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CHARACTERISTICS OF BUSINESS MODELS FOR INNOVATION CLUSTERS IN DECARBONATION PROJECTS

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Abstract. Roughly 97 % of the European Union (EU)'s building stock is not considered energy efficient, and 75 to 85 % of it will still be in use in 2050. 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.

The transformation of today's electric power sector to a more sustainable energy production based on renewable energies will change the structure of the industry. In this transformation towards a smart energy system interaction between sectors and technologies the main stakeholders (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.

We chose to characterize these business models by content, structure and governance of transactions for creating value by exploiting business opportunities. In the energy sector the following characteristics to the business models for energy supply have been identified.

The most predominant archetypes of business models for the energy supply are presented and discussed. Further, we propose to 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 Decarbonization Solutions. There are no specific business models for energy supply applied to renovation of districts. Uncertainties in the supportive measures for the application of DER makes it difficult to develop new business models for the utilities.

Keywords: Business models, energy supply, innovation cluster.

1. Introduction

Renovation strategies on building level need to be derived as a combination of energy efficiency upgrades for buildings and the use of renewable energy to decarbonise the energy supply, on district or city scale. To this end, the Annex 75 of the IEA EBC programme sets off to define a methodology to identify which strategies are most energy saving and cost-effective when applying both energy efficiency and renewable energy measures [1]. 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 at decarbonizing the energy supply system.

Nevertheless, to apply the large-scale renovation strategies and achieve the projected building stock decarbonisation, identifying the technical solutions is not enough. The renovation rate in Europe remains well below the targeted annual 3 % [2, 3]. Some of the main barriers to renovation have to do with the renovation cost and access to finance, as well as complexity, awareness, stakeholders' management and fragmentation of the supply chain [4]. As a result, business models are relevant to implementation and acceleration of renovations. Seddon et al. [5] defines "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.

1.1. Energy supply grid

Renovation strategies on district level comprise of energy efficiency measures on building level as well as energy supply measures on the district level.

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 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 district with their needs in terms of electric and thermal energy, however still most of the provided energy

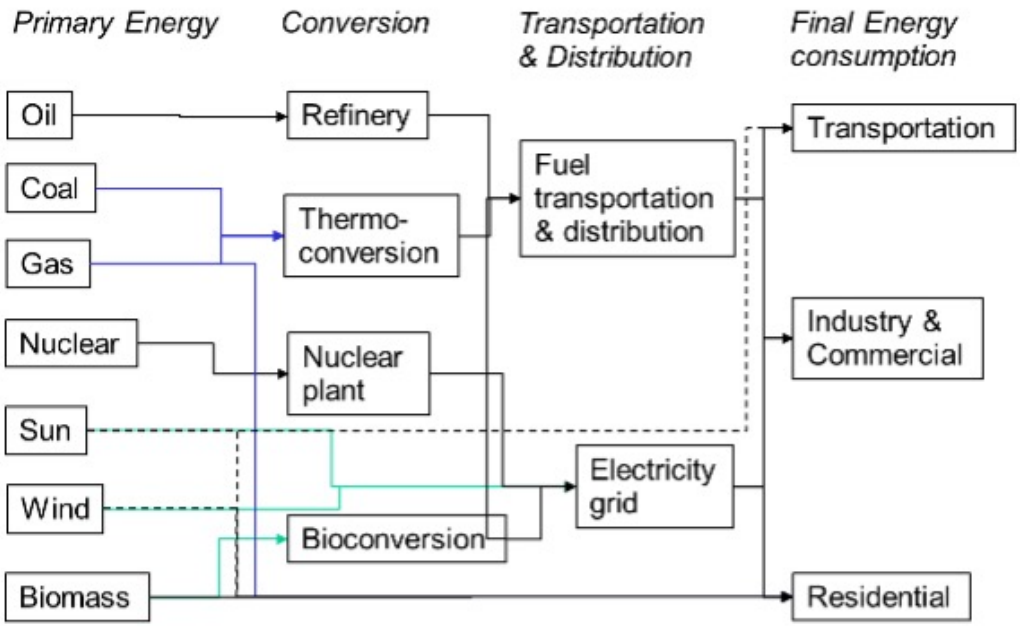

Figure 1. Illustration of energy supply system options (blue: gas, green: renewable: dotted: new connections).

is mostly electric energy.

