Evaluating business models of a decentralized energy system

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Abstract—**Commonly used visualization methods for business models reach their limits when applied to business models in the energy industry due to a large variety of stakeholders and their interactions as well as several other specific characteristics. This paper analyzes the shortcomings of these standard methods and subsequently derives suggestions for further development. The analyses show that a suitable method should include information flows, potentially changing roles of stakeholders and direct interactions between customers.**

Keywords- disruptive business models, platforms, integration of photovoltaic energy, smart meter, Business Model Canvas, Plattform Business Model Canvas, Service Business Model Canvas

I.   INTRODUCTION

In recent years, several technological and economic changes led to an energy system which enables novel kinds of business models. This trend is expected to continue in the future. Therefore, various actors in the energy industry develop and analyze new business models in order to take advantage of the new opportunities.

Commonly, visualizing methods like the renowned Business Model Canvas are applied as a first step of assessment and evaluation of new business models. These methods allow identifying the stakeholders, interactions and key activities which define a business model, in order to subsequently evaluate its viability. However, different specific characteristics of the energy industry, like the multitude of stakeholders, the potential interactions between different groups of customers or the large influence of regulatory entities, complicate the application of these standard methods.

This suggests the development of an adjusted visualizing method, which incorporates the specific requirements of today's energy industry. As a first step, this paper analyzes and assesses several existing methods regarding their applicability for these business models. By means of exemplary business models, shortcomings of these methods are identified and possible improvements are derived. Finally, this results in useful input information for the development of a tailored visualization method.

II.   SELECTION OF VISUALIZATION METHODS

There exists a variety of methods for evaluating business models. Basically, these can be divided into two groups according to their purpose – methods for generating ideas or visualizing business models. The former include, for instance, Value Proposition Canvas [1] and Blue Ocean Strategy [2]. The focus of this paper is on the second group though.

Visualization methods are applied in an early phase of the business development process. They provide a template for systematically describing the idea of the business model. This includes the value created and all relevant components and actors as well as their relationships among each other. Thus, these methods serve as basis for assessing the viability and complexity of business models.

In a first step, several existent visualization methods are screened with respect to their qualification for the purpose of this paper. Consequently, the following three methods are selected:

- Business Model Canvas

- Platform Business Model Canvas

- Service Business Model Canvas

A. Business Model Canvas

The most prevalent method is the Business Model Canvas (BMC) by Osterwalder and Pigneur [3]. It consists of nine components as depicted in Figure 1.
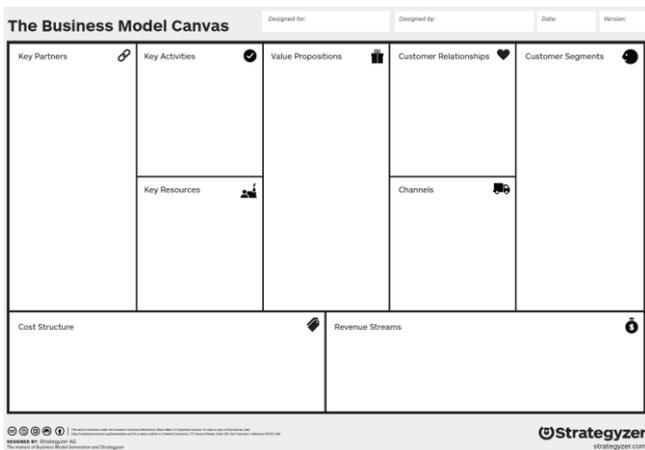
Figure 1. The Business Model Canvas [4]

Figure 2. The Platform Business Model Canvas [7]

In the center of the canvas, the *value propositions* are located. This component describes which values the products and services offered deliver to specific customer segments. In other words, the value propositions solve a customer's problem or satisfy a specific customer need.

On the right, the external perspective of the business model is depicted. The component *customer segments* defines the different customer groups the business model creates value for. *Channels* describe how the company interacts with its customers – e.g. via websites or stores. The component *customer relationships* involves how customers can be won and bound. Ultimately, *revenue streams* created by each customer segment are displayed.

On the left, elements of a company's internal perspective are located. *Key resources* are the essential assets needed for creating the value propositions. These can be e.g. financial, human, or physical resources. *Key activities* show the most important activities that need to be accomplished. Since not all key activities are performed and not all key resources are owned by the company itself, certain *key partners* such as suppliers and other partners are required. Finally, the *cost structure* summarizes the costs incurred for creating the value propositions.

