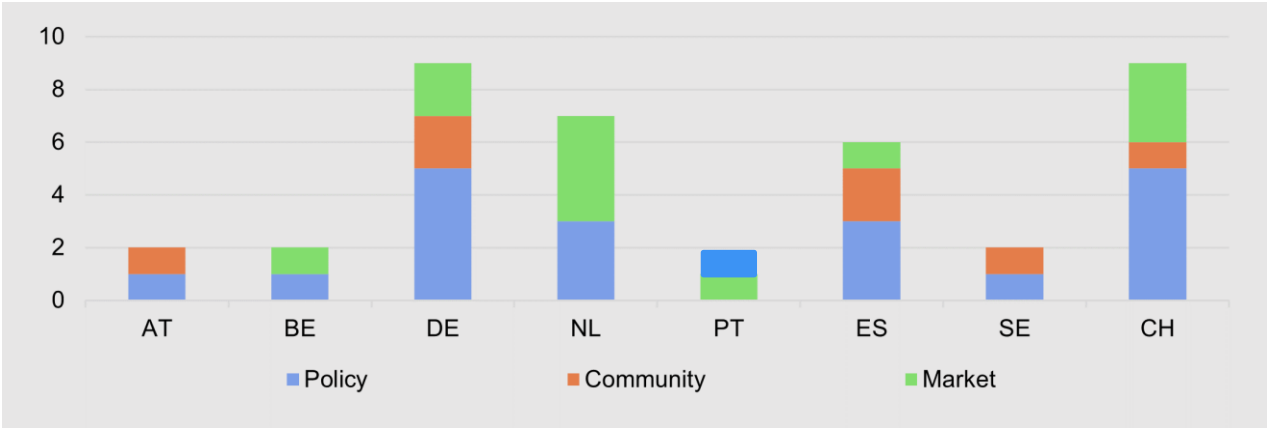

Figure 10. Number of interviews per country and stakeholder category, showing their participation in the BM.

Table 15. Number of interviews per country and stakeholder type.

Actor types	AT	BE	DE	NL	PT	ES	SE	CH	TOTAL
Policy actors	0	1	4	3	1	2	1	5	16
Renovation solution suppliers	0	1	2	2	1	0	0	0	6
Energy solution suppliers	0	0	0	1	0	1	0	1	3
Beneficiaries	1	0	2	0	0	2	1	0	6
Financing intermediaries	0	0	0	1	0	0	0	0	1
Other intermediaries	1	0	1	0	0	1	0	3	6
Total	2	2	9	7	2	6	2	9	39

Table 16. Number of interviews according to their participation in BM.

Actor categories	AT	BE	DE	NL	PT	ES	SE	CH	TOTAL
Policy/ Public	1	1	5	3	1	3	1	5	19
Community/ Demand	1	0	2	0	0	2	1	1	7
Market/ Supply	0	1	2	4	1	1	0	3	12
Total	2	2	9	7	2	6	2	9	39

5.2 The role of the stakeholders

5.2.1 Main stakeholders and their role

The main stakeholders regarding renovation at the district scale can be classified into 3 main categories, as found in the literature (Avelino & Wittmayer, 2016). Each category has distinct roles and influences in developing the built environment. The questionnaire analysis aims to identify the stakeholders, their role (Figure 11) and their influence (Figure 12). Table 17 and Table 18 present this information as a numerical average, the number of votes and standard deviation.

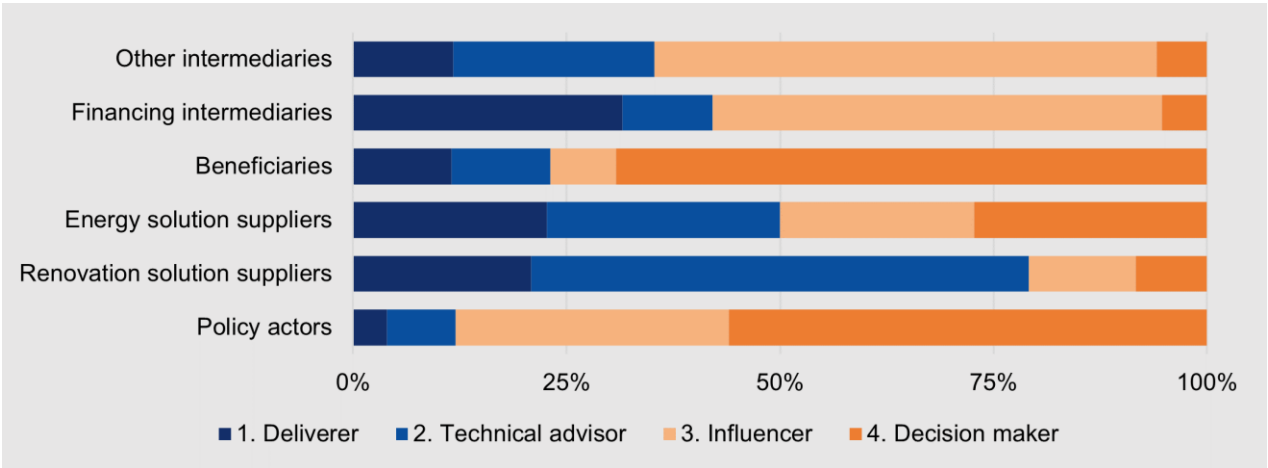

Figure 11. Role of the stakeholder types obtained relative frequency distribution of all votes.

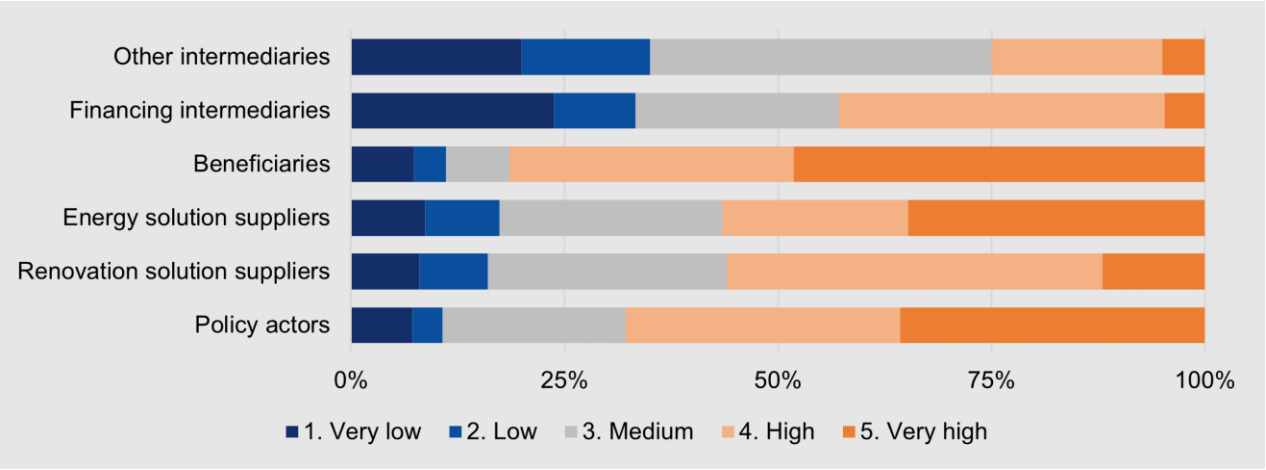

Figure 12. Perceived influence of the stakeholder types, obtained relative frequency distribution of all votes.

The most decisive stakeholder type is policy actors with 96% of votes (including decision-makers, influencers, and technical advisors), followed by beneficiaries and other intermediaries with 88%, and the stakeholder with the lowest role is the financing intermediaries with 68% of votes. In other words, the lowest role of suppliers was indicated for 32% of the financial intermediaries, 23% of the energy solution suppliers and 21% of renovation solution suppliers.

Table 17. Average scores on the role of stakeholder types and analysis based on the interviews' votes.

Stakeholder types	Av. Score Role (1 to 4 scale)	Av. Score Role (%)	Standard deviation (%)	Decision-makers & advisors % (votes 1 – 3)	Suppliers % (vote 4)	Number of votes 1-4 (incl. in score)	Doesn't know (not incl. in score)
Policy actors	3.4	80%	27%	96%	4%	25	13
Renovation solution suppliers	2.1	36%	27%	79%	21%	24	14
Energy solution suppliers	2.5	52%	37%	77%	23%	22	16
Beneficiaries	3.3	78%	36%	88%	12%	26	12
Financing intermediaries	2.3	44%	33%	68%	32%	19	19
Other intermediaries	2.6	53%	26%	88%	12%	17	21
Total average	2.7	57%	31%	83%	17%	22	16

Table 18. Average scores on the level of influence of stakeholder types and analysis based on the interviews' votes.

Stakeholder types	Av. Score Influ-ence (1 to 5 scale)	Av. Score Influence (%)	Standard deviation (%)	High influence % (votes 4 – 5)	Low influence % (votes 1 – 2)	Number of votes 1-5 (incl. in score)	Doesn't know (not incl. in score)
Policy actors	3.9	71%	29%	68%	11%	28	10
Renovation solution suppliers	3.4	61%	27%	56%	16%	25	13
Energy solution suppliers	3.7	66%	32%	57%	17%	23	15
Beneficiaries	4.1	78%	29%	81%	11%	27	11
Financing intermediaries	2.9	48%	32%	43%	33%	21	17
Other intermediaries	2.8	44%	28%	25%	35%	20	18
Total average	3.5	61%	29%	55%	21%	24	14

As shown in previous figures, policy actors and beneficiaries are the main decision-makers, and consequently, their influence is very high. The rest of the stakeholder types have more complex roles and influence levels that may depend significantly on each project situation.

The influence of financial intermediaries is high, but they are not considered to be the decision-makers. The next stakeholder types regarding their role are the other intermediaries and the financial intermediaries, with a role between technical advisor and influencer. However, their level of influence is medium-low. Indeed, in most cases, they are present in the process, but their influence is medium, so they are not considered to be the decision-makers.

On the other hand, renovation solutions and energy suppliers are perceived with an average role between technical advisor and influencer. Still, they were also acknowledged as relevant with medium-to-high influence levels. The case variability is considerable because, in many cases, they are considered high or very high influencers, especially the energy suppliers. In almost equal cases, their role is to deliver or advise on the technical solution. This differentiation in suppliers' roles can be attributed to each project's scope. It does demonstrate that suppliers are not always an integral part of the renovation.

The observed variability of roles and influence levels also indicate how different projects and BM can be reflected in the decision-making process. This is patent in the significant standard deviation for all the categories (31% and 29%), which reflects the variability in the perception. There are a lot of conflicting opinions about the role and influence of the different stakeholders. Of course, we need to consider the relatively low number of respondents.

5.2.2 Perceived role of stakeholders in renovation projects

This subsection reviews in more detail the experts' opinions about the role of stakeholders' types perceived by the three stakeholder categories, as explained in section 1.3, by separating the answers coming from the public (19 interviewees), community (7 interviewees) and market (12 interviewees).

Figure 13 summarizes the role perceptions and shows some differences. Perception of the policy category sees a lower role for itself than other market and community categories perceive. Likewise, the self-perception of the other stakeholders' roles, market and community, is also lower than the perception of the policy category.

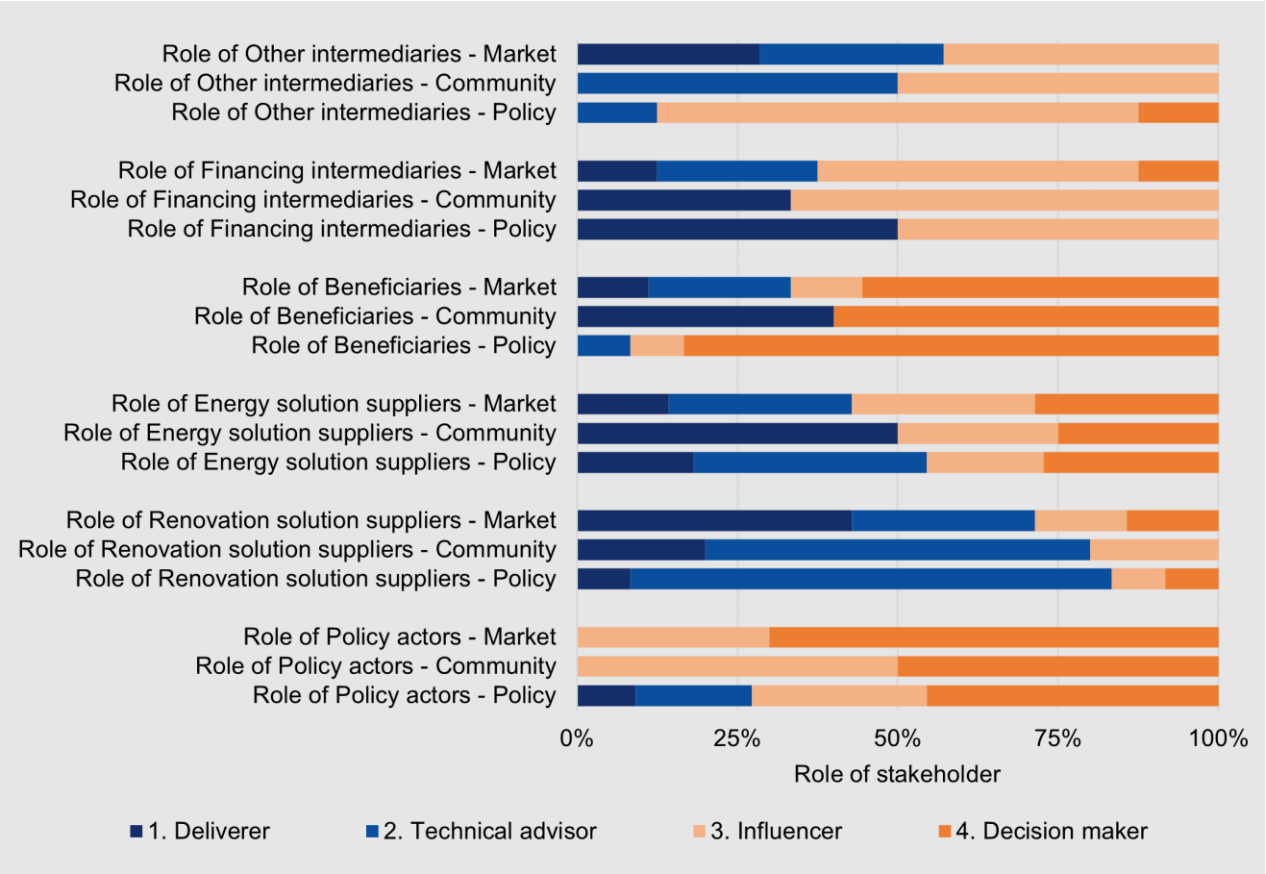

Figure 13. Role of the stakeholder types in renovation projects, frequency distribution of votes of policy/public, community/demand and market/supply.