Electricity supply companies today face a strong decrease in the number of customers. This has to do with new market actors which are operating with new business models centered on renewable energy and energy efficiency technologies. To understand the situation better, it is helpful to acknowledge that electricity supply companies act in an organized electricity market based on different marketplaces. The physical electric energy system encloses the infrastructure (generation, transport, distribution and use together with their components). Thus, the market consists mainly of the following actors [6]:

- Electricity generator: who generates electricity and sell it to the energy suppliers.
- Electricity suppliers who 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), who are responsible for transporting electricity for long distance 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 the consumption.
- Regulators, who set the market rules and oversee the functioning of the market.

1.2. Energy supply value stream

In the EU countries some energy supply companies operate transnationally, however still a large part of the worlds' electric energy supply is either based on fossil fuels like coal, gas, and oil or nuclear energy. The production, transmission and distribution of electricity accounts for the largest share of the world's anthropogenic greenhouse-gas emissions, while the use of emission-free nuclear energy comprises serious security risks and unsolved problems of hazardous waste, therefore the role of renewable energies as the most important instrument to mitigate climate change and reduce negative effects of energy production is increasing. Despite the fact that utilities (with national or transnational activities) still have a dominant position they are confronted with disruptions of their current way of doing business and face the challenge to develop new business models for electricity generation from distributed and highly intermittent renewable sources.

In this sense, the energy supply company changes into a service provider based on the idea of an innovation cluster which can be understood in two ways. The traditional view is that it is a collection of companies situated within some level of proximity, allowing for more collaboration, interaction, development of stronger ties and a natural growth of a collaborative strengths within the cluster.

In our work, these new energy service providers or Innovation clusters acts as ecosystems that create an active flow of information and resources for ideas to transform into reality. Through these ecosystems, a process is started which creates expertise in new areas (here buildings and energy), 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 [7].

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

exists already in some energy supply companies and 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.

For energy supply companies which want to activate value streams in the building sector it is important to understand the different business models.

1.3. Research question

The transformation of today's electric power sector to a more sustainable energy production based on renewable energies will change the structure of the industry [8]. In this transformation towards a smart energy system interaction between sectors and technologies the main stakeholders (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. When looking at the business model literature reveals that there exist basically two possibilities:

(1.) Ownership of renewable energy assets [9].

(2.) Utilities need to develop from commodity providers to energy service providers [10, 11].

According to this idea utilities should evolve to comprehensive energy-solutions providers for residential and commercial customers to create new sources of revenues.

But which characteristics of these new value creation streams exist and which could be extended and developed further?

2. Methodology

New business models are needed that are able to work with energy demand reduction and supply. Literature review was conducted in the Scopus and Science direct database based on the method iterative method proposed by Bocken et al. [12] starting with a cascading keyword search (business model, energy supply, districts, characteristics) resulting in 844 publications. Of these were 69 review articles of which 50 were reviewed to identify prominent schemes. Of the 710 research articles, 241 were doublets and disregarded resulting in a list of 468 research articles. A total of 523 articles were reviewed to identify examples and case studies. A total of 34 in-depth interviews with different stakeholders were conducted between November 2020 and September 2021 with energy experts from the Netherlands, Switzerland, Span, Austria and Germany. This formed the basis for compiling a number of main characteristics of business models for energy supply. We chose to characterize these business models by content, structure and governance of transactions for creating value by exploiting business opportunities. "Content" refers to the performed activities (transactions/exchanges of goods and information), together with the required capabilities and resources. "Structure" describes the links among the activities (transactions) and the participant parties, while "governance" provides information about who performs the activities and where, thus it refers to legal organizational form, incentivizing of participants and the way information, goods and resources flow. The analysis and compilation of the most common business models for energy supply can help to develop their own BM following the BMC (Business models canvas) principle.

3. Results

In the energy sector the following characteristics to the business models for energy supply have been identified that can be characterized by Servitization (energy-as-a-service), Financing and Ownership, Public interest, Customer's role, Decentralization, Energy tariff's structure, Infrastructure, Flexibility, and Management and control.

3.1. Servitization (energy-as-a-service)

The BM have a more service-oriented character, thus the companies are selling the functionality of the product rather than the product energy. The product is thus replaced by a combination of products and services and the notion of the value moves from exchange to application. In the energy transition context, servitization is correlated with energy services and energy efficiency. This means the perception of having a certain percentage cost savings due to the reduction of end-user's energy consumption. The variations of energy services range from additional services such as aggregated information and provision of data analysis to advanced services, such as performance and activity control, depending on servitization intensity. Energy-as-a-service activities include energy planning, project design, implementation, maintenance, management, operation evaluation and equipment supply. In this BM, performance is directly linked to the energy savings achieved where its remuneration includes savings guarantees.

