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Port Renewable Energy Community: An innovative business model canvas

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Abstract

Business Model Canvas (BMC) appears to be a convenient tool that makes business model intuitive and user-friendly while determining how a business creates, delivers, and captures values. Therefore, it represents a useful tool for understanding a company's business model and for conducting business model innovation even for Port Renewable Energy Community (PREC).

However, the BMC model developed by Osterwalder cannot fully capture the business model of PREC, since the latter has different characteristics from other commercial enterprises, so the Canvas needs to be adapted to fully capture the value that PREC can create. Since the BMC is licensed under Creative Commons, new versions of the Canvas based on the characteristic of each business and the understanding of business model can be developed. Regarding the PREC, developing and selecting the right Canvas is crucial in order to properly define its business model. However, in the literature, all the renewable energy community business models are applied to residential context and no study focuses on the port context. The aim of this paper is to provide an innovative business model based on BMC framework useful to design, test, and communicate the benefits of PREC for the port community and the cities where they are located.

Applying the snowball sampling method, relevant studies on the business model canvas of renewable energy communities and social enterprises is collected on Scopus Elsevier in order to understand the characteristics of these business models and to evaluate adaptations of the canvas for defining the PREC BMC. The result shows that for the PREC business model, five blocks need to be added to the nine blocks of the BMC proposed by Osterwalder and Pigneur, for a total of 14 blocks. These five additional blocks include "Vision", "Problem and Solution", "Impact Measurement", "Non-targeted Stakeholders" and "Unfair Advantages".

1. Introduction

The concept of business model (BM) is confused in the literature, as there is not a common agreement on its definition. However, according to Zott et al. (2011), emerging common themes, which could serve as basis to build a more unified study of business models exist among scholars' conception of business models: i) business models represent a new unit of analysis; ii) business models are considered as a holistic approach which explains how firms "do business"; iii) firm activities play an important role in the various conceptualizations of business models that have been proposed; and iv) business models aim to explain how firms create and capture value.

Caroli, (2021) goes further, arguing that the business model synthesizes a set of characteristic aspects of the enterprise which, when they are conducive to appropriate sustainable development, tend not to be changed. However, there exist several situations where the business model needs to be innovated: when some changes occur in the market (market-based drivers) and through regulatory and normative impetus (regulatory-based drivers). The market-based drivers of business model innovation include the introduction of new technologies, which can make current ways of generating value obsolete and creates the conditions for new, more effective or efficient business models, and the evolution of key consumer characteristics (e.g. Consumer needs and consumption patterns). In addition, a company may also be forced to modify its business model in response to innovations introduced by competitors, who may be quicker to respond to changes in technology or in the competitive environment. Besides changes in the market, new conditions in the broader environment, starting with the regulatory and normative system relevant to the business, may lead to business model innovation.

The business model innovation in the energy market has been guided by these two drivers: the market and regulatory changes. The market changes in the energy market increase the interest on energy business model first, and the introduction and change of the regulatory framework increase the interest on energy community business model ECBM. Indeed, for long-time energy systems were centralized, the energy market was closed, and the energy service were provided in a monopolistic perspective. In this vein, prior to the liberalization of the energy market, limited attention was paid to energy business model since the monopolistic utilities' value proposition was based on providing an undifferentiated commodity to a large customer segment (Reis et al., 2021). However, changes in the energy market such as market unbundling alongside with the increase of renewable-based decentralized generation have forced changes on the classical utilities BM. This situation opened the room for new energy business model to emerge by giving the possibility to smaller energy retailers to develop and offer innovative electricity supply services (Specht et al. 2019; Bryant et al. 2018). These energy business models tend to be primarily service-oriented, where different types of services are provided including electricity supply, energy management, energy efficiency services. In this vein, utility companies and small energy retailers strive to offer competitive and customized energy solutions increasingly focused on decentralized renewable energy generation and consumption (Hamwi & Lizarralde, 2017).

Moreover, the increasing integration of renewable generation in the energy system is forcing the transformation of the traditional energy production structure into an increasingly distributed structure. In this perspective, to maintain a continuous service, it is necessary to increase the flexibility of the system. According to López et al. (2024) RECs represent a viable solution for increasing flexibility of energy systems through the development of active demand management, generation control and energy storage systems. They claim that RECs will help to restructure the energy system and transform it into a decentralized, sustainable, flexible and efficient system with a very low environmental footprint. In this vein, several EC projects has been launched around Europe. Germany leads the ranking with around 1750 EC projects, then follow Denmark with 700 EC projects, Netherlands with 500 EC projects, United Kingdom with 431 EC projects and Sweden 270 EC projects (López et al. 2024). But these projects were developed following a different regulatory framework. In general, the absence of a regulatory framework and/or its insufficient development for long time have been a major obstacle to the proliferation of REC. As a result, a general regulatory framework was needed to give confidence to possible investors, to simplify the administrative procedures, to reduce risk or investor perception, to increase the public interest, to increase the motivation of community members (López et al. 2024). For these reasons, the European Commission introduced the RED II 2018/2001 and Internal Energy Market Directive (IEMD 2019/944) for regulating the REC in Europe. Thanks to the impulsion given by these Directives, RECs are making their way in Europe, although there is still a long way to go. The enabling framework promoted by these directives is expected to boost the creation of innovative business models and attract private and public investments, giving the opportunity to energy communities to diversify their revenue streams through the supply of new energy services in addition to local energy generation (Reis et al., 2021).

However, the definition of REC provided by the EU Commission in the RED II, seems ambiguous, with regards to both the conceptual framework and the concrete implementation tools available for the EU Member States, bringing the risk of missing the sustainable community development and energy democracy goals targeted. Therefore, there is a need a solution able to customize the broad definitions of REC provided by RED II to specific contexts (through the definition of the actors, the legal structure, the activities, the resources, etc.) and motivations (by identifying the main beneficiaries of the project and the functioning). A specific context for REC application is the port domain. Indeed, for carrying out their activities, ports consume a lot of energy, thus generating harmful emissions which negatively impact the environment. To reduce their negative spillovers, ports are urged to start at least partially to produce the consumed energy grounding on renewable energy sources and to progressively turn into innovative energy hub. In this way, they should lay the foundations for becoming a renewable energy community and position themselves as pioneers in the energy transition process. Specifically, given the importance of ports in the local economy where they are located (Cong et al., 2020; Coto-Millán et al., 2010), they are called upon to play a leading role in the energy transition, favouring the cluster's consumption of green energy. They are expected to play a more strategic role within the respective regional energy systems, acting as energy generation and distribution platforms. So as RECs, ports could contribute to the transformation of the energy landscape by empowering consumers and contributing to energy and climate targets in terms of demand for renewable energy and emissions reductions. PRECs can also play a key role in supporting local economy growth and job creation and can foster a collaborative social transformation through the engagement of local communities to pursue common goals such as energy costs reduction and energy self-sufficiency.

