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Current Business Model Practices in Energy Master Planning for Regions, Cities and Districts

Matthias Haase and Thaleia Konstantinou

Abstract Roughly 97% of the European Union (EU) building stock is not considered energy efficient, and 75–85% of it will still be in use in 2050 (Artola et al., Boosting building renovation: What potential and value for Europe? 2016). Residential buildings account for around two thirds of final energy consumption in European buildings. The rate at which new buildings either replace the old stock or expand the total stock is about 1% per year. Similarly, the current renovation rate of existing buildings in the EU is about 1–2% of the building stock renovated each year. Renovation strategies on building levels need to be derived from a combination of energy efficiency upgrades to buildings and the use of renewable energy to decarbonize the energy supply, on a district or city scale. IEA EBC Annex 75 subtask D2 focuses on promoting cost-effective building renovation at district level combining energy efficiency and renewable energy systems, by focusing on the business models that can make implementation possible. This paper intends to provide an overview of the business model archetypes that can support the development of district demand and/or supply of energy-efficient building renovations and/or renewable energy solutions by targeting various types of stakeholders. It builds upon existing literature to gain insights into the current distributed energy business model landscape. Further, implementation strategies are identified that focus on a holistic evaluation of the expected energy and CO_2 performance of the site and optimized infrastructure investment pathways.

Keywords Business models · Decarbonization · District scale

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1 Introduction

Renovation strategies on the building level need to be derived from a combination of energy efficiency upgrades to buildings and the use of renewable energy to decarbonize the energy supply, on a district or city scale. To this end, international work was coordinated under the IEA EBC technology platform in Annex75 (IEA Annex 75 2017). The work conducted in the IEA EBC Annex 75 sets out to define a methodology to identify which strategies are most energy-saving and cost-effective when applying both energy efficiency and renewable energy measures (IEA Annex 75 2017). By combining energy efficiency and renewable energy sources, the approach addresses both energy supply and demand in the built environment. In this sense, building retrofitting is an appropriate strategy to reduce demand, while the use of renewable energy aims to decarbonize the energy supply system.

Nevertheless, to apply large-scale renovation strategies and achieve the projected building stock decarbonization, identifying technical solutions is not enough. The renovation rate in Europe remains well below the targeted annual 3% (Artola et al. 2016). Some of the main barriers to renovation have to do with renovation costs and access to finance, as well as complexity, awareness, stakeholder management and fragmentation of the supply chain (BPIE 2011). As a result, business models are relevant to the implementation and acceleration of renovations. Seddon et al. (2004) define a "business model" as the outline of essential details of a firm's value proposition for its various stakeholders, and the activity system the firm uses to create and deliver this value proposition. In other words, a business model is the abstraction of a strategy, focused on the system of activities through which a firm creates economic value [4].

Given the limitations due to available financial resources and the large number of investments needed to transform a city's energy use in buildings, identifying cost-effective strategies and policies is important to accelerate the necessary transition towards low-emission and low-energy districts. Business models are thus relevant to the implementation and acceleration of renovations. A business model also provides a tool to overcome barriers such as split incentives and financial complications in upscaling renovations and combining energy renovation and energy supply. To this end, this paper aims to provide an overview of current business model (BMs) practices both for renovation and energy supply, by organising them into archetypes. Based on this analysis, the study offers an outlook on the characteristics and aspects of BMs that should be considered to combine the BM for renovation and energy supply.

2 Business Models for the Renovation of Buildings and Districts

Business model (BM) archetypes for building renovation are characterized by the way the renovation is managed, the role of the beneficiary/building owner, the involvement of intermediaries and project managers, and the return on renovation savings. This study compiled a catalogue of business models for energy-efficiency renovation by identifying four archetypes that summarize current approaches. The information was gathered by reviewing current literature and is illustrated by examples found in renovation practices and European research projects such as in (Brown 2018; Burger and Luke 2017; Gouldson et al. 2015; Haavik et al. 2014; Karine Laffont-Eloire et al. 2019; Mlecnik et al. 2019; Moschetti and Brattebø 2016; Teece 2010). Table 1 summarizes the characteristics of each archetype, highlighting the barriers they pose to upscaling to district, as well as the opportunities to overcome those barriers.