The main differences indicate that market and community categories perceive that the role of the beneficiaries and other intermediaries is less decisive than what is perceived by the policy category. On the contrary, the policy actors' role is perceived as decisive by the market and community categories, while the policy category sees themselves as less decisive. The most significant differences are the following:

- Role of beneficiaries: 1.0 higher by policy than by community (and 0.7 than market).
- Role of other intermediaries: 0.9 higher by policy than by market (and 0.5 than community).
- Role of policy actors: 0.6 higher by the market than by policy (and 0.4 than community)

Table 19 gathers all the details for each stakeholder type and their perceptions.

Table 19. Average scores for the role of stakeholders in renovation projects, analysis of responses of policy/public, community/demand, and market/supply.

Role of stakeholder types	Av. Score Role (1 to 5 scale)	Av. Score Role (%)	Standard deviation (%)	Decision-makers & Influencers % (votes 1 – 3)	Suppliers % (vote 4)	Number of votes 1-4 (incl. in score)	Doesn't know (not incl. in score)
Perceived by Policy							
Policy actors	3.1	70%	33%	91%	9%	11	8
Renovation solution suppliers	2.2	39%	23%	92%	8%	12	7
Energy solution suppliers	2.5	52%	36%	82%	18%	11	8
Beneficiaries	3.8	92%	20%	100%	0%	12	7
Financing intermediaries	2.0	33%	33%	50%	50%	8	11
Other intermediaries	3.0	67%	17%	100%	0%	8	11
Total average	2.8	59%	27%	86%	14%	10	9
Perceived by Community							
Policy actors	3.5	83%	35%	100%	0%	4	3
Renovation solution suppliers	2.0	33%	21%	80%	20%	5	2
Energy solution suppliers	2.3	42%	37%	50%	50%	4	3
Beneficiaries	2.8	60%	34%	60%	40%	5	2
Financing intermediaries	2.3	44%	33%	67%	33%	3	4
Other intermediaries	2.5	50%	13%	100%	0%	2	5
Total average	2.6	52%	29%	76%	24	4	3
Perceived by Market							
Policy actors	3.7	90%	15%	100%	0%	10	2
Renovation solution suppliers	2.0	33%	36%	57%	43%	7	5
Energy solution suppliers	2.7	57%	34%	86%	14%	7	5
Beneficiaries	3.1	70%	37%	89%	11%	9	3
Financing intermediaries	2.6	54%	29%	88%	13%	8	4
Other intermediaries	2.1	38%	28%	71%	29%	7	5
Total average	2.7	57%	30%	82%	18%	8	4

5.2.3 Perceived level of influence of stakeholders in renovation projects

This subsection reviews in more detail the experts' opinions about the level of influence of stakeholders' types perceived by the three stakeholder categories, as explained in section 1.3, by separating the answers coming from the public (19 interviewees), community (7 interviewees) and market (12 interviewees).

Figure 14 summarizes the influence level perceptions and shows significant differences. The perception of the policy category sees higher levels of influence in all the stakeholders, compared with the market and community. As the self-esteem, it happens like with the role perception seen in 5.2.2, the policy category has a lower self-perception of their influence level, and once again, the self-perception of the other stakeholder influence, that is market and community, is also lower than the perception from policy category.

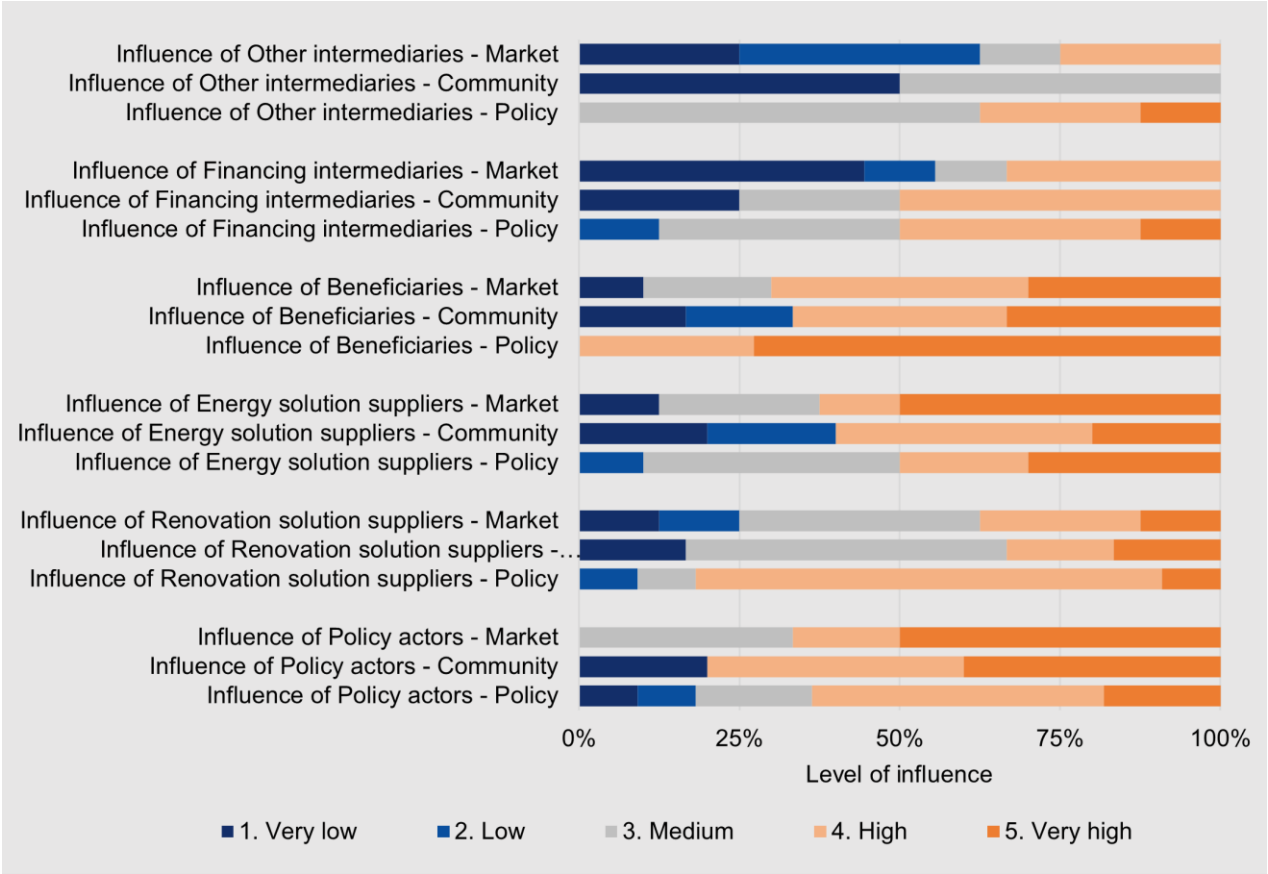

Figure 14. Frequency distribution of votes of the perceived influence of the stakeholder types in renovation projects, the frequency distribution of votes of policy/public, community/demand and market/supply.

The average values show a main outcome. There are different global perceptions of the influence levels since policy chose 3.8, market 3.3 and community 3.1. This difference in the perceived influence happens for all the stakeholders, apart from the policy actors who are opposite, with 4.2 perceived by the market, 3.8 by the community and 3.5 by the policy category.

The main differences are the following:

- Influence of other intermediaries: 1.5 higher by policy than by community (and 1.1 than market).
- Influence of beneficiaries: 1.2 higher by policy than by community (and 0.9 than market).
- Influence of financing intermediaries: 1.2 higher by policy than by market (and 0.8 than community).

Table 20 gathers all the details for each stakeholder type and their perceptions.

Table 20. Average scores for the role of stakeholders in renovation projects, analysis of responses of policy/public, community/demand, and market/supply.

Influence of stake-holder types, Perceived by Policy	Av. Score Role (1 to 5 scale)	Av. Score Role (%)	Standard deviation (%)	High influence % (votes 4 – 5)	Low influence % (votes 1 – 2)	Number of votes 1-5 (incl. in score)	Doesn't know (not incl. in score)
Perceived by Policy							
Policy actors	3.5	64%	29%	64%	18%	11	8
Renovation solution suppliers	3.8	70%	18%	82%	9%	11	8
Energy solution suppliers	3.7	68%	25%	50%	10%	10	9
Beneficiaries	4.7	93%	11%	100%	0%	11	8
Financing intermediaries	3.5	63%	22%	50%	13%	8	11
Other intermediaries	3.5	63%	18%	38%	0%	8	11
Total average	3.8	70%	20%	64%	8%	10	9
Perceived by Community							
Policy actors	3.8	70%	37%	80%	20%	5	2
Renovation solution suppliers	3.2	54%	30%	33%	17%	6	1
Energy solution suppliers	3.2	55%	37%	60%	40%	5	2
Beneficiaries	3.5	63%	38%	67%	33%	6	1
Financing intermediaries	3.0	50%	31%	50%	25%	4	3
Other intermediaries	2.0	25%	25%	0%	50%	4	3
Total average	3.1	53%	33%	48%	31%	5	2
Perceived by Market							
Policy actors	4.2	79%	22%	67%	0%	12	0
Renovation solution suppliers	3.1	53%	29%	38%	25%	8	4
Energy solution suppliers	3.9	72%	34%	63%	13%	8	4
Beneficiaries	3.8	70%	29%	70%	10%	10	2
Financing intermediaries	2.3	33%	33%	33%	56%	9	3
Other intermediaries	2.4	34%	28%	25%	63%	8	4
Total average	3.3	57%	29%	49%	28%	9	3

Figure 15 presents a visual representation of these findings. There is a global diversity in the perception of the stakeholders' influence. The policy category has declared significantly higher influence levels for almost all the stakeholder types (blue line), more than what was declared by the market and community categories. The policy category probably tends to overestimate the influence of all the other stakeholders except their own. The policy category thinks that beneficiaries are the most influencing stakeholder, while the market and community believe that policy actors and the energy solution providers are more influential. To conclude, the policy category sees the beneficiaries on top of the renovation decision-making, with a leading role. The view from the market and community categories is different and suggests that renovation projects are more balanced because the influence levels are more distributed.

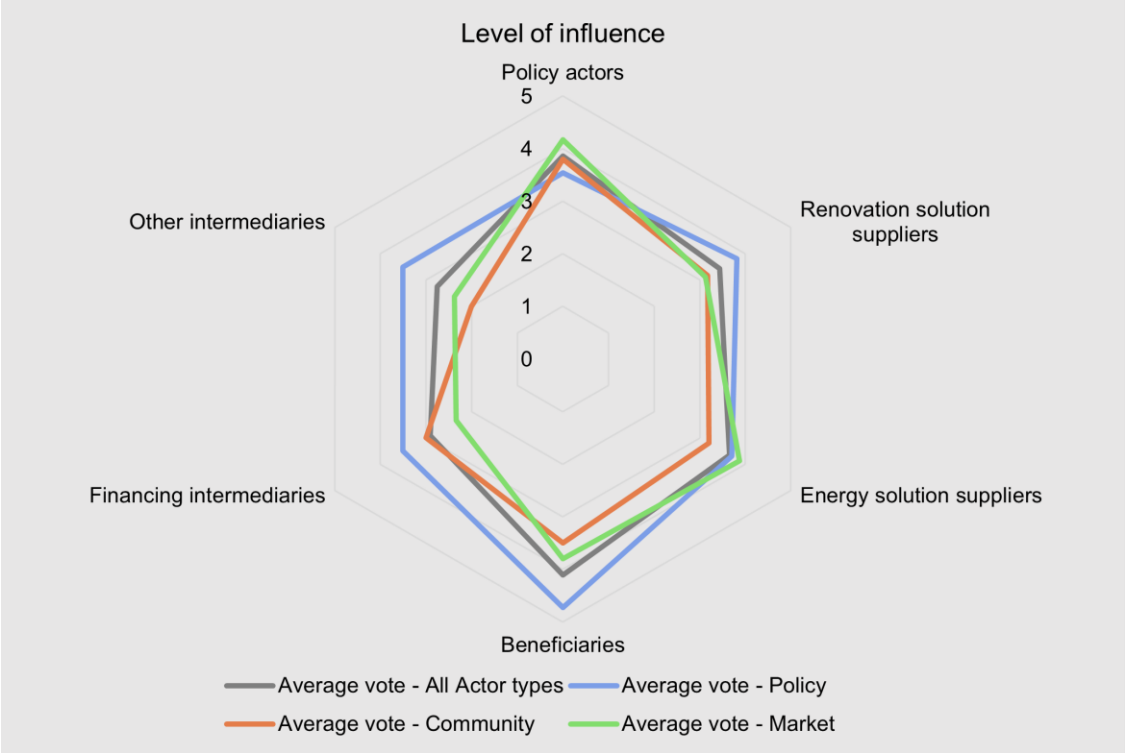

Figure 15. BM perspectives on the influence of stakeholder types on renovation projects, radial analysis.

5.3 Stakeholders' views on the BM characteristics for district renovation to combine energy efficiency and RES

This section analyses the stakeholders' views on the separate business model elements, as defined by Osterwalder et al. (2009) and discussed in Chapter 1, section 1.2, particularly regarding those that enable district renovation to combine energy efficiency and RES. The following sub-section discusses the BM archetypes and how the stakeholders believe they are applicable, according to their experience. Furthermore, the customer segments, value propositions, key activities and partnerships and cost and revenues.