Despite all the potential benefits of PREC, in the literature, all the renewable energy community business models identified are applied to residential context and no study focuses on the port context. Considering the existing gap in the literature, this paper endeavours to address the following research questions:

- Which business model is suitable for PREC?
- How the BMC can be applied to PREC to help visualise the development of its business model?

The paper makes a significant contribution to the academic field of management by presenting an innovative business model useful to design, test, and communicate the benefits of PREC to the port community and the cities where they are located. In addition, the paper offers insights for port decision-makers, providing them with a BMC framework for PREC, useful for potential application to a practical case.

The paper is structured as follows. The theoretical foundation is presented in Section 2. Section 3 describes the snowball sampling method applied in this paper to develop a PREC business model, Section 4 presents the main findings regarding the typology of the business model that can be adapted to PREC. Section 5 discusses the implications for practice and future research directions. Finally, the conclusions are drawn in section 6.

2. Theoretical foundations: Literature review

The implementation of REC implies moving away from the centralized energy system towards decentralized systems based on renewable sources. In this regard, new activities are expected to be created and new actors are expected to emerge within the energy sector. Consequently, new business models based on the different activities and relationships between traditional and new actors are needed. Several decentralized energy system business models applicable to REC emerged in the literature. These business models include the prosumerism business model, Public private partnership business model, third party business model.

2.1. Prosumerism business model

Prosumerism business model, also known as customer-side business model (Reis et al. 2021), customer-owned product-centered (Hamwi & Lizarralde., 2017), plug and play (Provance et al., 2011), host-owned (Strupeit & Palm 2016) or customer-owned PV (Huijben & Verbong 2013) refers to a complete user ownership, in which customers finance and own the REC project by investing in energy generation and storage technologies in order to benefit from self-consumption, energy bill reductions and emission reduction. The end users become prosumers and take advantage of demand side management (DSM) programs.

Regarding the modality of the renewable energy trading, two modes can be used: the "*all sold to the grid*" mode where the entire energy generated is injected into the grid and the "*self-consumption with surplus sold to the grid*" mode characterized by the self-consumption and only the energy surplus of the produced energy is injected into the grid (Hamwi & Lizarralde., 2017). In this architecture, power purchase agreements (PPA) are established with energy buyers (e.g., national grid operator, energy retailers), which buy renewable energy surplus and remunerate the prosumers through feed-in-tariffs. This business model can also be used by the end user with the aim to take advantage of demand flexibility, which consists of shifting energy demand from peak hours to other periods in response to price signals. In this case end-users invest in DSM enabling devices such as sensors, smart meters, monitoring devices (Behrangrad, 2015).

However, this architecture is subject to several constraints including i) Financial constraints: prosumerism business models are characterized by high investment costs and long-term payback periods (Reis et al., 2021). Accordingly, the prosumers (e.g., homeowners, SMEs) are expected to have the necessary financial standing or at least have the capability to access financing sources including bank loans or incentive programs. ii) structural constraints: in addition of the financial constraints, the prosumers must demonstrate to have the needed conditions to install onsite energy generation systems (e.g. sufficient land or available rooftop area for the installation of solar panels). To take full advantages from this business model, prosumers need to be flexible in their demand for energy to take benefits from DSM programs.

This architecture is the most self-sufficient as the prosumers finance and own the project, but the design and construction of the installation are outsourced to key partners (e.g. technology providers, energy suppliers, distribution system operators). In this perspective, the direct communication underpins the relationship between prosumers and "key partners". Salesmen, client support platforms and technical staff are at the disposal of prosumer and provide them with information on new products, offerings, solve technical and prosumers' issues and propose new tailored solutions and (Reis et al., 2021). The "key activities" of the prosumer business model include local energy generation, self-consumption and energy selling and if the end users aim to take advantage of demand flexibility, the key activities also include the changing consumption patterns. The "value proposition" of prosumer consist of reduction of energy costs through self-production and self-consuming, selling of energy to the national grid and benefits from participation in DR programs. The "cost structure" include investment costs (e.g. assets purchase, installation and grid interconnection costs), reparation and maintenance costs. If the end users also aim to take advantage of demand flexibility, the cost structure also includes the costs of the DSM enabling devices such as sensors, smart meters, monitoring devices. Regarding the “revenues streams”, prosumers are expected to return their investments by selling their surplus generated electricity and reducing their electricity bill.

2.2. Public private partnership business model

Also known as hybrid business model (López et al., 2024), in this business model, the ownership is shared between energy consumers (private) and another entity (usually public). As in the prosumer business model, the design and construction of the EC are outsourced. The main aim is to make the energy supply in the community where the project is implemented greener, healthier, and more affordable. In this vein, the “cost structure” include investment costs (e.g. assets purchase, installation and grid interconnection costs), and reparation and maintenance costs. Regarding the “revenues streams”, energy consumers are expected to reduce their electricity bill. If any, the energy surplus generated is not expected to be sold. As such, the “value proposition” of energy consumers consists of reducing the energy costs through self-production and self-consuming. In this architecture, the financial constraints are either nil or drastically reduced sine part or the entire financing is provided by the local authorities. The technical constraints persist and can be reduced by promoting the EC project only in region where there are not these technical constraints. This may be possible through the mapping of these areas upstream by the local authority. In this business model, three different organizational structures can be addressed (Greenpeace, 2019):

- Local authorities as funder and administrative facilitators. The local authorities bring funds partly or totally for the development of the EC. The authorities can provide funds to some institutions such as schools, community centers and industrial estates for solar panel installation, or can support other community energy groups such as cooperatives, social enterprises, community interest companies, tenants’ and residents’ associations, who are committed to helping their community make the transition to clean energy. The technical and operational components of the EC are not managed by the local authority but by the EC consumers.
- Local authorities as project facilitators. In this structure, the local authorities associate themselves with cooperatives, and encourage the creation of new ECs by providing them with everything they need. Local authorities aim is to ensure effective problem solving and decision making throughout the implementation life cycle of the EC project.
- Local authorities as infrastructure managers. The local authorities bring funds partly or totally for the development of ECs, and are responsible for the management of both technical and operational components of the EC.