3.2. Financing and Ownership

For the energy supply (mainly of the renewable energy sources (RES)) three main ownership models are predominant: consumer's ownership, collective community ownership and service-based with company ownership [13]. Since RES capacity may have an influence on the grid stability and energy supply security, the value stream is based on the notion that owners may influence grid balance. One emerging BM is the remuneration of these services to increasing or decreasing grid stability. In some BM there is a clear distinction between the customer or/and third-party ownership, where the prosumers or aggregators can choose to contribute (or not) to grid balance activities. This relates to the utility ownership, i.e. the energy supply company has the full authority to manage and maintain the grid and control the renewables production.

Collective community ownership is often considered as a BM where the source of income can be controlled locally. Therefore, financing these kinds of investments are more likely to be accepted within the community, because it helps developing local RES ownership and avoids that value leaks out of the local economy. Financing of RES technologies is a crucial factor for both micro-generation (where the costs are 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 RES technologies (where the large upfront cost is often described as a "barrier that prevents customers from financing RES and hence outsourcing financing to a third-party in order to remove this barrier") [14]. Alternative financing sources for RE investments are the newly emerging energy cooperatives, where the financial risk can be mitigated by local community investment or collectively fundraising for RE through crowdfunding platforms.

3.3. Public interest

The public sector may wish to steer a district energy project towards a variety of specific local objectives [15], 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. Economic modelling helps quantifying these objectives and thus creating additional value by extending standard financial modelling.

3.4. Customer's role

Understanding the different roles of the customer is centrally important to reduce the cost in the energy supply and specifically in the demand side management (DSM) for compensating consumers for their participation in demand response programs [14]. The relationship with customers has been modified since some years, by intensifying customer engagement or by delivering new services, by providing consumption and production related information real-time or by installing enhanced two-way communication channels. The knowledge about consumer's behavior, including attitudes, tastes and needs are critical success factors for the BM operating in decentralized systems. The reason is that multiple roles for the consumers are possible. First, there are active producers and consumers who produce and self-consume green electricity and/or heat simultaneously and alternating (e.g. day/night). Thus, customers act as financial investors in RES and demand user services as light, heat, etc. instead of an energy commodity. This results in interactions with local beneficiaries, project supporters/protestors/activists, and not least with technology hosts.

3.5. Decentralization

Energy systems can be designed on different levels of decentralization. Nowadays, due to the distributed nature of RES and their smaller production capacity a new decentralized energy market has been established. It requires different revenue models than the classical ones of centralized energy production. The associated BMs should provide distributed solutions (e.g. for each consumer separately), thus implying higher costs compared to previously dominating one-size-fits-all solutions. This provokes a strategy shift from big to small, from wholesales to a customer-oriented strategy, from commodity to service, and from long-term energy planning to a more flexible energy planning including further services/infrastructure like e.g. energy storage. In RES dominated energy production, the ownership of the RES and the vicinity between production and consumption sites plays a determining role in the choice of BM.

3.6. Energy tariffs structure

Today, energy company's revenues are typically based on a flexible fee and fixed price per energy. This means that the more energy is consumed the better it is for the utility. This is the reason why the current revenue model creates a incumbrance for utilities to offer incentives for energy efficiency, because thereby energy delivery decreases and revenues reduces. It is often argued that the current revenue model is the greatest obstacle between the current utility structure and a modernized energy delivery system or third-party owned decentralized power generation based on renewable sources [16]. Here, a decoupling of the relationship between sales volume and revenues is needed, a dynamic pricing (see flexibility below) should orientate on the wholesale prices for energy (time-of-use tariffs, off/peak prices, etc.), flatrate tariffs should be coupled to incentives to reduce energy consumption, new const structures would need to be more customer oriented.

3.7. Infrastructure

The infrastructure includes key resources to create a value proposition. 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), key partnership within a network of suppliers and partners to make the BM work. Even co-operations 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, when considering risk return expectations and transactions costs, energy companies will primarily focus on large scale projects.

Archetype	Type
Novelty oriented energy BMs	Going green BM Building energy communities BM
Lock-in oriented business models	BM that offer energy functionalities
Complementarities-oriented energy supply business models	Optimizing grid operations Combining value propositions Acting locally
Efficiency-oriented energy business models	Scaling-up Running platforms

TABLE 1. Summary of business models.