5.3.1 Business models for renovation and energy supply applicable to district renovation

Firstly, we look at the business model archetypes to evaluate how the stakeholders recognise the archetypes identified in Chapter 2. The interview analysis indicated that 20 out of the 39 interviewees characterised the BM of their project. The background and experience of the interviewees can explain this. Some stakeholders, particularly policy actors, were not involved in the development and application of the BM. Figure 16 provides the distribution of archetypes reported by the interviewees.

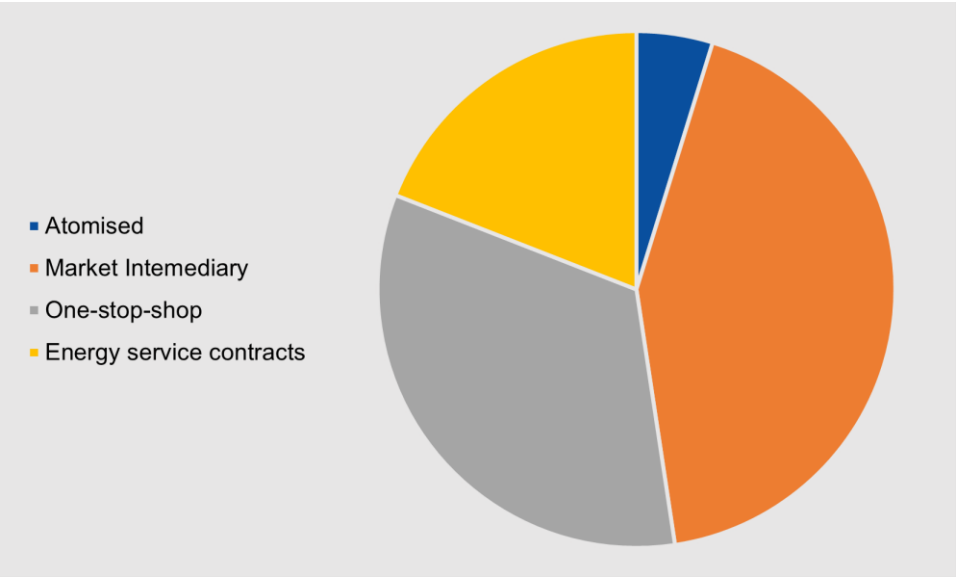

Figure 16. Identified BM archetypes for renovation.

Market intermediaries are the most common, followed by one-stop-shop. In that respect, most cases with the scope of large-scale renovation employ BM models that offer a single point of contact catering to all the project's needs. The atomised model is reported in only one case, which agrees with findings from success stories discussed in Chapter 4.2 that atomised model is not adequate for district renovation.

Energy service contracts were reported by four interviewees, which shows that they are yet to be widely applied in the renovation. In two cases, some public agency underpins the process (NL-004, AT-002). Regarding business model archetypes for energy supply, the stakeholders focused on the BM from the perspective of renovation. Nevertheless, in certain cases the projects combined energy supply as well, particularly the archetype of "going green" (CH-001) and "energy cooperative" (NL-002).

5.3.2 Customer segment

The customer segment refers to the actor that benefits from the value the BM offers. Usually, the customer segment is also the actor that invests or provides the revenue. The interviewees described the customer segment relevant to their experience, and the interviewer categorised it to the stakeholder type indicated in the questionnaire analysis template (**Addendum 2**). Out of the 39 interviewees, 23 characterised the customer segment. The majority (17) identified the "Client or beneficiary/ demand actor" as the customer segment. The specific type of actor category includes Private owner, Homeowner assembly, Private, public, or social housing association etc. Policy actors, such as municipalities, are also reported as customers, as well as public housing associations and district heating companies. Further analysis of the description resulted in a more detailed specification of the customer segment, as can be seen in **Figure 17**.

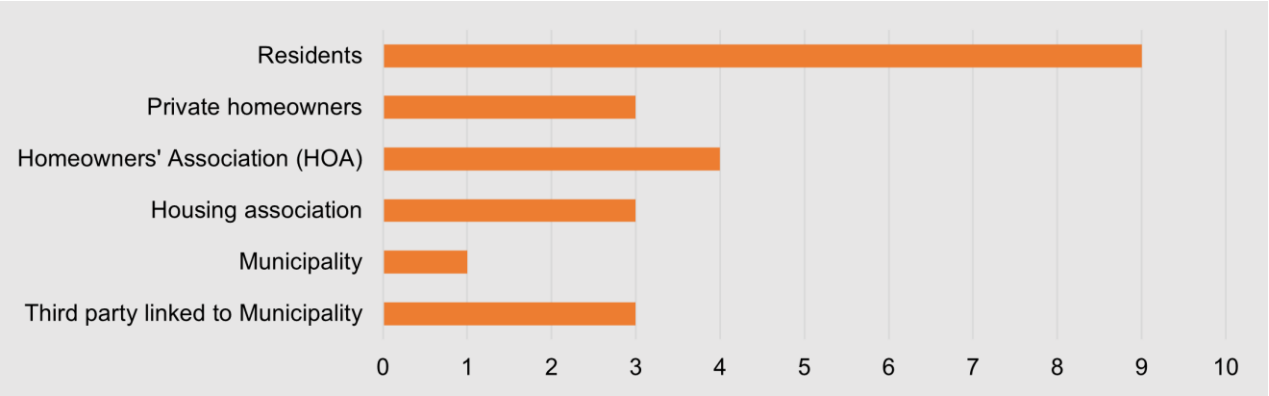

Figure 17. Actors' sub-categories and the frequency identified as the customer segment.

The main beneficiary reported is the Residents. For the analysis, the group of residents refers to the citizen or a community targeted for renovation, employment of renewable energy and district heating (NL-002, NL-003, AT-002, ES-005). Next to the residents, the group of private homeowners, HOA, and Housing association is reported as the beneficiary, which is expected as they are the owners of the buildings. In the case of housing associations, the tenants are indirectly the beneficiary as they benefit from the value the renovation offers. However, the housing associations are the investor, and the decision-makers are the beneficiary of the business model.

Municipalities, or third parties related to them, are also reported as beneficiaries. In those cases, the business model focused on financial intermediation and management (DE-001, NL-007) and urban planning and communication (DE-003, CH-003).

5.3.3 Value propositions

The value propositions were described by 20 interviewees. The answers were given as open text, as the interviewers reported them. Particularly the input regarding value propositions was considered the main aspect, as well as a more detailed description and remarks on how the value was offered. All the answers are shown in **Figure 18**, illustrated in the form of a word cloud where word size expresses the number of times each word was mentioned. Comfort, energy, costs, and quality are the highlighted keywords.

Figure 18. Word cloud of all the mentioned value propositions.

The open answers obtained by the sample were then assessed through content analysis techniques to identify the main types of Value propositions discussed by the interviewed stakeholders. This was conducted by manually coding the responses via inductive or open coding, that is, the identification of categories based on the in-depth exploration of the qualitative data itself, without predefined codes. This followed an iterative process of coding and re-assessing the information, which ended in a list of categories which defined the main types of bottlenecks identified throughout the renovation process by the sample. Seven main categories for the bottlenecks were identified, as follows: (1) Energy efficiency, (2) Comfort, (3) Cost savings, (4) Decision and implementation support, (5) Financial arrangement, (6) Neighbourhood quality/attractiveness, and (7) Increase value. **Figure 19** shows the frequency of the values reported by the stakeholders. Each interviewee might mention more than one value that it offered.

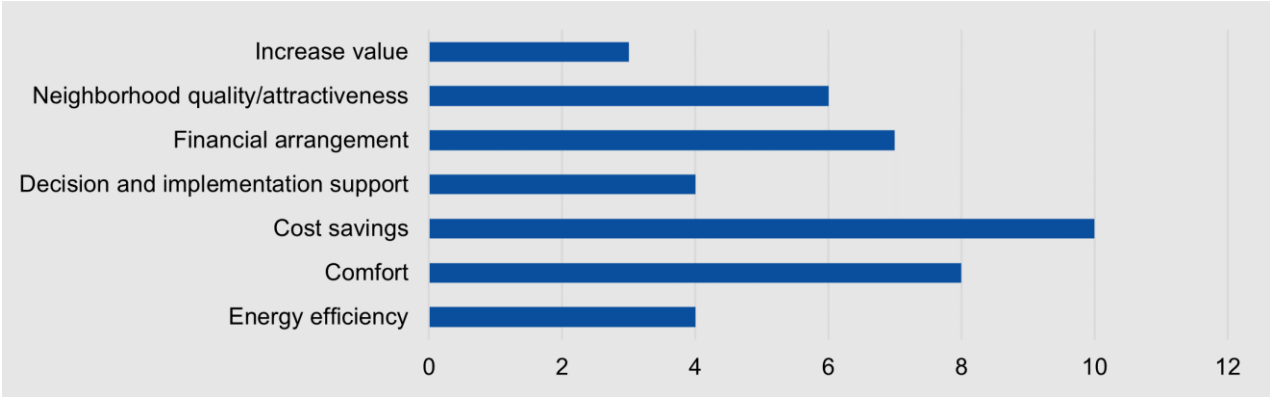

Figure 19. Main value propositions identified from the responses and frequency of their mentions.

Saving in the costs is reported as the main value the renovation offers, followed by improvement in comfort. Both values are related to building performance and energy efficiency, even though energy efficiency itself, as improved technologies to save energy, is mentioned fewer times. In this sense, energy efficiency can be seen as a means to achieve the goal of comfort and cost savings, which are the values offered in the BM.

The financial arrangement is also an important value that the reported BM offer. This category is diverse. It includes the availability of funds, such as in the case of co-financing of specific costs (NL-003), subsidies (AT-002), managing the financing structure (NL-001, NL-004, ES-004), and the provision of integrated services (ES-006).

"With assemblies of homeowners, an entry with an interest in solar panels is usually provided. This requires further action to develop a split switch, check the heating and refer to companies that provide sustainability consultancy."
(NL-002)

Regarding the recommendation to combine energy renovation and energy supply on a district scale, the stakeholder identified some possibilities to combine the financial benefits of energy generation with the potential of renovation for comfort and overall quality improvement (NL-002). Financial arrangements and adjustments in the models of energy supply are needed (NL-007, CH-003).

"To attract tenants in a generally less attractive district, energy measures and slightly lower energy prices do not help. You need to work on the whole package, including energy standards, mobility services, leisure infrastructure, etc."
(DE-004)

It is necessary to integrate energy efficiency and generation holistically to include the additional benefits for the neighbourhood and the city (DE-003, DE-004, CH-003, SE-001, SE-002). Combined BMs are necessary to offer the technical solution and support for the financial arrangements and stakeholders' dialogue to facilitate the residents' decision-making.

5.3.4 Key activities and partnerships

Some key activities take place to create the value described by the value proposition. In 16 of the interviews, the stakeholders give details on the type of activities in the form of open answers. As in the previous section, the answers are shown in **Figure 20**, illustrated in the form of a word cloud where word size expresses the number of times each word was mentioned. The word cloud highlights that the renovation itself is the most prominent activity to offer the value propositions described above. Furthermore, the organization of the process, financing, communication and raising awareness are also part of the activities.

Figure 20. Word cloud of all the mentioned key activities.

Particularly, the mentioned activities refer to the following type of activities. The range of activities relates to the sub-types of the value proposition and the complexity of the process related to the renovation. Next to the renovation execution which is prominently reported as an activity, Consulting, Communication, Organization and Financing are key activities indicated by the stakeholders.

To organize and execute those activities, which result in creating and offering the value proposition, a collaboration of the different actors is needed. The interviewed stakeholders reported a range of actors that partnered with each other. The key partnerships depend on the specifics of each project, such as county, scale, and objectives. It also depends on the experience and role in the process. Nevertheless, some patterns in the mentioned partnerships can be identified:

- Renovation market actors (general contractors, architects, consultants, suppliers) (NL-001, PT-001).
- Municipality and energy providers (DE-001, NL-002, AT-002, ES-006).
- Municipality, building owners, and neighbourhood actors (DE-004, NL-003).
- Renovation market actors, Municipality, and (financial) intermediaries (DE-003, NL-004, NL-005).
- Municipality, Building owners, and (financial) intermediaries (NL-007, CH-002, CH-003).
- Municipality, Renovation market actors (BE-002, ES-004).
- Building owners, energy provider (CH-001).

A main observation is that the municipality is present in most of the partnerships. The municipality, or other policy actors such as regions depending on the specific context, works with energy providers and the renovation market. However, based on the interviewees' experience, partnerships between energy providers and the renovation market have not been encountered. This observation aligns with the conclusions of this report (Chapter 3). Furthermore, policy actors partner with financial intermediaries as well as residents. It can then be concluded that the municipality has a dual role in supporting investors and financial arrangements, as well as involving homeowners.

5.3.5 Cost and revenue

The cost and revenue streams were specifically addressed by 17 interviewees, 9 and 8, respectively. The small sample of views on those topics can potentially be attributed to the position of the interviewed stakeholders, who do not focus on the details of the costs and revenue of the intervention. Another explanation can be the fact that the renovation revenue stream is often not separated from the overall company's (SE-001, SE-002) or municipality's (DE-001, BE-002, ES-002) revenue. For example, in the case of a housing association, the revenue comes from the rent of the dwellings, and it is not explicitly invested in renovation but in the many activities of the housing association. However, those activities do not normally extend to district-level intervention, as the housing association is not a decision-maker nor can it gain direct revenue. In the case of contract or other guarantees, the revenue stream is clarified, and it is related to the energy savings, such as in NL-004, NL-005, AT-002, ES-006, the energy production, such as in NL-002, or the energy cost (CH-002, CH-009, ES-004). Subsidies are also mentioned as a means to cover the costs, such as in DE-004, NL-001, NL-002, BE-002, and CH-002.