As in any general classification, there are variants to all the business models so the conceptual separation line from one to another might at times be difficult to define. For example, One-Stop-Shops can also extend their services from construction to post-construction monitoring if requested or can sub-contract the consultancy phase to a trusted company. Moreover, the simplification required to define archetypes needs to be taken into account. However, the archetypes distinctly highlight the difference in the process organization and integration of the solutions and financing.

Energy Performance Contracts (EPC) offered through energy service companies (ESCOs) provide an emerging financing mechanism, which empowers each citizen to shape their own energy efficient home through long term loans tied to energy savings. With the involvement of central or local governments, or even unusual sources like pension funds or healthcare providers, these loans can be made more affordable and attractive. This will help tilt the scales with undecided citizens to start a building energy retrofit.

Despite the advantage of EPC business models for renovations, particularly with regards to reduced or eliminated upfront costs to users, there are challenges that need to be considered (Bertoldi et al. 2021), which are hindering application of the model for housing renovation. The main challenges include performance risk, the high fees charged by ESCOs, and long-contract and old ownership structures (over 20 years, whereas many may be reluctant to sign a contract over 10 years).

For example:

- Long-contract and old ownership structures (over 20 years, whereas many may be reluctant to sign a contract over 10 years).
- Trust, where prices and revenue flows are not transparent.
- Company large initial investment (financing costs).
- Collective contract management.
- Expensive civil work.
- Individualization of systems as a freedom for families.

Table 1 Summary of business model archetypes for building energy retrofits

BM archetype	Value proposition	Financing mechanism	Barriers	Opportunities to overcome barriers
Atomized market	Single measure. Emphasis on energy cost savings	Homeowner pays for entire cost structure, payback through energy savings Access to finance through debt	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	Homeowner pays for entire cost structure, payback through energy savings Access to finance through debt	Relies on individual funding and initiative Additional interface 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 entire cost structure, through own debt Payback through energy savings, potential extra revenue from the sale of self-generated energy One-stop-shop interface is also adequate for equity financing	Lack of awareness for the benefits of integrated services 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, cost savings, comfort and environmental performance	Organizations pay upfront (lenders), charges homeowner with monthly instalments, capture energy savings and potential extra revenue from the sale of self-generated energy	Complex financial structure Long-term loans tied to energy savings	Financially attractive for homeowners Addresses market fragmentation Enables long-term planning

3 Business Models for Energy Supply

Energy supply for buildings relates to the supply of both electric and thermal energy. This section investigates business model archetypes for both the district thermal energy and electricity market. The aim is to identify current practices in business models as well as synergies within business models of energy supply companies, as they are seen in the literature.

There is a large variety of business models for energy supply. Those business models are characterized by different parameters such as the degree of servitization, meaning the range of energy services from basic to more advanced services such as energy management, project design, implementation, maintenance, evaluation and energy and equipment supply, savings guarantees, etc. Other parameters are the financing and ownership structure, the customer role, the decentralization level and the infrastructure it refers to. Four kinds of approaches of business models were identified:

1. Demand response (DR) and energy management systems (EMS).
2. Electrical and thermal storage (ETS).
3. Solar PV businesses (PV).
4. Customer relations and services (CRS).

There were basically six different business model archetypes identified, which can be split into several types and even sub-types. Sub-categories within the three main approaches can be defined as BM archetypes. Table 2 summarizes the types of business models and details their characteristics.

Six distinct themes that outline the value creation drivers for energy supply business models (BMs) were identified as follows:

- District heating BMs are often supported by local authorities due to the large infrastructure that needs to be installed. New generations of DH networks try to lower operating temperatures to increase efficiency and collect waste heat (e.g., from other sources).
- 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 sources, thus they are mostly technology driven BMs, nowadays with a strong predominance for solar PV businesses, (resulting in a pattern category named “Going Green”).
- “Building energy communities” is another pattern category where new organizations based on co-participation form are addressed in the structure element, while the governance element is based on shared resources and governance.
- Lock-in-centred business models refer to the ability of firms to attract, maintain and improve customer and partner associations with the BM.
- Complementarities-centred BMs refer to BMs as having goods bundled together instead of providing each of the goods separately.
- Efficiency-oriented energy BMs are the ones where measures are taken to achieve increased transaction efficiencies.