2.3. Third party business model

In the third-party business model, also known as top-down business model (López et al., 2024), third-party service centered business model (Hamwi & Lizarralde., 2017), third party-owned business model (Cai et al., 2019) or utility-side business model (Hamwi & Lizarralde 2019), ownership belong to a third party, which can be utilities. End users bear no financial risk, which is fully supported by the third-party company. The third-party company holds full control of the assets, and their value proposition is the creation of high-value energy services and remuneration streams (Reis et al., 2021). Typically, the third-party company that fully finances these business models owns several small-scale energy production units located remotely from each other and operates them as virtual power plants, centralizing the management of their energy resources (Brown et al., 2019).

The third-party company can also act as a local white-label supplier (Hamwi & Lizarralde., 2017; Hall & Roelich., 2015), by not taking the entire financial risk directly, but establishing a partnership with licensed energy suppliers in order to supply energy to consumers with its own brand identity.

As in the Prosumerism business model, the value proposition of third-party business model can also be to provide DSM-based services acting like energy aggregator. As aggregator the third-party company negotiates with producers of an energy service such as electricity on behalf of groups of consumers. Its main goal is to aggregate energy customers’ demand flexibility and sell it to a system operator (Reis et al., 2021). Costumers sign agreement with the third-party company, in which they commit to provide a pre-determined amount of energy. This energy is then sold to the system operators in reserve, balancing and ancillary markets.

Lastly, third-party company can also act as Energy Service Company (ESCO) by proving energy efficiency services such as energy audits, space heating, and lighting (Reis et al., 2021). As ESCO, the third-party company can operate under energy supply contract or energy performance contract (Hamwi & Lizarralde., 2017; Cai et al., 2016). Under the energy supply contract, the third-party company commits to meet the final energy demand of customers by providing services as electricity, heat or steam and is remunerated thank to the useful energy output delivered. In the energy performance contract instead, the third-party company implements energy efficiency projects and is compensated by the income stream from customer savings. In this contract, the greater the energy savings for customers, the greater the benefits for the third-party company.

The “key partners” are technology providers including energy production technologies such as PV, energy storage technologies, manufacturers and sellers of efficient appliances, smart metering and ICT-based devices for energy management, technical staff and power system entities such as distribution system operator, transmission system operator. These key partners are involved in the ‘key activities’ such as energy supply, energy efficiency activities as well as demand flexibility aggregation services. The relationships with key partners are based on direct communication channels with customer support services, technical staff. Marketing campaigns, face-to-face meetings are also used for communication. According to Cai et al., (2019), the revenues streams of this business model is based on long-term contracts such as power purchase agreements or leasing contracts, established between customers and the third-party company. Such a contract guarantees competitive and stable prices and conditions throughout the project. The key resources are typically financial and technical, and the cost structure includes investment costs (e.g. assets purchase, installation and grid interconnection costs), and reparation and maintenance costs. If the third-party company internally develops its own technology, the cost structure also includes the costs of research, design, development and assembling of technologies. In addition, costs related to market analysis, marketing strategies and the use of distribution networks, could be included in the cost structure.

2.4. REC Business model analysis according to RED II

The REC, well known as EC, takes its roots in collective energy projects. The term REC has been legally introduced in Europe by the RED II directive and several components of its business model is included in the directive. For the RED II, the primary purpose the REC business model is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits. The community members take all or part of the financial risks and the whole BM must be created by, for and with them (Mourik et al., 2020). Given the capital-intensive nature of the investments, the community members of REC are expected to have the necessary financial standing to participate in the REC. They can rely on external financing sources including bank loans or incentive programs. However, community members are strongly involved in decision making process including the design, implementation and operation of the REC. As a results, they influence the value creation process and share the risks and costs related to the REC (Yildiz 2014; Mourik et al., 2020). Therefore, from the investment and assets ownership perspective, REC business model can be assimilated to the prosumer business model and/or the third-party business model, since both are possible (Reis et al., 2021).

According to Bauwens (2019), the financial profit doesn’t constitute the main objective of the REC business model, but the return on investment represents one of the most important determinants for community shareholders to enroll REC projects. In this vein, the value proposition of the REC business model is partly based on the return on investment of the shareholders that is ensured by cheaper energy supply, energy surplus selling or participation shares, self-energy consumption and reduction of dependency from the national grid (Tounquet et al., 2019; CEER, 2019). Another key determinant of the value proposition are the environmental benefits emerged from the use of renewable energy, the ability of members to choose the right technologies for energy generation, the positive social impact such as energy poverty reduction, job creation, the increase in the welfare of the population created by the REC implementation (Koirala et al. 2016). The key activities indicated by the RED II includes local energy generation, supply, storage, consumption, trading, aggregation, e-mobility, system management and energy related services.

The success of the REC relies on several key resources, including: i) the structural resources, which consists of the availability of sufficient area for implementing energy generation and storage facilities. ii) the financial resources for the implementation and the management of the REC project; iii) the members, which bring social and financial value to the project; iv) the technical know-how; v) enabling regulatory frameworks as well as the availability of incentives and subsidies for renewable energy producers, and DSM programs. The RED II also indicates part of the key partners i.e., shareholders or members including households, SMEs and public entities. The other keys partners are technology suppliers, external investors, DSO, energy suppliers and other power system entities (as aggregators).

As the REC is controlled by shareholders or members which are both customers and business developers, the customer relationship and the communication channels are expected to be personal and direct as they invest their money and hold share of the REC (Reis et al., 2021). The costs structure of these business model includes the investment costs such as the feasibility costs (both economic and technical), the cost related to planning and licensing, the material structural cost (i.e. the capital costs of building and installing generation, storage, management and distribution assets), the maintenance cost, the operating costs (e.g., the cost related to the use of the network) and the other costs related to the REC.

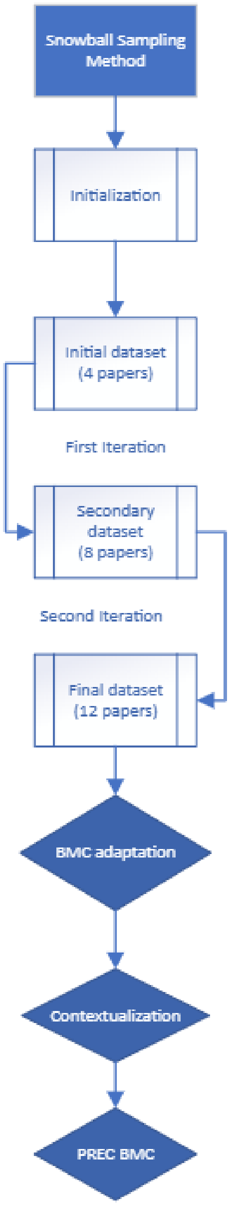
According to RED II, participation in RECs is autonomous, open and voluntary; anyone wishing to participate in a REC may purchase and hold shares in the REC. This purchasing of REC share is part of the revenue stream. According to Hunkin & Krell. (2018) the shareholding mechanisms allow RECs to be flexible to the entry and exit of members, without compromising the participation of the remaining ones. The energy surplus selling, renewables power purchase agreement, subsidies and incentives also constitute the REC revenue streams.