The cost reported by the interviewees referred to the following activities, which include technical interventions and services:

- Renovation (NL-004, NL-005, AT-002, SE-001, SE-002).
- Connection to district heating (CH-009, SE-001, SE-002, ES-006).
- Installation of RES, such as PV panels (CH-001, SE-001, SE-002).
- Communication (CH-002, NL-004).
- Facilitation of grants (NL-005, BE-002).
- Consultants (NL-001, NL-004, NL-005, BE-002, CH-002).

5.4 Risk and opportunities for business models and stakeholders' dialogue

This section concludes the analysis with recommendations for business models and stakeholders' dialogue, as derived from the interviews. There are, in particular, two aspects interesting for being able to evaluate the risks and opportunities for BM. The first aspect is the view of the different stakeholder groups on BM archetypes, particularly regarding the value proposition. The other is the view of combining actors for upscaling and combining EE+RES. The risks and opportunities in the view of the interviewed stakeholders can, in general, be summarised in the following four aspects: integral solutions, differences in incentives, financing, communication, and guarantees.

1. Integral solutions

A clear opportunity identified is to provide integral solutions to the neighbourhood and residents, aiming beyond energy aspects. The intervention and the respective business model need to respond to the priorities and real problems of the inhabitants, like accessibility, the overall quality of the neighbourhoods, and diversity in the dwellings. Increased thermal comfort for tenants can be combined with improved appearance and attractiveness of the area, resulting in an increased value of the properties and lower running costs to alleviate energy poverty.

Next to combining energy renovation and renewable energy with additional benefits for the quality of life of the citizens, the business models need to provide a value proposition that includes the renovation and implementation of the integral solution, from consulting and financial arrangements to construction and monitoring.

When it comes to the Customer segment, a risk for the integral solutions implementation is the diversity in the decision-making. For example, the building owners decide on their house renovation while a municipality for neighbourhood scale interventions. Effective governance and key partnerships to include the key stakeholders and solution providers can address that.

2. *Alignment of incentives of the stakeholders*

The stakeholders have different views on the business model and the incentives related to their role in the process. Homeowners are typically reserved regarding business models. The beneficiaries wait for the market to support them in the decision-making and implementation but need a simplified and transparent model for affordable solutions.

> *"There is no business model and there should be none. It is just my house; it has to be warm in winter. Why should anybody want to make money? I just want to live safely."*
> (NL-003)

Policy actors do not necessarily have an active role in business model development. However, they see the possibility of contributing and co-financing specific costs, e.g., the technical renovation design, urban planning aspects, communication, and business case development. In that respect, financial intermediaries point to the importance of national governments financially supporting the process and providing adequate policy instruments to stimulate the renovation.

Renovation solution providers see standardization and collective reduction of energy use offered by addressing institutional owners and combining the renovation of multiple houses in one commission. The collective use of energy sources (e.g., cogeneration) could be explored for energy providers.

To align the incentives of the stakeholder, energy renovation mobilization as a well-thought-out service is needed that is economically attractive, fair, easy, comfortable, ecological, and price stable. Solutions such as shared (green) roofs for renewable energy production also provide better air and green in the city, energy, and cost savings, supporting a combined value proposition. The services can be extended to offer free energy coaching when the renovation is intended, immediate replacement of light bulbs and check of control settings of heating, which supports the better performance of the building and allow for performance contracts and guarantees.

> *"There is more need for guarantees than for a one-stop-shop."*
> (NL-005)

3. *Financing*

Financial intermediaries stress that the financing instrument is crucial, but it is the closure piece of a process. Banks and other intermediaries are not proactive in setting up revolving funds to unburden homeowners, mediating financing commitment and making choices easier. Integral solutions for financing can include subsidies and reduced costs, offering improved comfort and all-in energy-saving measures based on (monthly) fees.

Subsidies help a lot, but it is important that these are not only available for individual measures (heating conversion) but for the entire renovation design and implementation process. What would be missing, but very important, is funding for external process support or moderation from start to finish - these are long-term processes.

It is also important to reduce financial risk. The municipality can give guarantees to its housing company which can borrow at very low interest (SE-001).

It is easier to make decisions in non-profit housing communities because there is a maintenance account from which at least a certain part of the financing can be covered. Here, decisions are often made beforehand for an increased contribution to savings.

4. Communication and trust

Stakeholder dialogue to build trust and awareness is key for the upscaling of energy renovations and combination with energy supply. Large assemblies of homeowners are difficult to reach because of the diversity of the beneficiaries. Transparency and clear communication about the cost and benefits are necessary. Thinking holistically and trying to create and communicate positive effects for the whole community is recommended. If partial renovation and single measures are focused on, there will be resistance from others.

"The most important is the tenant, but indirectly through the rental company, because it is a public service."
(ES-002)

"Regional energy plans are available. Organising (supply for) unburdening, guarantees and clear communication on the municipal level."
(NL-007)

Many subsidies are currently strongly aimed at individual measures (e.g., thermal renovation) or are research-related (lighthouse projects). We need subsidies that allow complete renovations to use the experience of the lighthouses. Still, it is not necessary to invent something new (innovative) every time but to implement it solidly.

Ease of operation and performance guarantees help the acceptance of the interventions. Nevertheless, it can be difficult to provide guarantees with innovative technologies. The renovation solutions providers need to focus on feasible proven solutions and best-practice examples. Using early adopters as demonstrators of neighbourhood renovations can help convince, but this lengthens the time frames by several years.

5.5 Conclusions

This chapter discussed the analysis of the stakeholder views, as they were collected in 39 in-depth, semi-structured interviews that were carried out in the framework of the IEA EBC Annex 75 project. Different stakeholders brought insights about how they perceive the role and influence of the different actors. This is important to identify the customer segments and the partnerships in the business model. Demand actors, such as homeowners and housing associations, have been identified as the main decision-makers and the main customer segments for the business models. Additionally, policy actors have a big influence on decision-making, particularly for the implementation on a district scale, and thus, they need to be addressed by the business models.

To combine actors for upscaling and combining EE+RES, policy actors found that structures such as Revolving funds, energy cooperatives, and initiatives which can offer a guarantee with public money can support the process to unburden the households of the initial renovation cost. Setting up a network and good practical examples are important for the combined business model development. Subsidies help a lot, but it is important that these are not only available for individual measures (heating conversion) but for the entire process. Financial intermediaries point to a strong direction from national governments to provide the framework that allows for innovative financial structures. Most importantly, funding is needed to support and moderate the process, particularly considering these are long-term processes on the district level.

A clear conclusion is that to upscale the interventions to the district scale, the value proposition of the business model needs to be integral, combining energy renovation with other measures on buildings and district, as well as additional services, such as consulting and performance monitoring. In this respect, business models that offer individual solutions, such as the atomised model, are not adequate. The integral value propositions call for integral partnerships and models such as the one-stop-shop that provide a variety of service with a single point of contact and the energy service companies that include financial arrangement and unburden the residents from the initial investment. Energy supply companies should be part of the dialogue between municipalities and beneficiaries to offer integral solutions.

6. Conclusions and recommendations for business models and stakeholders' dialogue

Within the framework of IEA EBC Annex 75, which investigates cost-effective strategies for reducing greenhouse gas emissions and energy use in city buildings at the district level, combining both energy efficiency and renewable energy measures, the study presented business model archetypes for renovation and energy supply. This report's objective is to guide policymakers and the industry to upscale renovations and the implementation of renewable energy sources. The present report sets off to investigate how to develop further business models for energy renovation and energy supply and what the role of the stakeholders should be. In particular, aspects such as the decision-making mechanism and the main stakeholders, overlap in the stakeholders and financing between energy efficiency renovation and RES/Energy systems, value propositions and the revenue streams, are discussed with the aim of answering the following research questions.

***Q 1**: Are the current practices in business models for renovation and energy supply applicable to district renovation?*

***Q 2**: Who are the main stakeholders and what is their role in the business models for district renovation to combine energy efficiency and RES?*

***Q 3**: Which business models characteristic are important to upscale district renovation to combine energy efficiency and RES?*

The main findings are the following:

Chapters 2 and 3: Catalogue of Business models both for energy renovation and energy supply, including the overview of archetypes, barriers, and opportunities.

Chapter 4: Key considerations in combining renovation and energy supply business models:
- Stakeholders mapping.
- Value creation.
- Combine customer segments.
- Main driver: renovation or energy supply.

Chapter 5: Stakeholders' views, as identified through the in-depth interviews.
- Role and level of influence.
- Business model archetypes, Customer segments, value proposition, activities, partnerships, cost and revenue.
- Opportunities for upscaling.

The research questions are answered in the following sections 6.1, 6.2, and 6.3, while section 6.4 provide recommendations.

6.1 Current practices in business models and their applicability to district renovation

Reviewing existing business model archetypes and discussing with the stakeholders showed that no specific business models combine energy supply and energy-efficient renovation of districts. Some renovation projects already apply RES, such as PV panels on the buildings' roofs. The scale is small and is not always combined as a business model. Even though this fragmentation in the business models, also suggesting fragmentation in the stakeholders and decision-makers, hinders the implementation, it offers possibilities for new players to create business models that provide combined values at the district scale.

To achieve large-scale renovation, the business model should offer a single point of contact catering to the project's needs. ESCOs that primarily use Energy Performance Contracts (EPCs) as a financing mechanism has an advantage in offering integral solution and services while unburdening the beneficiaries from an initial investment. The integral solution can incorporate energy supply, RES, and additional services that mobilise, consult, and inform the beneficiaries. The need for such additional services to be part of the integral value increases as the complexity grows with upscaling and combinations of energy renovation measures**,** especially when targeting single-home owners and mixed-ownership districts.

The cost efficiency might vary very much from case to case, depending on the different buildings but also different ownership structures. The role of the public actors is important to support and kick-start the process, even if they do not own the business model. They should provide guarantees to build trust and subsidies to alleviate the investment costs.

The main barriers identified are the separation between energy supply and building performance and the conflict between energy production/supply and energy savings. To this end, combining renovation and energy supply business models and the respective stakeholders is needed. An example of achieving that would be offering a performance guarantee from the technical solution supplier and energy supply.

Changes on a meta-level are needed to develop solid business models and get the market going. Understanding the policy and regulatory interdependencies is critical to ensuring the sustainable development of these businesses. The revenues – and thus the viability – of distributed renewable energy businesses (DER) in distribution networks are therefore exposed in part to these regulatory frameworks. Buildings are more commonly seen as micro-energy hubs with energy generated, stored, used, and saved in buildings and districts. Regarding the renovation market capacity, if the abovementioned opportunities trigger higher renovation activity, the business models that combine the demand can further support the implementation and achieve economies of scale.

Finally, it is important to support the building owners and users as the main beneficiaries, in deciding to renovate. Different financial interfaces are needed for different types of owners, as individual owners have different financial power than landlords. Moreover, effective management of the process is needed to address the complexity of stakeholder communication.

6.2 Main stakeholders and their role in business models for district renovation to combine energy efficiency and RES

The complexity of district renovation required innovation in the business model to involve a broader range of actors working together, often in newly formed partnerships. Identifying the main stakeholders and their role is key to creating those partnerships successfully. The analysis of existing business models and the quantitative analysis of the stakeholders'' questionnaires, in section 5.2, provided insights into the different types of stakeholders. These types can be organised into policymakers, who are policy actors at various levels and

scales (municipality; county council, provincial/ regional government; federal/ national government body, public agencies), and investors, who act as clients or beneficiaries of renovation or renewable energy projects. The investors cover a wide range of organisations which can be private or social, public, semi-public, or mixed, depending on the situation, such as private owners or assemblies of homeowners, but also investment funds, housing associations, and housing cooperatives. Furthermore, market actors need to be addressed as well since they are setting up the business models, offering value and forming partnerships to execute the activities.

As the main beneficiaries of the business model, policy and demand actors are the main decision-makers. Consequently, their influence is very high. Policy actors see the beneficiaries as the most influential. In contrast, non-policy actors see the influence of policy actors as high or very high. It is then clear that those actors are part of the dialogue and should be addressed in the business model.

Energy suppliers are also considered decision-makers since they determine the energy supply interventions, such as heating network extension and operation. Thus, heat and energy planning is the basis for cost-efficient energy renovation decision-making. Subsequently, the renovation solution providers are translating long-term plans and goals into concrete measures.

The influence of financial intermediaries is high, to help finance the measures' implementation, but they are following the decision, not necessarily determining it. In an innovative business model to upscale the implementation, financial intermediaries need to be involved earlier in the process and be part of the partnerships to help set up an equity financing mechanism that unburdens the initial costs from the beneficiaries.

6.3 Business models' characteristics for upscale district renovation to combine energy efficiency and RES

Even though no specific business models for energy supply are applied to the renovation of districts, some characteristics can support the development of business models for district renovation that combine energy efficiency and RES. The analysis of existing business models, success stories and the stakeholders' views on opportunities to upscale energy-efficient renovation to districts has highlighted the following aspects to consider when developing the business models.

Value proposition

The business model should offer an integral approach beyond the energy efficiency the technical solution achieves. Additional value propositions should be related to improving the overall living quality and the district's quality. Improved thermal comfort and lower energy costs for tenants can be combined with improved appearance and attractiveness of the area, resulting in the increased value of the properties.

As the complexity of multiple interventions on a district scale increases, the business model must offer one main point of reference as part of the service, such as in the case of one-stop-shops. The service should include technical advice for energy efficiency renovation and integration of RES, coordination of the solution providers and the construction, financial arrangements, such as subsidies and loan applications, and EPCs.

Partnerships

To create the value described by the value proposition, some key activities take place. To upscale renovation to districts and integrate renewable energy, it is clear that both renovation and energy supply actors need to collaborate and offer a combined value proposition. Communication and financial intermediaries also need to be considered.

The role of energy network providers is significant. With the integration of RES, districts becoming energy producers and their place in the energy infrastructure need to be considered. Energy systems are decentralised, and each household is a consumer and a prosumer. Regarding heating networks, the renovation state of the buildings influences the operation and needs to be considered and optimised. For example, low-temperature heating requires better-insulated buildings. The heating network provider will need to ensure energy efficiency through renovation interventions before deciding to lower the temperature of their network.