Hence, customer-side renewable energy business models are not expected to advance in scale in the near future [8].

3.8. FLEXIBILITY

Flexibility is the ability of energy supply systems to manage net load variation (and generation outage) with their existent resources. This spans over various time horizons when intermittent RES, such as solar and wind energy are present in the system. Flexibility can be stimulated either from consumption or from generation side by coupling them with timing service. The decentralized electricity and/or heat generation is thus not just developing sources of renewable energy but also finding ways of locally based balancing of production and consumption. Trading of flexibility services are important for reliable energy supply systems, due to their main functions (integration of intermittent resources, congestion management and portfolio optimization) which affect different users.

3.9. MANAGEMENT AND CONTROL

MC indicates the actors that take the responsibility of maintaining and keeping the energy supply hardware in optimal operating conditions. Many factors affect management (consisting of operation, control and governance), among other the proximity of the technology to the consumption's site, the contract, the partnership and the legal form. The management activities are actually optimization activities that improve electricity grid balance and trading service, maintain the co-owned infrastructure and lever the fluctuation of renewable energy production and grid balance.

Table 1 summarizes the types of business models that these Innovation clusters can follow. There were basically four different business model archetypes identified which can be split in several types and even sub-types.

However, there are other objectives that are to be fulfilled as well. Buildings are more commonly seen as micro-energy hubs with energy generated, stored, used and saved in buildings and districts as indicated by BPIE (2016), aiming at [17]:

- Maximising energy efficiency of the buildings.
- Increasing on-site or nearby RES production and self-consumption.
- Encouraging energy storage capacities in buildings (or nearby).
- Incorporating demand-response capacity in the building.
- Decarbonizing the heating and cooling energy for buildings.
- Empowering end users via smart meters and controls.
- Making dynamic price signals available for all consumers.
- Fostering business models aggregating micro-energy hubs.
- (Re)Building smart and interconnected districts (renovate/retrofit).
- Building up infrastructure for further market uptake of electric vehicles.

The most predominant archetypes of business models for the energy supply are presented in Table 1.

- **Novelty**-centered BMs are the ones where new ways of performing the economic transactions have been adopted. Novelty is rooted in one or several activity system design elements and present in different innovation forms. Accounting for the content element, the fossil fuel energy is replaced in these BMs with RES, thus they are mostly technology driven BMs. Nowadays these BM provide a strong predominance in the solar PV businesses, resulting in a pattern category named "Going Green". "Building energy communities" is the second pattern category where new organizations based on co-participation are addressed in the structure element, while the governance element is based on shared resources and governance.
- **Lock-in** centered BMs refer to the ability of the company to attract, maintain and improve customer and partner association with the BM.
- **Complementarities**-centered BMs refer to the BM bundling goods and services together instead of providing each separately and finally

- **Efficiency**-centered BM are the ones where measures are taken to achieve increased transaction efficiencies.

4. Conclusions

The energy sector is undergoing a continuous process of transformation where, together with decentralization and digitalization, a ultimate shift of energy supply towards renewable, CO_2 neutral energies is taking place. The classical structure of the electrical energy industry that emerged after the liberalization of the electricity and gas markets in Europe including established business models, is subject to disruptive and substantial changes.

Business models in the electric power sector have to be seen as interlinked with the regulatory and policy frameworks that characterize the sector. Up to now, the energy system is based on a distribution system which state- or national government-appointed regulatory commissions regulate. This influences also the revenues of electricity distribution companies and thus the viability of distributed renewable energy businesses (DER) in distribution networks are exposed in part to these regulatory frameworks. Correspondingly, 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) in wholesale electricity markets. In addition, the electric power sector is subject of significant national and EU policy support, taking the form of subsidies or favorable rules for a variety of technologies, like e.g. solar-based energy (electricity and heat) generation. On the other hand, new DER business models selling services in wholesale electricity markets must conform to the market rules and regulations established by these authorities. One way out would be to change these market rules and regulations together with authorities and policy makers. Better understanding these regulatory and policy interdependencies is decisive to ensure the sustainable development of these businesses.

- Four different archetypes of BM were identified that ensure a maximum of impact.
- There are no specific business models for energy supply applied to renovation of districts.
- Uncertainties in the supportive measures for the application of DER makes it difficult to develop new business models for the utilities.

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