3. Methodology

The paper provides an innovative business model based on business model canvas (BMC) framework applicable to ports. The framework is based on the prominent literatures on energy community business model, following the RED II directive.

A qualitative research method is applied, for collecting and analysing qualitative data. In particular, the snowball sampling (Figure 1) is used to collect prominent studies on Scopus Elsevier (Biernacki & Waldorf, 1981). This method generally uses smaller data sets that are sufficient enough to reach reliable results, where the data collection continues until saturation is reached. It represents conceptual research, as it aims to develop new concepts or interpreting existing concepts. It includes historical research, theory development, literature reviews, and critical analysis and can be used to establish concepts in an area (Håkansson, 2013).

Figure 1: Snowball Sampling Method applied to PREC



Source: Authors' elaboration

The initialization phase consists of analysing the BM of decentralized energy systems existing in the literature (i.e. prosumerism business model, Public private partnership business model, third party business model), the identification of businesses that have similarities with REC (i.e. Energy community and social enterprise), and the application of the BMC to these businesses.

By using keywords as "business model" and "energy community"; "business model" and "social enterprise", a prior literature reviews about EC BMC, and social enterprise BMC is performed. The initial sample consists of four papers: Two related to EC BMC (Kubli & Puranik 2023; Reis et al., 2021) and two related to social enterprise BMC (Sparviero, 2019; Qastharin, 2016). These papers were consulted and used as initial sample of papers. We included the social enterprises in the sample because they have the same goals as REC, which is not only to generate the profit but above all to achieve social and environmental.

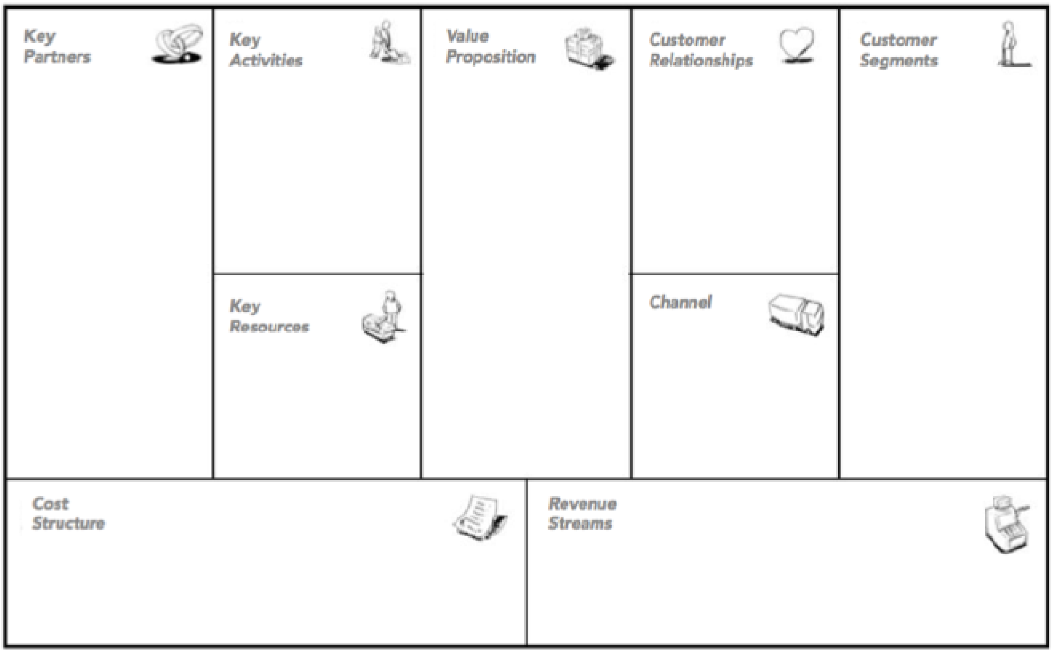
Subsequently, we looked at the references cited in those papers to identify essential contributions; then, we looked at the references in the new ones to recognise even more significant papers addressing REC BMC and social enterprise BMC. This process was repeated until we thoroughly selected the most relevant papers for our research objective. As this paper apply a qualitative method, the qualitative data for this paper is the available Business Model Canvas adaptations for REC and social enterprise.

Successively, we conducted a comprehensive examination of the BMC adaptation for REC and social enterprise business proposed in the selected sample papers to identify the most valuable elements for constructing a novel and original BMC for PREC. In this perspective, four questions were considered to guide and frame the research based on the BMC (Osterwalder & Pigneur 2010) and the morphological box (Kubli & Puranik 2023): 1) who are the relevant stakeholders of the PREC and what are their needs? 2) what are the key activities to be performed to meet their energy needs? 3) what is the value proposition? 4) what are the key resources to be combined to offer the value proposition? At what costs and with what revenue stream?

Application of BMC for the definition of the PREC business model

Osterwalder & Pigneur (2010), in defining the business model, they distinguished themselves among others by offering not only the definition and components of the business model, but they also provided a visualisation of the model itself. They claim that the Business Model Canvas allows business model to be simple, relevant and intuitively understandable, while not oversimplifying the complexities related to the functioning of an enterprise (Osterwalder & Pigneur, 2010 p.15). Given the above, the business canvas (Figure 2) is considered as a shared language and a useful tool for stakeholders to talk about business model (Reis et al., 2021; Qastharin, 2016).