Policy partners must support communication and build trust between the beneficiaries and the market actors. Moreover, they need to secure a long-term commitment and connect this business model and related interventions to the larger district development and the energy transition plan.

Financing

With the increasing complexity of the energy supply in building clusters, the partition of Energy Service Companies (ESCOs) of the total market should steadily increase. Energy savings performance contracts help policy actors meet energy efficiency, renewable energy, water conservation, and emissions reduction goals by streamlining contract funding for energy management projects. The streamlined financing could provide multiple benefits, such as increased quality and value and smart project management.

The public sector is in a situation to balance a variety of local objectives, including cheaper local energy for public, private, and residential customers (e.g., the alleviation of fuel poverty); local job creation; local wealth retention; low-carbon power generation; and/or local air pollution reduction. By quantifying these objectives through economic modelling, it is possible to create additional value for new financial models.

Innovation in the business model and improved energy efficiency make older business models obsolete. Energy providers also need to consider managing energy and not only providing energy. Alternative financing sources for RE investments are the newly emerging energy cooperatives, where the financial risk can be mitigated due to local authority investment or collective fundraising for RE through crowdfunding platforms. Community ownership is often considered a source of income that can be controlled locally. Therefore, these kinds of investments are more likely to be accepted socially because it helps develop local supply ownership and keep the value in the local economy.

Communication

Communication among the stakeholders, particularly the dialogue with the residents to build trust and awareness, is key for upscaling of energy renovations and combination with energy supply. It should underline the common societal goal for decarbonisation but also understand the individual district's needs. Ecologic conscience is well developed these days but still cannot be built on as a trigger for high and uncertain investments. The intrinsic motivation from affected actors is usually quite low. A good approach is to address the energy and sustainability benefits in a regular renovation cycle. Transparency and clear communication about the cost and benefits is necessary.

6.4 Recommendations

The analysis and conclusions of the present report provide insights regarding business models that can support the development of district demand and/or supply of energy-efficient renovations and/or renewable energy solutions, targeting various types of stakeholders. Moreover, we can derive recommendations related to the business models and the different key stakeholders' categories, as discussed in 6.2. Of course, we need to consider that each category's actions are not independent of the others, as the actors' influence in the district is interwoven.

Policymakers

Setup of a comprehensive Energy Master Plan: For existing large areas, the planning process is complex and includes consideration of future use and energy costs as well as of maintenance and operation of existing infrastructure. Energy system implementation plans cover many years of actions to increase efficiency, resilience, and reliability. These plans are important to provide the scope, schedule, and security to projects funded directly or using a third-party financing body.

Thus, district energy/ heat planning is important for renovation/ efficiency measures decision-making on a single building level. Against this background, heat and energy master plans have to be "translated" to a building level and liked to respective renovation options. This should prevent lock-in effects due to investments for a renovation that does not fit the broader energy supply plan and does not pay tribute to long-term decarbonisation goals.

As a result, the energy master plan needs to be combined with a district renovation plan. This is an essential step in combining renovation and energy interventions and supporting the dialogue between the respective actors.

Policy instruments: Regulations, support schemes, communication programmes, or organisational services defined by policymakers, such as minimum energy standards, financial incentives to renovate, and subsidies are instrumental in mobilising renovations at a large scale (IEA EBC Annex 75, D.1 report). Financial guarantees and employment of national and regional funds constitute support means by policy actors.

Governance: The process of building efficient and sustainable communities requires careful coordination between stakeholders, including master planners, energy planners, and building designers. These stakeholders work at differing levels of detail and use different planning horizons, which may lead to suboptimal decisions for the community as a whole. Coordinating the myriad stakeholders and organizations, often based on the co-participation form, can be a challenge. An effective governance model with clear roles and actions is needed. These governance models should consider the business model(s) that will be developed.

Investors

Long-term planning for renovations: Building owners, from private homeowners to housing associations, need to coordinate the renovation cycles of their properties to align with the district solutions, as outlined in the long-term energy plans. This is challenging at an individual house or building level, considering mixed ownership, short turnover periods, limited funds, etc. The process should take advantage of the policy instruments, such as subsidies, and innovative financial schemes, such as EPCs, prosumers' revenue, and crowd-

funding. Long-term planning can be achieved through the dialogue between the policymakers and the investors, with the help of advisors and other market intermediaries with the knowledge and experience to facilitate the investors' decision-making.

Active participation: District renovation required both top-down and bottom-up approaches. The demand actors need to put their requirements for improvements on buildings and districts forward to policymakers and participate in initiatives that provide renovation solutions. Housing owners' associations and neighbourhood actors are important residents' representatives in the dialogue. Participation of the demand actors in the dialogue can also lead to the democratisation of the energy market, particularly concerning the aspects related to the business models, such as increased stakeholders' involvement, facilitating difficult decision-making processes, balancing long-term investments vs. short-term revenues, etc.

Market

Include additional value propositions: Alternatives can explore different levels and scopes of building stock renovation and energy supply strategies. Building stock renovation scenarios can include scopes as broad as renovation of the whole-building stock, including an analysis of different energy efficiency levels with possible multiple benefits. Various supply strategies such as decentralised energy supply, renewable energy sources, short-term and seasonal thermal energy storage, batteries, etc., and distribution strategies will provide different energy and cost scenarios, which can be a time-consuming process that depends on the tools and expertise used.

Most importantly, decarbonisation can be offered as a new value proposition that aligns with the national and international goals of the policymakers and is expressed in energy planning. Further improvement of the district quality and infrastructure, including the buildings, needs to be offered as part of the integral values of the interventions in coordination with the urban planning of the policy actors.

Set up (or use existing) innovation clusters: based on these promising BM to ensure that innovative business environments (innovation clusters) will grow that have the potential for upscaling and replication of District Decarbonisation Solutions in Energy communities. It is necessary to consider not only the current energy demand of the building stock but also project the improved energy performance of the renovated buildings when designing and optimising the energy supply. However, uncertainties in the supportive measures for the application of DER make it difficult to develop new business models for the utilities.

Partnerships of energy companies with renovation solution suppliers will coordinate the translation between overarching plans and concrete measures. The flexibility of the infrastructure for distributed energy (innovations concerning networking and monetization) and implementation of digitised solutions (by advances in digital control and communications) must be part of the business model's key activities.

Setting up (or using existing) such partnerships ensure that innovative business environments (innovation clusters) will grow that have the potential for upscaling and replicating District Decarbonisation Solutions in Energy communities.

Participatory processes: In conjunction with public bodies and beneficiaries, the market needs to participate in the communication and awareness raising between the decision-makers. Proven technological solutions and transparency for the cost and benefits that are key for the stakeholders' dialogue can only be provided by the expertise and experience of the market actors who implement the solutions.

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Addenda

The following three Addendums can be consulted for an improved understanding of the working method that served as the basis for the analysis of sub-tasks C and D of IEA EBC Annex 75, contributing particularly to these reports:

- Barriers and drivers for energy efficient renovation at district level
- Policy instruments for cost-effective building renovation at district level combining energy efficiency & renewables
- Business Models for cost-effective building renovation at district level combining energy efficiency & renewables

IEA EBC Annex 75 Addendum 1: interview guidance document

This document was used by all interviewers in multiple countries to approach interviewees with the same questions, in a comparable way.

IEA EBC Annex 75 Addendum 2: interview analysis template

This document was used by the interviewers to provide an analysis of all interviews in a similar fashion.

IEA EBC Annex 75 Addendum 3: success stories analysis

Summary table of the IEA EBC Annex 75 successful stories from a business model perspective.

IEA EBC Annex 75
ENERGY EFFICIENCY AND RENEWABLE ENERGIES AT DISTRICT LEVEL

GUIDANCE FOR INTERVIEWING KEY ACTORS[1]

INTRODUCTION TEXT FOR WEB QUESTIONS & MAILING

TIP:
Clarify in advance the topic of the interview. Select stakeholders that are either relevant to exemplary district projects or to gathering opinions from types of stakeholders about district renovation and renewable energy in districts. You can find an actor list in the Annex of this questionnaire: think about having an approach for collecting multiple viewpoints from civic/demand, public/policy and private/supply actors. The following text can be used for the first contact.

Dear (stakeholder),

The (insert your institute) is engaged in various research projects related to managing energy transitions in residential target areas. In this framework, we would like to invite you to respond to some questions.

We particularly want to know your view on instruments and projects that are being developed or planned in your local authority to support energy renovations and renewable energy systems in districts.

Purpose of this knowledge request:

Your knowledge supports the IEA EBC Annex 75 project "Cost-effective Building Renovation at District Level Combining Energy Efficiency & Renewables". The IEA EBC Annexes are international groups of independent researchers, voluntarily organized in a task force on energy-related issues. The aim of this project 75 is amongst others to recommend policy instruments and business models to stakeholders.

The information gathered by this questionnaire and the interview will be used only for the purposes of the IEA EBC ANNEX 75 project, namely, to provide guidance to various types of stakeholders for upscaling building renovations and renewable energy at the district level.

[1] This guidance document was produced in the framework of the IEA EBC Annex 75 by Erwin Mlecnik and Thaleia Konstantinou (TU Delft, The Netherlands) in collaboration with Juan Maria Hidalgo-Betanzos (Universidad del País Vasco UPV/EHU, Spain); Hauke Meyer (Deutscher Verband für Wohnungswesen, Städtebau und Raumordnung e. V.) & Uta Schneider Gräfin zu Lynar (B&SU Berlin, Germany); Erik Johansson & Henrik Davidsson (Lund University, Sweden), and Ricardo Manuel Mafra Barbosa (University of Minho, Portugal).

Privacy:

(Insert your institute and regulations) takes the utmost care with personal data and in doing so acts within the law, including the General Data Protection Regulation (GDPR). All collected data will respect your privacy according to the Global Data Protection Regulation. You can read our privacy statement on (add a link to your institute regulations).

For this request we collect no specific personal data from you; only your experience and informed opinion as an expert is asked for. We will take care your statements are anonymized, taking into account only the location and your actor category.

In case you have any doubts about this, or if you want to review your statements, please contact your official country IEA EBC ANNEX 75 partner (write your name) for further information.

Next steps:

To prepare for our meeting we would like you to fill in the following:

Your agreement to participate:

I understand the purpose of the interview and I have read and agree with the privacy statement provided by the interviewer. ☐ *Yes* ☐ *No*

Please provide us with the following information before the interview:

Your affiliation: _____

Municipality, city, county or region: _____

Country: _____

Which project or (policy or business) instrument related to energy renovations or renewable energies in districts are you the proudest of and would you like to discuss during our interview?

We would like to prepare our interview a bit according to this. Do you have any background documents on this, such as reports, web links, and so on? Please mention them here.

We are looking forward to your reply.

Yours sincerely,

(your name)
(your institute)

TIP:
After receiving a confirmation, ASK THE INTERVIEWEE TO FILL IN THE FOLLOWING TABLES. If they don't respond before the interview, aim for a reply during or after the interview. Translate the tables if you think this will lead to a better response. If you have specific local authority initiatives in mind, you can slightly change the wording in Table 1 if needed. If you know some details of existing projects, you can already partially fill in Table 2 before sending.

You can do the follow-up interview in your own language (translate the tables if you think it is appropriate); we will collect the data later in English. Check in advance with the interviewee if you want to focus on a particular project, policy instrument or business model.

IEA EBC Annex 75: Interview Tables

Part 1:

Before our interview, we would like you to reflect on the situation in your region, particularly how your local authorities and other stakeholders support district renovation projects in your municipality, city or region. Can you please fill in the following tables?

LOCAL POLICY INSTRUMENTS

Our interview will deal, amongst others, with how local authorities could better achieve energy-saving targets. Before our interview, we would like to ask you about how you think your municipality, city or region is using instruments to achieve building renovations and renewable energy in districts or neighbourhoods.

Do/did you already use the following instruments to stimulate building renovation and renewable energy in districts or neighbourhoods?

Instrument	*No, not considering*	*No, but interested*	*No, but planning to*	*Yes*	*Yes, with good experiences*	*I don't know*
Enforcement of energy standards or solutions in districts	☐	☐	☐	☐	☐	☐
Inspections and energy audits in districts	☐	☐	☐	☐	☐	☐
Financial incentives created by local authorities for specific districts	☐	☐	☐	☐	☐	☐
Financial incentives for groups of homeowners	☐	☐	☐	☐	☐	☐
Creation of renovation services in districts	☐	☐	☐	☐	☐	☐
Local energy desks for awareness-raising and consultancy	☐	☐	☐	☐	☐	☐
Dedicated local website or other local media development	☐	☐	☐	☐	☐	☐
Networking meetings in districts	☐	☐	☐	☐	☐	☐

How <u>important</u> do you think it is to develop the following instruments to stimulate building renovation and renewable energy in districts or neighbourhoods?

Instrument	*No, not considering*	*No, but interested*	*No, but planning to*	*Yes*	*Yes, with good experiences*	*I don't know*
Enforcement of energy standards or solutions in districts	☐	☐	☐	☐	☐	☐
Inspections and energy audits in districts	☐	☐	☐	☐	☐	☐
Financial incentives created by local authorities for specific districts	☐	☐	☐	☐	☐	☐
Financial incentives for groups of homeowners	☐	☐	☐	☐	☐	☐
Creation of renovation services in districts	☐	☐	☐	☐	☐	☐
Local energy desks for awareness-raising and consultancy	☐	☐	☐	☐	☐	☐
Dedicated local website or other local media development	☐	☐	☐	☐	☐	☐
Networking meetings in districts	☐	☐	☐	☐	☐	☐

How <u>difficult</u> do you think it is to develop the following instruments to stimulate building renovation and renewable energy in districts or neighbourhoods?