Table 2 Summary of business model archetypes for energy supply

BM archetype	Approaches explored	Value proposition	Financing mechanism	Barriers	Opportunities to overcome barriers
District heating BM	ETS, CRS	Economies of scale, exploiting various heat sources (including waste heat)	Incomprehensive tariff structure, usually high connection costs, obligations to connect to existing networks	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 Including external costs (CO_2 tax) EPP including other sectors Heat storage opportunities
Going Green models	PV, ETS	Renewable electricity generation from various stakeholders	Energy utilities use renewable energy and extend their value proposition by adding on new renewable energy sources to satisfy customer demand for renewable energy	High investment costs, limited local renewable energy potential, mismatch between demand and supply	Lower operational costs (reflected in Lifecycle costing (LCC)), energy storage
Building energy Communities BMs	PV, ETS	Renewable electricity generated by private investors in a community form	Allows multiple participants to invest in and/or benefit directly from the energy produced from a shared system	Legal restrictions, lack of expert knowledge	Adjusted legal framework (sand pitch), "One-stop-shop" offers

(continued)

Table 2 (continued)

BM archetype	Approaches explored	Value proposition	Financing mechanism	Barriers	Opportunities to overcome barriers
Lock-in oriented business models	CRS	Offer energy functionalities, e.g., provide energy services that reduce energy consumption using more efficient energy systems	Customers pay a fixed price per kWh for direct use of the solar system, immediate reduction in operating costs, a predictable cost of electricity over 20 years and lower investment costs	Based on existing relationships with customers of local authorities, so difficult to attract new customers A more energy-efficient system is fossil fuel based	Obligations Combine Renewable Energy Supply (RES) and energy efficiency (EE)
Complementarities-oriented energy supply business models	DR, ETS	Active grid management of energy (balancing the demand–supply mismatch)	Revenues from actively managing the grid	Costs for grid balancing services are not established Various stakeholders for grid management (consumers, producers, Distribution system operators (DSO), Transmission system operators (TSO)	Establish incentives for grid stability services (IEA EBC Annex82) Add time to the value of energy (summer vs. winter) Convert energy supply to energy-balanced services (incl. storage)
Efficiency-oriented energy business models	CRS, ETS	Economies of scale	Cheaper production through economies of scale, digital services for distribution and sales	Scaling up mechanisms Infancy of digital technologies Slow (and too big?) established market players (with little incentives for change)	Opportunities for new market participants Active change management

4 Combining Business Models

District heating work is not generally part of the renovation business model. Some measures on a building level that comply with district heating, such as low-temperature radiators, are included in building energy efficiency renovation packages. Thus, this creates two almost parallel, business models, one at a household and business level, and the other at a higher system level, where digital platforms aggregate multiple vectors and services on a large grid scale. These two BMs need to be connected in a way where real (also digital) innovation of these business models is combined with renovation BMs. These two BMs ought to be brought together through technical and market means—aggregation and market trading. For example, innovation includes 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 to create and capture social and environmental values, especially for users, through digital innovations.

Local energy markets (as shown in the Community Energy BM) are seen as the most suitable to also integrate renovation-based BMs. Thus, the local demand and supply system can be optimized. Local authorities can help to set up these 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 decarbonizing the built environment. For a successful implementation, it is essential to start with an energy master plan that includes local constraint analysis, political goal setting and setting up alternative solutions.