Figure 2: Business Model Canvas



Source: Osterwalder & Pigneur (2010)

Despite the flexibility and strengths of this approach, BMC brings some limitations: i) there is not a strong representation of relationships among businesses elements, as a result it overlooks strategic dimensions such as competitive position (Lima & Baudier, 2017; Euchner and Ganguly., 2014); ii) few details are presented because of the canvas-structured model, which hinders creativity and the disclosure of other dimensions of the business (Fritscher & Pigneur, 2009); iii) BMC lacks a section to define vision statement or goals and ambitions of a project or company; iv) the BMC only takes into account the economic dimension of profit, i.e. revenues minus costs, whereas there are several other dimensions to be taken into account. For example, in addition to economic impacts, environmental and socio-economic impacts should also be taken into account; v) the BMC allows assumptions within the business model but doesn’t offer a clear way to verify them. A good strategy should include these elements. However, these weaknesses do not seem to affect the growing application of the BMC, which remains the most widely used approach for business description (Reis et al., 2021). Therefore, it will be used in the scope of this work. Taking into account the criticisms of BMC, we don’t focus only on the BMC as proposed by Osterwalder & Pigneur (2010), but we used its adaptation (e.g. lean canvas) applied to the REC and social enterprise context to assess and compare their BM in order to propose a BMC applicable to ports. The choice of canvas adaptations to be examined in more detail are based on the recognisability and accessibility of the adaptations in the literature. Recognizability is determined by the facility with which the adaptation based on Osterwalder's framework is recognized. We assessed whether the building blocks are arranged in a canvas and whether the blocks are more than 50% similar in title and meaning to the Osterwalder canvas. Accessibility is defined by the ease of which the adaptation is accessed by using search engine. Using inductive approach, theories and propositions with alternative explanations are formulated from observations and patterns found in the collected data.

4. Results/Findings

Table 1 shows the relevant papers that address an adaptation of business model canvas that we retain useful for the scope of this study. We identified 12 papers that address the BMC distinguishing from energy community BMC (7 papers) and social enterprise BMC (5 papers).

Reis et al. (2021) propose a review of business models for energy communities by analysing community projects across Europe. They found a dominance of traditional self-consumption place-based communities business model, while business models dealing with ancillary energy services such as demand flexibility, energy aggregation, energy efficiency and electric mobility are still scarce. In addition, they identified eight community business model archetypes based on the European regulatory framework. Successively, they used BMC and the Lean Canvas frameworks to characterize and compare these archetypes. The authors used the BMC for describing and comparing the key dimensions of EC BM emerged from the literature. The Lean Canvas is used as a solution to overcome the BMC limitations in order to identify the market challenges and the proposed solutions offered by the 8 BM archetypes. By combining both BM frameworks, they provided a thorough set of boxes and tasks that help for the visualization and conceptualization of the BM, shedding light on their main strengths and weaknesses, which could facilitate the analysis for decision-makers and EC promoters.

Table 1: Business Model Canvas Adaptations for EC and Social Enterprises comparisons

Authors	Key partners	Key activties	Key resources	Value propostion	Customer relationships	Channels	Customer segments	Cost structure	Revenue streams	Additional blocks
Reis et al., (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Problem and solution Key metrics Competitive advantage
Qastharin, A. R. (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Mission Impact and Measurement
Sparviero, S. (2019).		Yes	Yes	Yes (Social value proposition)		Yes	Yes (costumers and beneficiaries)	Yes	Yes (Income)	Governance Non-targeted stakeholders Costumer and Beneficiaries engagement Mission values Objectives Impact measures Output measures
Abdu, S. (2024).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Dobrowolski, Z., & Sułkowski, Ł. (2021).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Mission Impact and accountability
Iazzolino et al., (2022).	Yes	Yes	Yes	Yes (offered value)	Yes	Yes	Yes	Yes	Yes	
Kubli & Puranik (2023).	Yes	Yes (Key functions)		Yes			Yes (Energy community members)		Yes (Energy value capture)	Network effects
Horváth, & Szabó (2018).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Problem and solution Key metrics Unfair advantage
Bryant et al. (2018).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Herbes et al., (2017).	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Yeoman & Moskovitz (2013)		Yes (solution)		Yes		Yes	Yes	Yes	Yes (Financial sustainability)	Unfair advantage Key metrics Problem existing activities
Graves, T. (2011)	Yes	Yes	Yes	Yes	Yes (Relations)	Yes	Yes (Co-creators)	Yes (value stream)	Yes (Value stream return)	

Source: Authors' elaboration

In the combined framework, in addition to the BMC blocks, they introduce the Lean Canvas blocks. The structure of Lean Canvas is based on the BMC which replaces some of its blocks. The Lean Canvas replaces the BMC "key partners" by the "problem" block. The aim of this block is to clearly identify the customers' problems which justify the need for a new product, service. After understanding the problem, the "solution" block is provided by the Lean Canvas. This block aims to propose solutions to the identified problems, and it replaces the BMC "key activities" block. Successively, a block entitled "key metrics" made up of a dashboard of observable KPIs is introduced. These KPIs aim to keep a record of the most important operation elements, that allow to evaluate the BM performance. The Lean Canvas also includes an "unfair advantage" block (or 'competitive advantage' block). This block aims to identify the barriers (e.g. financial and profitability barriers, institutional and policy barrier, technical barriers) that can hinder potential competing companies from entering the market. Finally, in the Lean Canvas, the “key resources” as well as “customer relationships” blocks are removed as they are indirectly presented in the ‘key metrics’, ‘unfair advantage’ and ‘channels’ blocks (Horváth & Szabó 2018). The value proposition become Unique value proposition.

Horváth & Szabó (2018) instead address the barriers that may obstacle the deployment of distributed energy solutions. They used a literature review to identify the main inhibiting factors. In order to identify how to address the obstacles to the deployment of distributed energy they investigated the evolution of photovoltaic business models. Applying the Lean Canvas, they showed the principal differences between analysed models (i.e. the community shared model, host-owned and third party-owned solutions) and describe the benefits of these models. Then, using Osterwalder and Pigneur's business model definition, they summarized the most important value propositions, value creation, delivery and capture mechanisms of each business model. Energy bills reduction appears to be common to all three models, even if the saving level may be different for each. They claim that the community-owned model represents the model with the highest benefits which are principally based on the possible economies of scale that may result. In order to overcome regulatory and institutional issues that can hinder the deployment of distributed energy, they claim that policymakers have to develop extensive regulatory and incentive schemes that provide multiple options for fostering the spread of renewable energy sources. Indeed, financing mechanisms and innovative business models tailored to local or regional context could deeply increase the use of renewables.

Kubli & Puranik (2023) propose a morphological analysis of 90 energy communities and pioneering companies that apply business model design options that can be adopted in energy communities. They identified 25 emerging business model design options applicable to energy communities. These options can be used by users to configure tailor-made business models for energy communities. The morphological box that is not a complete business model, represent an instrument for supporting community facilitators and promoters in the development process. It works as a toolbox to configure an energy community business model based on design option. Table 2 provides the five dimensions of energy community business model developed by Kubli & Puranik (2023).