Instrument	*No, not considering*	*No, but interested*	*No, but planning to*	*Yes*	*Yes, with good experiences*	*I don't know*
Enforcement of energy standards or solutions in districts	☐	☐	☐	☐	☐	☐
Inspections and energy audits in districts	☐	☐	☐	☐	☐	☐
Financial incentives created by local authorities for specific districts	☐	☐	☐	☐	☐	☐
Financial incentives for groups of homeowners	☐	☐	☐	☐	☐	☐
Creation of renovation services in districts	☐	☐	☐	☐	☐	☐
Local energy desks for awareness-raising and consultancy	☐	☐	☐	☐	☐	☐
Dedicated local website or other local media development	☐	☐	☐	☐	☐	☐
Networking meetings in districts	☐	☐	☐	☐	☐	☐

Please mention here the initial ideas you would like to share during the interview, particularly about the development of policy instruments:

Please add your comments here

STAKEHOLDER INVOLVEMENT IN PROJECTS

Our interview will explore your project experiences and wishes considering stakeholder collaboration for achieving district renovation goals. We would like to ask you which of the following stakeholders you already worked with for developing specific projects regarding energy efficiency and renewable energies in districts?

Stakeholders	*I am:*	*For district projects I already worked with:*	*Their role in this project was:*	*I think their level of influence in the project was:*
Policy actors (e.g.: local or regional authority, public agency or institute,..)	☐	☐	☐ decision-maker ☐ influencer ☐ technical advisor ☐ deliverer	☐ very low ☐ low ☐ medium ☐ high ☐ very high
Renovation solution suppliers (e.g. planning and construction parties, urban planners, architects, design team, general contractors, products suppliers, ESCO, contractor, energy monitoring, facility manager, installation provider, one-stop-shop,..)	☐	☐	☐ decision-maker ☐ influencer ☐ technical advisor ☐ deliverer	☐ very low ☐ low ☐ medium ☐ high ☐ very high
Energy solution suppliers (e.g. distributor system operators, energy supply companies, energy agencies, renewable energy companies, heat grid operators, aggregators, service providers, net managers, energy monitoring providers, energy cooperatives,..)	☐	☐	☐ decision-maker ☐ influencer ☐ technical advisor ☐ deliverer	☐ very low ☐ low ☐ medium ☐ high ☐ very high
Beneficiaries (e.g. clients, residents, homeowner assemblies, community/occupants' organizations, action groups, Housing associations and cooperatives: private, public, semi-public,..)	☐	☐	☐ decision-maker ☐ influencer ☐ technical advisor ☐ deliverer	☐ very low ☐ low ☐ medium ☐ high ☐ very high
Financing intermediaries (e.g. banks, investment funds, real estate developers, project developers, portfolio managers, ESCOs,..)	☐	☐	☐ decision-maker ☐ influencer ☐ technical advisor ☐ deliverer	☐ very low ☐ low ☐ medium ☐ high ☐ very high
Other intermediaries (e.g. federations, trade organizations, not-for-profit organizations, neighbourhood interest associations, neighbourhood communication agents, business model developers, consultants,..)	☐	☐	☐ decision-maker ☐ influencer ☐ technical advisor ☐ deliverer	☐ very low ☐ low ☐ medium ☐ high ☐ very high

We would like to ask you which of the following stakeholders you would like to work with to <u>better achieve a good coupling of energy-efficient renovation and renewable energies in districts</u>.

Stakeholders	*In future district projects, I would like to work with:*	*They can positively contribute to achieving (combining) district renovation & renewable energies in districts, because:*
Policy actors (e.g. local or regional authority, public agency or institute,..)	☐	
Renovation solution suppliers (e.g. Planning and construction parties, urban planners, architects, design team, general contractors, products suppliers, ESCO, contractor, energy monitoring, facility manager, installation provider, one-stop-shop,..)	☐	
Energy solution suppliers (e.g. distributor system operators, energy supply companies, energy agencies, renewable energy companies, heat grid operators, aggregators, service providers, net managers, energy monitoring providers, energy cooperatives,..)	☐	
Beneficiaries (e.g. clients, residents, homeowner assemblies, community/occupants' organizations, action groups, Housing associations and cooperatives: private, public, semi-public,..)	☐	
Financing intermediaries (e.g. banks, investment funds, real estate developers, project developers, portfolio managers, ESCOs,..)	☒	
Other intermediaries (e.g. federations, trade organizations, not-for-profit organizations, neighbourhood interest associations, neighbourhood communication agents, business model developers, consultants,..)	☐	

Part 2: INTERVIEW
(OPEN QUESTIONS GUIDED BY EXPERT INTERVIEWER)

TIP:
In the questions, we generally ask about perceived opportunities and barriers. We have integrated various aspects of opportunities and barriers in various places in this questionnaire. This includes:

- policy/ legal/ environmental issues (section 1);
- economic/ financial issues (section 2);
- technical/ social/ communication/ collaboration issues (section 3);

The interviewer is not required to make separate questions for each type of barrier but is asked to keep these various viewpoints in mind all the time, as they will be used for analysis afterwards.

1. POLICY INSTRUMENTS (D.1)

TIP:
If applicable, refer to the local policy instrument(s) the interviewee is proud of. Alternatively, focus on a policy instrument the interviewee wants to explore or has experience with within a district project.

TIP:
Note that the term 'local authority' can refer to various types of local policy actors, such as district governors, municipal council members, city mayors, responsible actors from various departments (urbanism, planning, housing,..), county representatives, elected ambassadors, regional and national liaisons. Similarly 'local authority region' refers to the geographical area they have a say in or influence on.

We would like to ask you a few questions about your experiences regarding (the development of) policy instrument XXX (fill in the policy instrument from previous answers or use "policy instruments" in general) to support renovations of residential buildings and renewable energy systems.

1.1 Can you tell us something about the external opportunities you see for using XXX to activate residential building renovations/ renewable energies in districts?

1.2 Can you tell us something about the external barriers and threats you see for using XXX to activate residential building renovations/ renewable energies in districts?

1.3 Can you tell us something about the strengths you see for using XXX to activate residential building renovations/ renewable energies in districts within your organisation?

1.4 Can you tell us something about the weaknesses you see in using XXX to activate residential building renovations/ renewable energies in districts within your organisation?

TIP:
Repeat these four questions for each policy instrument XXX that you think is new for this city or region.

TIP:
Check the table below to check if certain aspects are missing in the answers to previous questions. If applicable ask follow-up questions like "Do you also perceive opportunities and barriers related to P/E/S/T issues?"

	Policy/ Legal/ Environmental	Economic/ Financial	Social/ Communication	Technical/ Management
Strengths (internal to the interviewee)				
Weaknesses (internal to the interviewee)				
Opportunities (external to the interviewee)				
Threats/Barriers (external to the interviewee)				

1.5 (optional questions for local authorities)

So far, how have various policy instruments been connected to energy planning or other overarching strategies supporting the renovation of residences in districts?

1.6 What kind of barriers do/did you encounter in COMBINING energy efficiency and renewable energies in residential districts?

1.7 (optional questions for local authorities)

How do you think have currently implemented policy instruments encouraged or hindered the optimal combination of energy efficiency measures and renewable energy measures in residential districts?

1.8 How do you see the further development of policy instruments (regulations, incentives, organization, communication) in your municipality/ city/ region related to this combination effort?

2. RENOVATION FINANCING AND BUSINESS MODEL (D.2)

TIP:
If you want to discuss specific business or financing initiatives, rephrase a bit according to the specific business model or policy instrument you want to discuss.

2.1 What was/is your main driver to carry out or support district renovation or renewable energy project(s)? (main value proposition)

2.2 Can you tell us how the financing of (supporting) district renovation or renewable energy project(s) was structured in your project, or how you think this can be done?

TIP:
Ask more specific follow-up questions to go deeper or give clues if applicable, for example: How did/do you finance your own contribution and partners in a project? Did/do energy tariffs or financial energy savings play a role in the costing structure?

2.3 (optional question)
How did/do you solve financing challenges to go through with (supporting) district renovation or renewable energy project(s)?

2.4 (optional question)
How do you think that current financing models or tariff structures encourage or hinder the optimal combination of energy-efficient renovation and renewable energy measures in residential districts?

TIP:
Ask more specific follow-up questions to go deeper or give clues if applicable, for example: How did/does the business model of stakeholders play a role? How could financing structures, business models or energy tariff structures be improved according to your opinion?

2.5 How did/do various types of stakeholders (such as homeowners, suppliers, policy actors, and so on) participate in the decision-making?

TIP:

Use the filled-in table for the interviewee to comment upon.

2.6 (optional question)

How do you think that decision-making processes can be improved to achieve an optimal combination of energy efficiency and renewable energy measures in residential districts?

TIP:

Ask more specific follow-up questions to go deeper or give clues if applicable, for example: Does the current decision-making hinder this development? Is there a need for incentives, regulation, communication, and organization?

2.7 Can you tell us your insights regarding the contracting arrangements between various types of stakeholders (such as homeowners, suppliers, policy actors, and so on) and/or how you think they could be improved?

2.8 (optional question)

Can you tell us something about how you imagine future business models for (combining) energy efficiency and renewable energy measures in residential districts?

2.9 (optional question)

What opportunities and/or challenges do you see for innovative financial structures, such as Energy Performance Contracts (EPCs) and investment funds for energy efficiency and renewable energy measures in residential districts?

2.10 (optional question)

Which parties were or could be involved in setting up innovative financial structures, and for what purpose?

2.11 In general, what do you think can be new promising ways of financing, contracting and stakeholder engagement to encourage/facilitate the optimal combination of energy efficiency measures and renewable energy measures in residential districts?

TIP:

This question can be optional if you already covered combination issues in the previous optional questions.

3. SOCIO-TECHNICAL ISSUES (D.2 & C.3)

We would like to ask you a few questions about the technical and social issues you encounter in achieving renovations of residential buildings and renewable energy systems in districts.

3.1 Can you tell us something about the technical opportunities and barriers you encounter(ed) for achieving residential building renovations and renewable energies in districts?

TIP:

Ask more specific follow-up questions to go deeper if applicable, for example: What is/was your experience with implementing technological innovations?

3.2 Can you tell us something about the project management opportunities and barriers you encounter(ed) for achieving residential building renovations and renewable energies in districts?

TIP:

Ask more specific follow-up questions to go deeper if applicable, for example: How do/did you manage changes of ambitions during a project?

3.3 Can you tell us something about the opportunities and barriers you encounter(ed) for activating homeowners in districts?

TIP:

Ask more specific follow-up questions to go deeper if applicable, for example: How do/did you make sure all end users are informed or engaged?

3.4 Can you tell us something about the opportunities and barriers you encounter(ed) in supplying solutions in districts?

TIP:

Ask more specific follow-up questions to go deeper if applicable, for example: How do/did you involve local small and medium-sized enterprises? Do/did you work with prefabricated solutions?

3.5 Can you tell us something about the opportunities and barriers you encounter(ed) in activating local authorities for district projects?

TIP:

Ask more specific follow-up questions to go deeper if applicable, for example: Do/did they set up specific initiatives or communication for supporting a project?

3.6 (optional question)

Can you tell us something about the opportunities and barriers you encounter(ed) for collaborating with multiple stakeholders at the same time to activate residential building renovations and renewable energies in districts?

TIP:

Ask more specific follow-up questions to go deeper if applicable, for example: How do/did you manage their expectations?

3.7 Can you tell us something about the strengths and weaknesses you see for yourself to activate residential building renovations and renewable energies in districts?

3.8 What kind of barriers and opportunities did you notice regarding stakeholder dialogue or management when addressing the combination of energy-efficient renovations and renewable energies in residential districts?

3.9 Can you tell us something about how you imagine improved stakeholder dialogue or management to combine residential building renovations and renewable energy systems in districts? What could be your role in this?

TIP:
Check this table to understand if you covered most aspects until now. If needed, ask additional questions, for example about what the interviewee thinks are their own strengths and limitations to solve certain barriers.

	Policy/ Legal/ Environmental	Economic/ Financial	Social/ Communication	Technical/ Management
Strengths (internal to the interviewee)				
Weaknesses (internal to the interviewee)				
Opportunities (external to the interviewee)				
Threats/Barriers (external to the interviewee)				

4. FINAL REMARKS

4.1 Do you have any other concerns, remarks or issues you want to share regarding developing or combining energy-efficient renovations and renewable energy systems in districts in a cost-efficient manner? For example, regarding policy instruments, business models, stakeholder dialogue, future initiatives, improvement of success, and cost-efficiency of actions, ...?

4.2 (optional question)
Are there perhaps documents or web links you would like to share for our report?

4.3 Can you give us the contact details of persons we should contact to discuss innovative developments in more detail?

Can we contact you in case we need further clarification ☐ Yes No ☐

Would you like to subscribe to the EBC Annex 75 newsletter to be kept informed about the project results? ☐ Yes No ☐

If your answer is Yes, what e-mail address would you like to be contacted at?

Thank you for your collaboration!

Annex: TYPE OF INTERVIEWEE

TIP:
In IEA EBC Annex 75, we aim to interview multiple stakeholders that are involved in a district project or that can provide an expert view on the topic of cost- and energy-efficient district renovation. We aim to include and compare various stakeholder perspectives in our follow-up reporting.

The previous questionnaire integrates these perspectives and supports at the same time C.3, D.1 and D.2. For example, for assessing policy instruments (D.1.), we target public actors that facilitate the adoption of (district) renovations - such as local authorities -, but we would also like to compare with the viewpoints of civic (e.g. homeowner assemblies or housing stakeholders) and private stakeholders, or collaborations thereof that play a role for developing policy instruments.

For assessing business models (D.2.), we target mainly suppliers, but we would also like to compare with the viewpoints of demand and policy actors and intermediaries that play a role in business development.

For assessing project management (C.3.), we target mainly project managers, but we would also like to compare with the viewpoints of clients, (sub)contractors, and other parties that might play a role in project management such as controllers and facilitators.

The questionnaire integrates these perspectives and fits different types of actors you might encounter during snowball sampling. Researchers working on these deliverables aim to share questionnaire results in a format that is anonymized.