Typically, energy communities follow the Energy master plan approach by:

- allowing for total life-cycle costs to be minimized, supporting the decarbonization of the energy supply process to end users and increasing the resilience of thermal and power energy supply systems.
- implementing novel and more efficient end-use technologies, Building Energy Management Systems and energy supply solutions, including thermal energy storage, combined heat and power (CHP) plants and reversible heat pumps. Integrating renewable energy sources into distribution grids can help to slow down or even reverse the increase in energy demand, reduce the size of energy generation equipment by shaving peak loads (in particular cooling peaks in warm climates), and make energy systems more resilient to the growing number of different natural and manmade threats and hazards.
- integrated energy systems which act as so-called “virtual batteries”. District heating can be provided by a CHP plant, heat pumps, electric boilers, and thermal energy storage (TES) units. These measures allow for scheduling of equipment operations in response to daily and weekly fluctuations in prices on the electricity market.
- the use of modern state-of-the-art district hot water systems which reduce operating costs; increase overall system efficiency; integrate the use of waste heat

from industry and renewable energy sources, both directly and via heat pumps; and generally improve system resilience (Sharp et al. 2020).
- building configurations that include such improvements as well-insulated building envelopes; efficient Heating, Ventilating, and Air-Conditioning (HVAC) systems with large surface radiant heating and cooling technologies (e.g., floor or ceiling mounted heating and cooling); the use of building core activation that can exploit smaller temperature differences between supply and return water used for heating and cooling, all support the use of district systems with low exergy sources, e.g., ground (geothermal), solar thermal and groundwater, river or lake water, heat from sewer systems, etc. (see also Annex 73, Guidelines for Energy Master Planning).
- sharing in these "energy communities" often a single owner is regulated to form a legal entity with one single point of contact (and decision maker) which allows energy efficiency measures to be made for individual buildings (e.g., building envelope renovation, replacing HVAC equipment and lighting systems with more efficient ones) can be used to reduce community-wide peak demand. When such projects are planned as a part of a holistic Energy Master Plan, they can improve the cost-effectiveness of the plan by improving building environmental conditions, use resources better and enhance system resilience. This approach requires collaboration between all stakeholders and strategic timing of different projects. Local communities with numerous building owners face difficulties with optimally timing building renovations for all community buildings.
- Energy communities have the potential to act as separate Microgrids. In that way they can be used to avoid distribution tariffs since the costs of operating their own low-voltage grid are lower than the distribution tariffs from the utility company. In such cases, even large gas-driven CHP plants located within the community are not connected to the community grid but are rather connected to the utility grid and operated based on market energy prices.

5 Discussion

After looking separately at energy renovation and energy supply business model archetypes, this discussion aims to evaluate the potential to combine building renovation and energy supply business models. For that, we identified stakeholder mapping, the identification of value creation, the combination of customer segments and the main drivers as the key aspects that can contribute to the development of integral business models.

5.1 Stakeholder Mapping

The nature of business model innovations involves broader sets of stakeholders working together, often in newly formed partnerships. 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. Since these business model innovations create new interfaces between users and the grid they also open up opportunities to create new sources of value, such as reducing pressure on electricity networks, price arbitrage, time-shifting consumption etc., but these can be small or intangible. There are often trade-offs between sources of value and how that value is shared. For example, local balancing has the potential to reduce supplier imbalance costs and reduce customer bills, provide an uplift to the generator and increase supplier margins. The key challenges to developing successful business model propositions are balancing innovation, attractiveness, risk, adhering to regulations and meeting decarbonization goals. Many of these business models rely on growing local demand for RES, flexibility and storage services and see the development of value propositions as a step process, first focusing on value propositions which would appeal to a greater group of users, to then develop more innovative services that could be delivered at a later date. When trying to establish new BMs for renovation and energy supply on a district scale, clusters of stakeholders are needed and an innovation eco-system. The traditional view of such ecosystems is that it is a collection of companies situated with some level of proximity, allowing for more collaboration, interaction, development of stronger ties and a natural growth of collaborative strengths within the cluster.

5.2 Value Creation

The market becomes more personalized. Consumer behaviour, attitudes, tastes and needs are critical factors for BMs operating in decentralized systems where multiple roles for 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.