Table 2: Morphological box for energy community business models.

Business model dimension	**Energy community design options**					
Community value proposition	Generating renewable energy	Increasing self-consumption	Increasing grid reliability	Reducing energy consumption	Reducing energy costs	Becoming a living lab
Energy community members	Residential prosumers	Large-scale prosumers	Local energy producer	Energy service company	Community platform operator	
Energy value capture	Revenues from energy services	Saving energy costs	Revenue from external services	Community service fee	Data valorization	
Key functions	Facilitating P2P trading	Aggregating energy and flexibility	Managing storage systems	Co-optimizing energies	Coordinating partners	
Network effects	Peer effects & creating a community feeling	Economies of scale and scope	Learning effects	Co-benefits and co-amortization of investments		

Source: Kubli & Puranik (2023)

The value proposition dimension represents the scope behind the development of an energy community. This scope can include reducing energy consumption, reducing energy costs, generating renewable energy, ect. The dimension members of energy community identifies the keys actors of EC including the prosumers, consumers, and service providers as well as their role.

The dimension energy community capture value refers to the ability of energy community member to capture value for profit-making. The key functions dimension shows how the energy community members create and deliver value. Finally, the network effects dimension represents the value or utility that community members can gain from increasing the number of community members. These effects include the peer effects and community feeling creation, economy of scale and scope, learning effects, and co-benefits and amortization of shared investments.

Qastharin, (2015) proposes a BMC for social enterprise. The author evaluates the Canvas adaptations for understanding the definitions and characteristics of business model, business model canvas, and social enterprise in order to design an appropriate BMC for social enterprise. Then a new BMC for social enterprise by combining other Canvas adaptations is provided. The author added two key blocks (i.e. "mission" and "impact and measurement") to the BMC proposed by Osterwalder and Pigneur. The author claims that the business model of social enterprise is mission-focused and impact-driven since their whole business model is based on the social/environmental mission and the success on the social/environmental impact to be achieved. The "Mission" block defines the purpose of the social enterprise. Specifically, this block defines the problem, the customer, the method and the impact in a single clear sentence which will represent the guidance for the enterprise. The "Impact and Measurements" block instead describes the benefits for the social enterprise's customers along with the indicators for measuring the success and progress of the social enterprise. The author also provides a different sequence of the social enterprise's building blocks. This sequence starts from Mission block, then proceeds as suggested by Osterwalder to Customer Segments, and ends with Impact and Measurements after Cost Structure.

Sparviero, (2019) introduces a BMC for social enterprise builds for designing the organizational settings of social enterprises, for resolving the mission measurement paradox, and for meeting challenges related to the strategy, legitimacy and governance. The author performs a literature review of the BMC from multiple disciplines and fields and applied the result to a case study. To build the BMC for social enterprise the author put emphasis on social value and building blocks that take into account several blocks including non-targeted stakeholders, principles of governance, the involvement of customers and targeted beneficiaries, mission values, short-term objectives, impact and output measures.

Table 3 shows the BMC for social enterprises composed of 14 building blocks proposed by Sparviero, (2019). Four of them are exactly the same as the BMC proposed by Osterwalder & Pigneur and contain the same type of information; five of them correspond to the remaining building blocks of the BMC but have been redefined to fit the analysis and terminology of social enterprise, and finally, five building blocks are new and specific to the analysis of social enterprise.

Table 3: The Social Enterprise Model Canvas

<table>
<tr><td colspan="6">Governance (GOV)</td></tr>
<tr><td rowspan="2">Non-Targeted Stakeholders (NtS)</td><td colspan="2">Key Resources (KR)</td><td colspan="2">Channels (CH)</td><td rowspan="2">Customers & Beneficiaries (C & B)</td></tr>
<tr><td colspan="2">Key Activities (KA)</td><td colspan="2">Customer & Beneficiaries Engagement (C&B E)</td></tr>
<tr><td colspan="2">Mission Values (MV)</td><td rowspan="2" colspan="2">Social Value Proposition (SVP)</td><td colspan="2">Impact Measures (IM)</td></tr>
<tr><td colspan="2">Objectives (Obj)</td><td colspan="2">Output Measures (OM)</td></tr>
<tr><td colspan="3">Cost Structure (C$)</td><td colspan="3">Income (I$)</td></tr>
</table>

Source: Sparviero (2019)

The five building blocks inherited from the BMC (as defined in Osterwalder & Pigneur 2010) are: Key Resources, Key Activities, Channels, and Cost Structure.

The building blocks that have been reframed to align with the analysis and terminology of social enterprise include: “Social Value Proposition” block that substitutes Value Proposition in the BMC and describes the bundle of products and services that create social value for specific customers and beneficiaries. The building block “Non-targeted Stakeholders” replaces the Key Partnerships of the BMC and focuses on stakeholders that might be likely affected by the activities of the organizations. The building block “Customers and Beneficiaries”, replaces the Customer Segments of the BMC, defines groups of people that the social enterprise aims to reach and serve. “Customers and Beneficiaries Engagement” building block replaces the Customer Relationships of the BMC, suggests a deeper analysis of the relationships established by the organizations with its targeted beneficiaries. This relation is considered as two-ways, because customers and beneficiaries are also involved in the creation of value for the organization. The building block “Income” replaces the Revenue of the BMC, suggests the inclusion of all types of financial and in-kind resources received by non-profit and for-profit organisations.

The five building blocks that are new and specific to the analysis of social enterprise include: the “Mission Values” block, which defines the higher, long-term, ultimate goals of the organizations; the “Objectives” block, which defines desirable modes of conduct and more practical targets of the organizations in the short term; the “Impact Measures” block, which defines how mission values are assessed and measured, the “Output Measures” block , which defines the assessment measures of the objectives; and finally the “Governance” block, which sets out the key rules and/or boards and committees set up to manage the organization.

Yeoman and Moskovitz (2013) proposes Social Lean Canvas, based on Lean Canvas. The Lean Canvas used by the authors include different building blocks such as Purpose, Problem, Solution, Key Metrics, Unfair Advantage, Financial Sustainability and Social/Environmental Benefit.

The “Purpose” building block represents the guidance of the business model. The “problem and solution” building block aims to guarantee that the right solution is chosen to answer the problem identified by the enterprise. “Key Metrics” block defines measurements framework for assessing the performance of the social enterprise. “Unfair Advantage” block focuses on what makes the social enterprise different and successful. “Financial Sustainability” replaces Revenue Stream and include all the potential revenue streams for social enterprise. “Impact” block addresses the impact of the social enterprise activities.