Check here how the interviewee identified their affiliation:

- *Policy actor*
  - *Municipality or city*
  - *County council*
  - *Provincial/ regional government*
  - *Federal/ national government body*
  - *Other, namely:…*

- *Public agency or institute*
  - *Innovation agency*
  - *Energy agency*
  - *Public service*
  - *Educational institute*
  - *Research Institute*
  - *Other:…*

- *Renovation solution provider*
  - *Planning and construction party*
  - *Urban planner*
  - *Architect*
  - *Design team*
  - *General contractor*
  - *Subcontractor*
  - *Supplier of products or technologies*
  - *Supplier of concepts or systems*
  - *Facility manager*
  - *Installer*
  - *One-stop-shop*
  - *Other:…*

- *Energy solution provider*
  - *Distribution system operator (DSO)*
  - *Transmission system operator (TSO)*
  - *Energy supply company*
  - *Energy service provider*
  - *Renewable energy company*
  - *Heat grid operator*
  - *Aggregator*
  - *Energy monitoring provider*
  - *Energy cooperatives*
  - *Other:…*

- *Financing intermediary*
  - *Bank*
  - *Investment fund operator*
  - *Real estate development company*
  - *Project development company*
  - *Building portfolio manager*
  - *ESCO*
  - *Other:…*

- *Client or beneficiary/ demand actor*
  - *Private owner or assembly thereof*
  - *Private owner*
  - *Homeowner assembly*
  - *Housing cooperative or co-housing*
  - *Other:…*
  - *Housing association or company*
  - *Private housing actor or real estate company*
  - *Public or social housing actor*
  - *Semi-public or mixed*
  - *Other:...*

- *Other representative expert*
  - *Federation*
  - *local authorities*
  - *suppliers*
  - *contractors*
  - *architects*
  - *homeowners*
  - *renters*
  - *building owners*
  - *other:...*
  - *Trade organization*
  - *Not-for-profit organization*
  - *Neighbourhood interest association*
  - *Private actor contracted as intermediary process actor*
  - *Neighbourhood communication agent*
  - *business model developer*
  - *consultant*
  - *Other:…*

IEA EBC Annex 75 subtask D: STAKEHOLDERS INTERVIEWS
Analysis template

Dear ANNEX 75 partners,

We are contacting you to invite you interviewing stakeholders that may have experience with district renovations and EE+RES combinations.

To organise the process and facilitate the further analysis we have created this analysis template. In our March meeting we will show some examples and give additional information. As you know, among the ANNEX 75 tasks we are conducting some interviews to local experts and key stakeholders to gather useful experiences and insights: particularly valuable for C3, D1, D2 and D3 deliverables. Regarding the timeframe, these interviews are expected to be done before summer.

Now that templates of the interview and analysis are available, we invite you to read them and join this valuable task for StC and StD. If you have any doubts let us know.

The foreseen recommended steps are the following:

Step 1 – Download the questionnaire guidance and analysis templates (version of 2021):
The last version of 2021 consists of a guidance word file and an analysis excel file which may help you during all the process: preparing the interview, leading the questions and getting more information out of the discussed topics. These templates show the type of outcomes we expect from these interviews, the details that are more important from their experience in renovations at district scale or combining EE+RES.
Regarding the Data Protection, each institution and country may adapt the template. We have included a general base and, in a separate file, a more detailed example from TU Delft.
The original template is in English, but you may need to translate it to the local language. If you do so, please upload to Teams the new language version, this may help the other colleagues. So far, English and Spanish versions are available.
See the attached files, or find it in the Teams folder:
https://teams.microsoft.com/_#/files/General?threadId=19%3Ac2cfc77f7d804471a64dbdbba45a68a2%40thread.tacv2&ctx=channel&context=2_Interview%2520Templates%2520(guidelines%2520%252B%2520Analysis)&rootfolder=%252Fsites%252FTriple-AWP1-4team%252FGedeelde%2520documenten%252FGeneral%252F2_Interview%2520Templates%2520(guidelines%2520%252B%2520Analysis)

Step 2 – Find potential experts and interesting stakeholders.
To confirm their availability and explain the goal of the interview, you can share the template with the potential interviewee. The interview template is divided in: Part I Interview preparation; and Part II. Interview questions.
If possible, we recommend asking them to fill in the Part I beforehand, with a double aim: to understand their overall experiences and to get their acceptance of Data protection before the interview.
Acoording to your institute's ethical rules and GDPR, inform the interviewee about the project and how you will treat the data and ask for explicit written consent (example attached).

Step 3 – Register your interview in the interview overview table:
After their acceptance, register it in the common table. The file will be updated with your contributions and show all the interviewed stakeholders.
It is available in Teams:

https://teams.microsoft.com/l/file/A12B1096-0BAC-41FA-88BF-E230B94ADA90?tenantId=096e524d-6929-4030-8cd3-8ab42de0887b&fileType=xlsx&objectUrl=https%3A%2F%2Ftud365.sharepoint.com%2Fsites%2FTriple-AWP1-4team%2FGedeelde%20documenten%2FGeneral%2F1_List%20of%20interviews%20and%20codes%2FIEA%20EBC%20Annex%2075_STD_Stakeholder%20Interview%20List.xlsx&baseUrl=https%3A%2F%2Ftud365.sharepoint.com%2Fsites%2FTriple-AWP1-4team&serviceName=teams&threadId=19:c2cfc77f7d804471a64dbdbba45a68a2@thread.tacv2&groupId=ee6b88c2-7056-42a0-9526-4171ca00de58

Step 4 – Conduct the interview:
To obtain better results with the interview, please read the templates carefully, including the tips in word document and the analysis template where all the concepts and crossed and evaluated.
If the interviewee allows it, you can record it in voice or video, to check and complete your notes during the analysis.
Please use one separate file per each interview, including all the answers and notes.

Step 5 – Analyse the gathered information:
Create a new file for each interview analysis. The file name must include the interview code in the beginning (example: "ES-002 interview final.xlsx")
Please follow the template to complete the analysis and be concise. This may facilitate future analyses and so get more outcomes from this work.
It is recommended to make the analysis shortly after the interview. If possible, just after the interview or few days later.
Once the analysis template is finished, please make a final review to detect missing aspects. Be aware that some interview questions can be connected to several analysis sheets (pages).

Step 6 – Send the final analysis file:
Send the final analysis file (excel format, 5 pages) to the coordinator (juanmaria.hidalgo@ehu.eus).
The coordinator will update the status of your finalised interview analysis in the common overview table and send you a confirmation.

All the files of the analysis will be located in this shared Teams folder:
https://teams.microsoft.com/_#/files/General?threadId=19%3Ac2cfc77f7d804471a64dbdbba45a68a2%40thread.tacv2&ctx=channel&context=General&rootfolder=%252Fsites%252FTriple-AWP1-4team%252FGedeelde%2520documenten%252FGeneral

Once again, thank you for your contribution and shall you have any doubts, please contact us for further explanations.

We look forward to hearing from your interviews.
Best regards,
StD interview team

IEA EBC Annex 75 subtask D: STAKEHOLDERS INTERVIEWS
Analysis template: 1. Identification

Template to be completed for each interview

Objectives: Follow a common methodology for the interview analyses, to provide better information to StC and StD deliverables and improve the ANNEX75 outcomes.

Instructions: Download this template and create a new file for each interview analysis. File name must include the interview country code in the beginning (example: "ES-002 interview final.xlsx")
Please follow the template 5 pages to complete the analysis and be concise. This may facilitate future analyses and so get more outcomes from this work.
It is recommended to make the analysis shortly after the interview. If possible, just after the interview or few days later.
Once the analysis template is finished, please make a final review to detect missing aspects. Be aware that some interview questions can be connected to several analysis sheets (pages).
Send the final analysis file (excel format, 5 pages) to the coordinator (juanmaria.hidalgo@ehu.eus).

Dates: Interviews between February-April 2021. Submit the analyses the latest in May 2021. First interviews results will be presented in 23-25 march meeeting.

Shall you have any doubts using this template or any suggestions, please email (Juanmaria.Hidalgo@ehu.eus)

Interview identification				Stakeholder type and description		Interviewee details (Non-publishable Private Data)	
Country	**Interviewer name, affiliation**	**Date of interview**	**Interview code**	**Stakeholder type**	**Description**	**Interviewee affiliation**	**Institute or company name**
Example							
The Netherlands	*Erwin Mlecnik, TU Delft*	*3/11/2020*	*NL-001*	*R. Renovation solution provider*	*Non-profit service supplier for living-cost neutral renovation of apartment buildings*	*DIRECTOR*	*INSTITUTION NAME*

List of stakeholder types

P. Policy actor
o Municipality or city
o County council
o Provincial/ regional government
o Federal/ national government body
o Other, namely:..
o Public agency or institute: Innovation agency, Energy agency, Public service, Educational institute, Research institute, Other:..

C. Client or beneficiary/ demand actor
o Private owner or assembly thereof: Private owner, homeowner assembly, housing cooperative or co-housing, other:..
o Housing association or company: Private housing actor or real estate company, public or social housing actor, semi-public or mixed, other:..

F. Financing intermediary
o Bank
o Investment fund operator
o Real estate development company
o Project development company
o Building portfolio manager
o ESCO
o Other:…

E. Energy solution provider
o Distribution system operator (DSO)
o Transmission system operator (TSO)
o Energy supply company
o Energy service provider
o Renewable energy company
o Heat grid operator

R. Renovation solution provider
o Planning and construction party,
o Urban planner
o Architect
o Design team
o General contractor
o Subcontractor
o Supplier of products or technologies
o Supplier of concepts or systems
o Facility manager
o Installer
o One-stop-shop
o Other:…

I. Other intermediaries
o Federation of local authorities, suppliers, contractors, architects, homeowners, renters, building owners, other:...
o Trade organization
o Not-for-profit organization
o Neighborhood interest association
o Private actor contracted as intermediary process actor: Neighborhood communication agent, business model developer, consultant, other:…
o Other:…

Country list:
Austria
Belgium
China
Czech republic
Denmark
Germany
Italy
The Netherlands
Norway
Portugal
Spain
Sweeden
Switzerland

IEA EBC Annex 75 subtask D: STAKEHOLDERS INTERVIEWS
Analysis template: 2. Policy instruments (page 2 of 5)

EBC Energy in Buildings and Communities Programme
Annex 75

How to fill in: Fill in the "Stakeholder viewpoints" (columns D-F) using the pre-defined ratings and drop-down menus. Main information in questionnaire Part I, "Local policy instruments".
Complete the "Discussion" (columns G - J) and summarize the key points. Information in questionnaire Part II, "1. policy instruments".
Please include any interesting: quotes, remarks, recommendations for upscaling district renovations and combining EE + RES.
Quotes (ask permission to use) or remarks may be used later in the report to emphasize immportant points. Add the sources given by the interviewee (reference web sites, relevant policy or strategic documen
Please consider adding any valuable related information and remarks from all the interview, obtained during other questionnaire sections as well (for example Part II, "1. policy instruments")

Questions: *Shall you have any doubts using this template or any suggestions, please email (Juanmaria.Hidalgo@ehu.eus)*

Overview table + reflection of stakeholder on different policy instruments

The interviewee is (stakeholder type): | **Code**

		Stakeholder viewpoints			Discussion			
Policy needs	**Policy instrument**	**Use**	**Importance**	**Difficulty**	**Interesting quotes and sources for the report**	**Remarks interviewee**	**Recommendations for upscaling and combining EE+RES**	**Remarks interviewer**
Need for regulation by (local) policy actor	E.g. enforcement of energy standards or solutions in districts							
	E.g. inspections and energy audits in districts							
Need for incentives from (local) policy actor	E.g. financial incentives created by local authorities for specific districts							
	E.g. financial incentives for groups of homeowners							
Organizational needs from (local) policy actor	E.g. creation of renovation services in districts							
	E.g. local energy desks for awareness raising and consultancy							
Communication needs from (local) policy actor	E.g. dedicated local web site or other local media development							
	E.g. networking meetings in districts							

Please use these Ratings for the answers:

Use rating (1-5):	**Importance rating (1-5):**	**Easiness rating (1-5):**
1. No, not considering	1. Not important	1. Difficult
2. No, but interested	2. Somewhat importan	2. Somewhat difficult
3. No, but planning to	3. Neutral	3. Neutral
4. Yes	4. Important	4. Somewhat easy
5. Yes, with good experiences	5. Very important	5. Easy
X. I don't know	X. I have no opinion	X. I have no opinion

IEA EBC Annex 75 subtask D: STAKEHOLDERS INTERVIEWS
Analysis template: 3. Business models and stakeholder dialogue (page 3 of 5)

How to fill in: Fill in the "Stakeholder viewpoints" (columns C-E) using drop-down menus. Main information in questionnaire Part I, "Stakeholder involvement in projects".
Complete the "Discussion" (columns F-I): interesting quotes, remarks, recommendations for upscaling district renovations and combining EE + RES.
Quotes (ask permission to use) or remarks may be used in the report to emphasize points. Add also the sources given by the interviewee (web sites, policies, documents, ...).
Please consider adding any valuable related information and remarks from all the interview (for example Part II, 2. Renovation financing and BM)

Questions: *Shall you have any doubts using this template or any suggestions, please email (Juanmaria.Hidalgo@ehu.eus)*

Overview table + reflection on stakeholder dialogue in projects

The interviewee is (stakeholder type): | **Code**

Stakeholder viewpoints			Discussion			
For district projects the interviewee already worked with:	**Their role in this project/s was:..**	**I think their level of influence in the project was:..**	**Remarks interviewee on having worked together with this stakeholder**	**Remarks interviewee on working together with this stakeholder in the future**	**Other remarks interviewee**	**Remarks interviewer**
Policy actors (e.g.: local or regional authority, public agency or institute,..)						
Renovation solution suppliers (e.g. planning and construction parties, urban planners, architects, design team, general contractors, products suppliers, ESCO, contractor, energy monitoring, facility manager, installation provider,						
Energy solution suppliers (e.g. distributor system operators, energy supply companies, energy agencies, renewable energy companies, heat grid operators, aggregators, service providers, net managers, energy monitoring						
Beneficiaries (e.g. clients, residents, homeowner assemblies, community/occupants' organizations, action groups, Housing associations and cooperatives: private, public, semi-public,..)						
Financing intermediaries (e.g. banks, investment funds, real estate developers, project developers, portfolio managers, ESCOs,..)						
Other intermediaries (e.g. federations, trade organizations, not-for-profit organizations, neighborhood interest associations, neighborhood communication agents, business model developers, consultants,..)						