Decarbonization, digitalization and decentralization are interconnected processes and can significantly enhance the diffusion of low-carbon technologies and the ability of certain stakeholders (such as local authorities) to participate and develop innovative business models on multiple scales (from household to system level). For example, the distributed energy resource (DER) market has seen a significant increase over the past decade with increasing focus on integrating DER by both connecting and utilizing their flexibility, which has been made possible through increased digitalization in the energy system. Decentralization, digitalization and decarbonization of energy services are leading to several value creations including opening up 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). Opening up the electricity grid takes many forms, from opening up the low voltage part of the grid to local community energy groups, to Distribution Network Operators providing forecasts of their flexibility needs in different areas 5–8 years ahead. Here, a reduction in energy demand through deep energy renovation can provide new values that energy supply-focused service companies still have to adapt to. Often, the main value propositions are improved comfort, energy use reduction and a reduction in environmental impact. Additional value propositions were related to the improvement of overall living quality and the quality of the district (Rose et al. 2021).

5.3 Combined Customer Segments

This provides possibilities for a combination of energy efficiency (renovation on a building level) and energy supply (decarbonization and exploitation of local RES) by market players that cover all aspects of this ecosystem. This combination of customer segments requires a set of market players that organize themselves in clusters to enhance resource and information flow. This provides the potential for upscaling and replication in districts and energy communities.

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 and Tierno 2019).

The value of an innovation ecosystem lies in access to resources and the flow of information for ecosystem 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 is significant, either indirectly through taxation and industrial policies or directly through national cluster programs and direct funding schemes.

In this view, pre-existing clustering of member companies matters, but there is also a belief that clusters can grow and develop over time, often developing from small, emerging clusters into globally oriented innovation superclusters. For innovation clusters in the building sector, it is important to understand the different business models in the renovation market and energy supply business.

5.4 Main Drivers

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

Energy poverty is central in many political agendas and thus this must be addressed in the energy master planning process. Energy renovation BMs often involve the use of established interfaces and work with incumbent players (i.e., the interface on the micro-grid remains the existing energy supplier). In some instances, these business models can exist entirely separately from the energy system and cover a diverse set of activities, such as energy generation and its onsite use by individual households.

Often these business models are put in place to deliver specific social values such as alleviating fuel poverty and providing better energy comfort. For example, a microgrid local supply business model involved social housing owned and operated by a LA, providing a certain amount of free solar power to vulnerable residents. Business models at this level are usually built on the use of specific technology and are focused on delivering benefits to users and generators. Often, part of the investment comes from public money, either as direct financing or in the form of subsidies to homeowners or other frameworks.

6 Conclusions

Within the framework of IEA EBC Annex 75, which investigates cost-effective strategies to reduce greenhouse gas emissions and energy use in buildings in cities at district level, combining both energy efficiency measures and renewable energy measures, this study presented business model archetypes for renovation and energy supply. The objective was to provide guidance to policymakers and the industry to upscale building renovations and implement renewable energy sources.

The analysis showed that there are different BMs currently in practice. They differ with regard to the degree of "servicization (energy as a service)" process organization and the role of the different stakeholders. There are no specific business models for energy supply applied to the renovation of districts.

Based on these conclusions, we propose to set up (or use existing) innovation clusters, based on these promising BMs to ensure that innovative business environments (innovation clusters) will grow that have the potential to upscale and replicate District Decarbonization Solutions in Energy communities. However, uncertainties on supportive measures for the application of DER make it difficult to develop new business models for utilities. Moreover, innovative business models need to provide additional value propositions beyond energy efficiency, e.g., related to improving the overall living quality and quality of the district, and supporting users by providing a single point of reference, like in the case of one-stop-shops.

As final remarks on business models and financing, we can highlight the role of public bodies, such as regional bodies, municipalities and their affiliated housing associations, in decision-making and financing larger (infrastructure) projects. The role of public figures is also 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 investment costs.

Moreover, the need for comprehensive energy master planning approaches for district-scale renovation became obvious, not only in implementing technical solutions but also in terms of business and financing models, as well as with regard to process management.

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