Graves (2011) proposes changes on the labels of the building blocks proposed by Osterwalder and Pigneur (2010): Customer Segments becomes “Co-Creators”; Customer Relationships turn into “Relations”; Cost Structure becomes “Value Streams – outlay and costs”; and Revenue Stream turn into “Value Streams – returns”. These changes in labels aim to broaden the scope of the social enterprise, for example do not narrow customer segments to those that merely pay for product/service, but also include those that benefit from it, and not restrict the value to monetary value or costs. Therefore, the expected success of a social enterprise can be put in Value Streams – returns.

5. Discussion

According to Acciaro et al., (2014) as energy hub, ports represent an area where high-energy demand and supply activities are concentrated and, energy-intensive industries, power generation, distribution and related activities and projects take place. These high energy demand and supply activities are responsible for significant harmful emissions in the port and the related cities, and energy efficiency, economic and financial sustainability of port activities remain a major challenge for ports to address.

PREC can participate to address these challenges by considering ports as an ideal location for the implementation of innovative energy generation systems grounding on the economies of scale principle (Notteboom et al., 2022). In this perspective, ports could play a more strategic role within the respective regional energy systems, acting as energy generation and distribution platforms and turning from energy hubs to renewable energy communities.

Responding to the first RO1 “*Which business model is suitable for PREC”*, we claim that PREC could use both the prosumerism business model and the third-party business model depending on investment and assets ownership perspective. In the prosumerism business model the customers and beneficiary finance and own the REC project by investing in energy generation and storage technologies in order to benefit from self-consumption, energy bill reductions and emission reduction. They are prosumers and take advantage of demand side management (DSM) programs. In third party business model instead, the third-party company (in the port context the port authority for example), can own several small-scale energy production units within the port or located remotely from each other and operates them as virtual power plants, centralizing the management of their energy resources (Brown et al., 2019). But the RED II directive promotes the energy community of place model in which participants are close to the place where the renewable energy projects are developed. In the port context, such model corresponds to the port micro grid, which is a decentralized electricity system, designed to operate in a limited community area. But another decentralized energy system existing in the port context is the smart grid, which is a large-scale power supply network designed to operate on large community power supply technology without any constraint of proximity to the area where the renewable energy project is realized. But this model is excluded by the RED II. This limitation can drastically reduce the benefits of PREC, thus, in the port context, we claim that PREC should be understood as locally and collectively organized energy systems, encompassing both the concepts of micro grid and smart grid. Specifically, the definition of PREC should consider all the energy-related activities proposed by the RED-II and IEMD but should not be restricted to a specific geographical area. All types of technologies should be used without restrictions including renewable generation, smart-grid infrastructures, as well as storage devices. This should allow the development of differentiated energy services and the exploitation of demand flexibility.

When it comes to the RO2 regarding *“How the BMC can be applied to PREC to help visualise the development of its business model?”*, we were guided by the BMCs of the REC and social enterprise. The PREC Business Model Canvas we developed consists of 14 building blocks (Figure 1).

Figure 3: Business Model Canvas for PREC

<table>
<tr><td colspan="5">1. Vision
I) Contribute to climate change mitigation; II) Contributing to the achievement of the goals dictated by energy transition; III) Decarbonizing the port activities and the related supply chain</td></tr>
<tr><td colspan="2">2. Problems and Solutions</td><td>3. Value Proposition</td><td>4. Unfair advantages</td><td>5. Customers and Beneficiaries</td></tr>
<tr><td>Problems</td><td>Solutions</td><td rowspan="2">* Self-sufficiency in energy
* Self-production of renewable energy
* Reduction of pollution and energy costs
* Increasing the energy system reliability
* Financial compensation for participating to demand response program</td><td rowspan="2">* Energy autonomy from the national network
* Good location of ports
* Port land use conversion for social purposes
* Local community education
* Employment creation</td><td rowspan="2">* Terminal operators
* Carriers
* Port users
* Other concessionaires
* Passengers
* Port's employees</td></tr>
<tr><td>* Capital intensive investments
* Lack of energy efficiency
* Reliability and stability of energy supply
* Energy demand flexibility
* Lack of area for assets installation</td><td>* Shared investments and partnerships
* Use of technologies for increasing the energy efficiency
* Implementation of distributed energy resources (DERs)
* Participation to demand side management (DSM) programs
* Combination of inside and outside energy generation</td></tr>
<tr><td>6. Non targeted stakeholders

* Local community and societal groups of interests</td><td>7. Key Activities
* Renewable energy supply
* Energy demand planning (demand-side management)
* Energy supply planning
* Balancing energy demand and supply
* Operation management and maintenance
* Marketing activities
* Energy efficiency and energy conservation activities
* Recruitment and training activities</td><td>8. key Partners
Port stakeholders
* Terminal operators
* Carriers
* Port users
* Other concessionaires
* Passengers
* Employees
* Shareholders/owners
* Financial community
*Regulatory agencies
Other stakeholders
* Technology Suppliers
* Energy suppliers
* Power system entities
* Technical staff
* Distribution system
rators (DSO)</td><td>9. Key Resources
Funding schemes
* International funding (e.g., from the European Commission),
* Funding from national, regional and local governments,
* Private funding (terminals, energy companies, banks)
* Self-financing (PREC members)
* Public incentives
Technical resources
*Port location
* Use of the national network as backup
Human resources
* PREC members)</td><td>10. Customers and Beneficiaries Engagement
* Personal and direct interaction
* Long term and trustworthy contract
* Relationship based on shared interests</td></tr>
<tr><td rowspan="2">11. Channel
* Technical Meetings
* Focus group
* Online and off-line marketing strategies
* Customer service</td><td rowspan="2">12. Cost Structure
* Capex
* Opex
* Maintenance cost
* Marketing cost</td><td rowspan="2">13. Revenue Streams
* Sale of energy surplus
* Subsidies from European commission and national/regional/local government
* Remuneration from feed-in tariff
* Participation to demand response program
Sale of ancillary services</td><td colspan="2">14. Impact measurement</td></tr>
<tr><td>Environmental
* Reduction of GHG emissions
* Use of renewable energy
Economic
* Investment confidence index
* Net profit margin
* Total expenditures
* Disposable income
* Utility bill rate</td><td>Social
* Awareness rate
* Community amenity
* Community structure disruption
* Energy justice
* Employment rate
* Involvement rate
*Social justice
* Level of social acceptance</td></tr>
</table>

Source: Author’s elaboration adapted from Business Model Canvas (Osterwalder & Pigneur, 2010)

Seven of the building blocks are inherited from the BMC (as defined by Osterwalder & Pigneur 2010) and contain the same type of information; two of them represent the remainder building blocks of the BMC, but they have been reshaped to fit the analysis and terminology of PREC, and finally, five new building blocks have been introduced and are specific to the analysis of PREC.