Please use these Ratings for the answers:

	Role in this project (1	**Level of influence (1-5):**
Yes	1. Decision maker	1. Very low
No	2. Influencer	2. Low
	3. Technical advisor	3. Medium
	4. Deliverer	4. High
		5. Very high

IEA EBC Annex 75 subtask D: STAKEHOLDERS INTERVIEWS
Analysis template: 4. Business models (page 4 of 5)

How to fill in: Fill in the "BM definition" (column D). See the tips and information sources given (column C). Main information in questionnaire Part II. "2. Renovation financing and BM"
Complete the "Discussion" (columns E-I) with interesting quotes, remarks, recommendations for upscaling renovations and combining EE + RES.
Quotes (ask permission to use) or remarks may be used in the report to emphasize points. Add also the sources given by the interviewee (web sites, policies, documents, ...).
Please consider adding any valuable related information and remarks from all the interview (for example Part I, Stakeholder involvement in projects to detect key partnerships).

Questions: *Shall you have any doubts using the business model template or any suggestions, please email (T.Konstantinou@tudelft.nl)*

Overview table + reflection on stakeholder dialogue in business models

The interviewee is (stakeholder type): | **Code**

		BM definition	Discussion				
Analysis of Business Model elements	**Tips to fill in these elements / concepts**	**Main aspect**	**Describe how the interviewee experienced this aspect**	**Interesting quotes and sources for the report**	**Remarks by the interviewee**	**Recommendations for upscaling and combining EE+RES**	**Remarks by the interviewer**
BM archetype	What is the (nearest) BM archetype? See further details in Table 2 below. If unsure, contact D2. Information: Questions 2.8 and 2.9						
Customer segment	Who benefit/use/pay for the renovation/RES? The main decision-maker is often the main costumer sergment. Information: Part I table						
Value Proposition	What is the value to the costumer? how to solve problems and satisfy customer needs. Information: Question 2.1, and Part I table						
Key Partnerships	who partners in the business model? Such as a general contractor, a service company,... Information: Questions 2.7 and 2.10.						
Costumer Relationships & Channels	How is the value proposition delivered to customers? Communication, distribution, sales... How are relationships forged and sustained? Information: Questions 2.7, 2.11 and 2.10.						
Cost Structure	What is the value proposition cost? Renovation and RES investment (context of Annex75) and other costs... Information: Question 2.2 the cost can be funded By financing mechanisms, such as Dept or Equity.						
Revenue Streams	How does the organisation generate revenues? How the investment is paid back. Information: Questions 2.2, 2.4 and 2.7.						
Key Activities & Resources	How is the value proposition achieved? The activities and resources required to offer and deliver the value.						

Table 2. Summary of the Business Models archetypes, highlighting the barriers they pose to upscale to district, as well as opportunities to overcome those barriers

BM	**Value Proposition**	**Financing mechanism**	**Barriers**	**Opportunities to**

archetype	Value Proposition	Financing mechanism	Barriers	overcome barriers
Atomised market	**Single measure**. Emphasis on energy cost savings.	· Homeowner pays for entire cost structure, payback through energy savings.	· Relies on individual funding and initiative · Fragmented and uncoordinated problem solving	· Awareness raising · Financial incentives for renovation
Market intermediation	**Single measure**. Emphasis on energy cost savings. Expert advice and reduced time investment for homeowner.	· Access to finance through debt.	· Relies on individual funding and initiative · Additional interface can add to cost and time. · Less opportunities for innovation and integrated solutions	· Awareness raising · Financial incentives for renovation · Intermediary builds trusted relationships suppliers, to provide integrated solutions
One-stop-shop	**Multiple measures.** Emphasis on energy cost savings, comfort and environmental performance.	· Homeowner pays for entire cost structure, through own debt. · Payback through energy savings, potential extra revenue from sale of self-generated energy. · One-stop-shop interface is also adequate for equity financing	· Lack of awareness for the integrated service benefits · High investment costs, due to complex and expensive solutions, and expert consultations	· Awareness raising and coordinated renovation projects · Development of integrated, modular, scalable solutions.
ESCO (Energy Service Company)	**Multiple measures**. Emphasis on energy services (eg. Indoor temperature, hot water volume, …)., cost savings, comfort and environmental performance.	· Organisation pays upfront (lender), charges homeowner with monthly rate based on historic energy consumption, captures energy savings and potential extra revenue from sale of self- generated energy	· Complex financial structure · Long term loans tied to energy savings	· Financial attractive for home-owners

Options for BM dropdown menus:

BM archetypes	Atomised	Market Intermediary	One-stop-shop	Energy service contracts		
Customer segments	Policy actor (eg.municipality, government)	Client or beneficiary/ demand actor (eg. Private owner, Homeowner assembly,Private, or public or social housing actor)	Renovation solution provider (eg. General contractor, one-stop-shop, Supplier of products or technologies)	Energy solution provider	Financing intermediary (eg. investor fund, bank)	Other: please describe here the customer in more detail.

Value Proposition
Key Partnerships
Costumer Relationships & Channels
Cost Structure
Revenue Streams
Key Activities

IEA EBC Annex 75 subtask D: STAKEHOLDERS INTERVIEWS
Analysis template: 5. SWOT evaluation (page 5 of 5)

How to fill in:
Fill in the "PESTLE evaluation" (columns C-F) with their own practice or cases. Main information in questionnaire Part II, "3. Socio-technical issues ".
Aim to integrate information from all the questionnaire, i.e. process management (development), needs from local policy, business practice and stakeholder dialogue.
It is possible that you didn't find information for all blocks; that is OK.
Complete the "Discussion" (columns G-J): interesting quotes, remarks, recommendations for upscaling district renovations and combining EE + RES.
Quotes (ask permission to use) or remarks may be used in the report to emphasize points. Add also the sources given by the interviewee (web sites, policies, documents, ...).

Questions:
Shall you have any doubts using this template or any suggestions, please email (Juanmaria.Hidalgo@ehu.eus)

SWOT Analysis table on stakeholder engagement, policy instruments and business models

The interviewee is (stakeholder type):		**Code**	

	P.E.S.T.L.E. evaluation				**Discussion**			
Analysis local contexts for energetic district renovation	**Policy/ Legal/ Environmental**	**Economic**	**Social/ Communication**	**Technical**	**Interesting quotes and sources for the report**	**Remarks by the interviewee**	**Recommendations for upscaling and combining EE+RES**	**Remarks by the interviewer**
Strengths (internal to the interviewee)								
Weaknesses (internal to the interviewee)								
Opportunities (external to the interviewee)								
Threats/Barriers (external to the interviewee)								

		BM Archetype	Customer	Value proposition	Financing	Activities	Partners
1	AT	One-stop-shop Complete solutions	Non-profit building association GSWB and Bausparerheim City of Salzburg Municipal Department	- Increase the living quality and adapt buildings to a contemporary standard of living. - Quality improvement and increase in the value of the building stock. - Improve the quality of open spaces in the district. - Ensure permanent rentability. - Reduce energy costs and CO_2 emissions. - Improve the district image and its effect as identification for the inhabitants and the district itself.	Debt: City and Housing Association fund the renovation.	- Thermal renovation. - Connection to district heating. - PV on-site electricity production. Surplus electricity for mobility.	Municipality Neighbourhood actors Building owners Financial intermediaries Advisors
2	DK	Market intermediation	Housing association	- Improve energy efficiency (energy label to Renovation Class 2). - Diversify housing types. - Replacement for low-temperature radiators.	Debt: The housing association funds the renovation.	- Collaboration model for an energy partnership between housing organizations, the municipality, and an energy company. - Integration of Kildeparken in the existing energy supply network.	Architects and technical advisors. Energy supplier (delivery).
			Energy consumers	- Renovate district heating. - Low-temperature district heating and renewable energy. - Energy optimization at the building level and at the energy system level towards “Smart Grid” concepts.			Aalborg District Heating

3	IT1	Atomised model Specific measures delivered by the supplier	Energy consumers	- Maximize the use of a singular central system in place of private heating devices to achieve useful energy saving for the whole city. - Optimization in energy use, and a lower impact on families' income.	Public funds	- Construction of a district heating network and connection to the existing buildings. - Connecting the buildings to the network.	Partnership between public entities and private companies.
4	IT2	ESCO	Housing association Energy consumers	- Improvement of the building and its energy performance. - Energy generation.	One-third from the public body, while the buildings' owner "ALER- Varese" assigned the remaining two-thirds to an ESCO.	-Buildings envelope thermal insulation. -Air-to-water heat pump per building (PHeating = 31.8 kW - PInput = 9.1 kW - COP = 3.51) for producing DHW. -Installation of PV systems grid-connected.	Regione Lombardia Public Financier ALER Housing association CNP ESCO Co-Financier
5	IT3	Atomised model Specific measures delivered by the supplier	Municipality-public building user	- Reduce energy costs and CO_2 emissions. - Use renewable sources for energy use. - Increase the living quality and adapt the buildings to a contemporary standard of living. - Improve the district image in order to bring a good effect and serve as an identification both locally and for the inhabitants.	Debt: Regione Veneto- user of public buildings.	- Central biomass heating plant (wood chips) to fully meet the thermal needs of users. - Solar heating system to supplement the summer domestic hot water needs of nursing home users. - Maintenance of existing boilers, after appropriate requalification and regulatory adaptation, as an emergency system in case they are needed. - System management.	- Policy actors: Municipality. - Users: housing association and school administration. - Design and consultant company: Studio Centro Sicurezza Ambiente, in charge of design and realization stages.

6	IT4	Atomised model	IUVA- property owner	- Minimize energy consumption and carbon emissions derived from the use of heating and maximize energy savings.	Equity: Kyoto revolving fund Public money (Kyoto fund) and private money, meaning the main role of ENGIE group as Energy Service Company (ESCO).	- Trigeneration plant with natural gas composed of a co-generation group. - A hot water district heating based on 90° C supply temperature that serves the 5 neighbouring buildings.	University IUVA ENGIE group (ESCO)
7	PT1	One-stop-shop	Existing tenants New private owners	- Increase the average area of the housing units. - Improve the liveability of the dwellings (the original dwellings were very small). - Restore consistency and homogeneity to the buildings and exterior spaces.	Public funds for the renovation of a 2-storey building. Investor for new, high-end social housing and private dwellings.	- Adapt the living areas to modern living standards. - Improve indoor comfort. - Renovate outdoor areas such as playgrounds and circulation areas. - Exterior walls insulation. - Roof insulation. - Double glazing windows. - Daylight improvement with bigger windows in the living room. - Energy-efficient heating and cooling systems. - Solar thermal system for DHW.	Domus Social public housing AYTHYA – Investimentos Imobiliários, Lda.
8	PT2	Market intermediation	Homeowners	- Current energy and indoor air quality requirements. - Renovate the entire neighbourhood from an architectural and aesthetic perspective.	70% from national funds (QREN) and the remaining 30% from the municipality of Vila Nova de Gaia.	- Roof insulation and cladding. - Ventilation exhausts. - Exterior wall insulation and GRC cladding. - Windows replacement. - Shading.	The City of Gaia, the municipality energy agency – ENERGAIA Owners Association Residents' association Condominiums association

							Junta de Freguesia de Vilar de Andorinho Vilar de Andorinho Church Gaiaurb-Urbanism and Housing EM CONSTRUCT – University of Porto
9	PT3	Market intermediation	Housing association	- Improve energy and thermal performance while considering the environmental performance of the buildings. - Improve neighbourhood. - Improve the quality of life for tenants.	European funding in the framework of "QREN - Quadro de Referência Estratégico Nacional 2007-2013".	- Thermal insulation (black cork agglomerate) on the envelope. - Replacing the existing single-glazed windows with double-glazing PVC window frames. Solar thermal energy panels installed in the pool and sports complex.	Eco-Bairro GEBALIS: Owner/Decision-maker ARMABB-Tenants Association
10	ES1	One-stop-shop VIS manages, contracts, supervises, and finances the correct design and execution of the renovation work. +Subsidies	Homeowners and HOAs	- Improve their comfort conditions and energy consumption. - Improve district conditions.	The project was partly financed (up to 54%) by different public institutions: - 23% by European Commission. - 25% by Regional Government. - 6% by City Council. In agreement with the regional government, a guarantee fund in the form of soft loans for those persons that could eventually need an additional amount to afford the cost of the	- Retrofitted envelope. - Energy systems replaced with a connection to the district heating. - New biomass (wood chips) district heating network. - Integrated energy management system. - Acquisition of electric vehicles.	Project SmartEnCity Public company VISESA (VIS) as delegate promoter of the retrofitting actions, on behalf of the HOA Vitoria-Gasteiz Municipality Basque Government GIROA VEOLIA LKS KREAN (ESCO and engineering company), design of DH network and boiler room adaptation.

					project. It could cover up to 100% of the cost, taxes included.		
11	ES2	One-stop-shop + ESCO	Homeowners' Associations	- Dwelling improvement (comfort, energy savings, accessibility). - Energy savings and the reduction of heating costs. - Improve the neighbourhood quality.	Public grants and private loans to HOAs. Debt: Buildings' owners Bank (Caja Navarra) + Subsidies and favourable financing opportunities.	Improving the energy efficiency of the building envelopes, district heating boilers and distribution pipes.	Tudela city council-Financial/ regulations facilitator Navarra and European Government-Direct subsidies Building managers Residents: GIROA – district heating
12	SE	One-stop-shop Comprehensive measures	Housing Association	- Thermal comfort in the dwellings. - Increase the value of the area, while maintaining financial sustainability. - Social Engagement. - Discounts on optional renovation.	Financed by public funds, specifically by the EU and LKF (public housing company). Rent only slightly increased.	Window replacement. Roof insulation. South façade insulation. Optional balcony glazing. Renovation of the ventilation system. Electricity production. Improved district heating performance, with additional stations and renewables.	LKF (decision-maker) Lund Municipality, CITyFiED

ANNEX 75

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