The seven building blocks inherited from the BMC are: “Key Partners”, which describes the most important partners needed to develop a successful PREC. They include port stakeholders (e.g.

terminal operators, shipping companies) and other stakeholders (e.g. DSO, technology suppliers). The "Key Activities" building block, which describes the most important actions a PREC must carry out to make its business model work. This building block includes activities such as renewable energy supply, energy demand and supply planning. The "Key Resources" building block, which describes the most important assets needed to develop a successful PREC includes funding schemes (international, national, regional), human resources (e.g. PREC members), technical resources such as a good port location. The "Value Proposition" building block, which describes the range of products and services that create value for specific customers and beneficiaries of the PREC. It includes the energy self-sufficiency, the self-production of renewable energy, the reduction of pollution and energy costs, the increase of energy system reliability.

The "Channels" building block, which describes how PREC communicates with and reaches the customers and beneficiaries to deliver the value proposition. Communication channel includes technical Meetings, focus group, customer service. "Cost Structure", which describes all costs incurred by the PREC to operate. It includes the capex i.e. the investment costs (e.g. assets purchase, installation and grid interconnection costs), the operation costs and maintenance costs. The "Revenue Streams", which describes the various sources from which the PREC earns money. It includes the sale of energy surplus, subsidies from European commission and national/regional/local government, remuneration from feed-in tariff, participation to demand response program and the sale of ancillary services.

Building blocks redefined to suit PREC analysis and terminology include: The "Customers and Beneficiaries", which substitutes "Customer segments", defines target groups that the PREC aims to reach and serve. As prosumers are expected to co-create the value in the PREC, customers and beneficiaries include port stakeholders such as terminal operators, carriers, port users…ect. The building block "Customers and Beneficiaries Engagement", which substitutes "Customer relationships", stresses the engagement of the prosumers in the PREC activities. They are expected to be involved in the decision-making process of PREC. The PREC could engage them through communication about upcoming port authority meetings, newly proposed energy related infrastructure projects, notices of environmental impact documents, port commission meeting minutes and monitoring of environmental socio and economic performance.

The five new building blocks that have been introduced and are specific to the analysis of PREC include: "Vision" building block, that represents the "what" of the PREC. It describes the main goal the PREC aims to address in the long term. These objectives include the contribution to the climate change mitigation, the achievement of the goals dictated by energy transition for achieving energy efficiency, and the decarbonization of the port activities and the related supply chain. In this perspective port should choose the partners with the same vision (e.g. suppliers who comply with environmental, quality and social standards). The "Problem and Solution" building block, describes the mission of the PREC by defining how the PREC intend to reach the vision. In this vein, the problem the PREC wants to address is first identified, and successively, the right solution to address this problem is found. For example, to respond to the capital-intensive nature of the investments related to REC implementation, a shared investment strategy can be adopted by the PREC participants. To tackle the lack of area for assets installation, a strategy consisting of combining inside and outside energy generation can be adopted. Therefore, a network of microgrids can be developed, and using the smart grid concept, this network could be efficiently managed using digital technologies. Another important building block is "Impact Measurement", which aims to first identify the potential impact of PREC (both positive and negative) including environmental and socio-economic impacts and develop a dashboard of KPIs for assessing these impacts. As the participation to PREC is open and voluntary participation, stakeholders that don't participate to the REC or have left it may be affected by the impacts of the PREC, so it is necessary to identify them and assess the magnitude of such impacts on them. For this reason, we introduced the "Non-targeted stakeholders", which can include the local community and societal groups of interests. The last building block is the “Unfair advantages”, which describes the competitive advantages of the PREC. It includes the energy autonomy from the national network, the good location of ports, the port land use conversion for social purposes…etc.

6. Conclusion

The paper provides an innovative business model based on BMC framework useful to design, test, and communicate the benefits of PREC to the port community and the cities where they are located. The snowball sampling is used to collect prominent studies on Scopus Elsevier considering EC and social enterprise BMs. The BMC appears to have several limitations, so several adaptations emerged in the literature. In this vein, the Lean Canvas appears to be a great solution for overcoming the limitations of BMC. It helps for the visualization and conceptualization of the BMs, highlighting their main strengths and weaknesses, and facilitating the analysis of decision-makers (Reis et al. 2021; Cai et al., 2019; Horváth and Szabó 2018).

PREC could use both the prosumerism business model and the third-party business model depending on investment and assets ownership perspective. BMC effectively can help to visualise the development of PREC. However, an adaptation is needed to align with the scope of PREC. In this perspective, the business model BMC we developed consists of 14 building blocks. Seven of the building blocks are inherited from the BMC (as defined by Osterwalder & Pigneur 2010) and contain the same type of information; two of them represent the remainder building blocks of the BMC, but they have been reshaped to fit the analysis and terminology of PREC, and finally, five new building blocks have been introduced and are specific to the analysis of PREC.

This paper contributes substantially to the academic debate regarding business model innovation, by providing drivers for business model innovation and using the snowball sampling method to develop a PREC BMC. Additionally, the findings provide policymakers with valuable insights that can serve as a cornerstone for developing a specific regulatory framework for PREC (for example going beyond the energy community of place). It also brings valuable insights to support port managers in enhancing their decision-making processes regarding the decarbonization of the port activities. These insights can potentially advance the environmental sustainability and energy efficiency efforts of ports, by fostering the self-energy sufficiency, the self-production of renewable energy, the reduction of pollution and energy costs the increasing of the port energy system reliability.

Nevertheless, it is crucial to recognise specific limitations in this paper, which provide opportunities for future research. By applying the snowball sampling method, the paper excludes conference paper and an important number of grey literature contributions which are expected to include references to implemented practices and ongoing initiatives developed by ports and other actors of the port industry. In addition, the paper considers only BMC adaptation from EC and social enterprise. For this reason, this paper is in no way intended to provide a perfect BMC for Port. Rather, it seeks to provide a theoretical BMC for PREC, that can be used as a starting point for the implementation of real cases. Further research can extend the BMC adaptation to other sectors where innovation is high like ICT sectors. Then the BMC could be validated through a questionnaire administered to port and related stakeholders.

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