B. Platform Business Model Canvas

The Platform Business Model Canvas (P-BMC) is a modification of the original BMC created particularly for platform business models [5, 6]. Generally, platform business models provide a marketplace via which at least two groups of actors exchange goods or services. The platform increases its value as it attracts more users. In the future, these kinds of business models are expected to play an important role. As illustrated in Figure 2, the P-BMC is designed as a circle divided into four quadrants – one for each of the following actors: owner of the platform, producer, consumer, and partner.
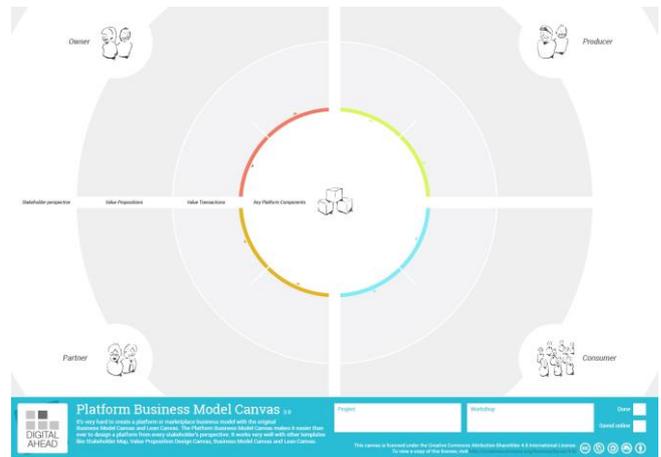
The *Producer* adds value to the platform by e.g. offering goods, services, or information. These are then consumed by the *consumer*. *Partner* corresponds to key partners of the BMC. These can either actively participate in the platform or act in the background as business partners of the *platform owner*. The latter operates the platform.

The canvas consists of three circles which are arranged one inside the other. The outermost circle is the *value proposition* each actor gains from being part of the platform. At first glance, this appears contradictory to the definition of the value proposition in the BMC, in which the value proposition defines the value provided for customers. Considering the nature of a platform, this appears logical though and technically, the definitions do not differ. In the BMC, customers benefit from the value proposition and do not offer values themselves. Thus, the definition could be changed to the value that customers gain from the business model without neither changing the meaning nor the content of this component. *Value transactions* are values or money provided or received (indicated by corresponding arrows) by each actor. By using different colors for each actor, it can be illustrated who delivers value to whom. The inner circle contains the *key platform components* which are similar to the key activities and key resources of the BMC. They comprise the features of the platform and all further elements necessary for realizing the business model. However, it is not shown by which actor these components need to be provided.

C. Service Business Model Canvas

The Service Business Model Canvas (S-BMC) was developed, as the name suggests, for service business models [8, 9]. It breaks down the original BMC into three perspectives – *company perspective*, *customer perspective* and *partner perspective*. Each perspective is represented as an own line and again consists of the remaining components of the original BMC – cost structure, key resources, key activities, value propositions, relationships, channels and revenue streams (see Figure 3). Since customer and partner are their own perspectives now, they are omitted from the components.

The Service Business Model Canvas table:

Customer (Customers in the business model)						
(Costs borne by customers)	(Resources provided by customers)	(Activities carried out by customers)	(Value proposition for customers)	(Contribution of customers to maintain the relationship)	(Channels provided by customers)	(Revenues captured by customers)
Cost Structure (Costs borne by the focal company)	**Key Resources** (Resources provided by the focal company)	**Key Activities** (Activities carried out by the focal company)	**Value Proposition** (Value propositions of the focal company)	**Relationship** (Contribution of the focal company to maintain the relationship)	**Channels** (Channels provided by the focal company)	**Revenue Streams** (Revenues captured by the focal company)
(Costs borne by partners)	(Resources provided by partners)	(Activities carried out by partners)	(Value propositions for partners)	(Contribution of partners to maintain the relationship)	(Channels provided by partners)	(Revenues captured by partners)
Key Partner (Partners in the business model)						

(Left margin labels: Customer perspective, Company perspective, Partner perspective)

Figure 3.   The Service Business Model Canvas [9]

It is important to notice that the components of each actor are defined from their point of view, i.e. cost structure of the customer contains costs incurred by the customer and channels of the customer are channels from the customer to the company. It may not always be necessary to fill in all components, but the arrangement in three lines from the bottom to the top illustrates the relationship between partners, the company and the customers.

D. Further Visualization Methods

There exists a variety of further methods that, however, do not appear appropriate for the purpose of this paper. Nevertheless, in the following they are described briefly and the reasons for excluding them from further analysis are explained.

There exist various additional modifications of the BMC by Osterwalder and Pigneur with the Lean Canvas being the most prevalent. It modifies the components of the internal perspective of the original BMC. More specifically, key partners, key activities and key resources are replaced by problem, solution and key metrics. *Problem* and *solution* capture the top three customer problems and the corresponding three features of the product/service. Thus, the Lean Canvas emphasizes the role of the customers and their needs. *Key metrics* basically correspond to key activities of the original BMC. By eliminating customer relationships and including unfair advantage the canvas integrates competition and competitive advantages [10]. As stated above, business models of the energy sector are typically characterized by a large number of actors. Thus, focusing on customers and their needs at the expense of analyzing partners does not appear expedient. Therefore, the Lean Canvas is not included in further analysis.

The St. Galler Business Model Navigator™ (BMN) is based on the assumption that new business models result from the adaption of existing business models [11, 12]. As stated above, new market entrants will appear in the energy sector. Nevertheless, new business models are also expected to evolve from established ones. Thus, the BMN could fit the purpose of this study. It is designed as a "magic triangle" which comprises the four dimensions who, what, how and value. *Who* defines the customer group and is placed in the center of the triangle. *What* corresponds to the value proposition. *How* summarizes key activities and key resources of the BMC and thus, relates to the company's value chain. Ultimately, *value* comprises all aspects associated with the financial viability of the business model. The BMN captures all relevant components of a business model. However, the level of detail is significantly lower compared to the methods described above since it is not possible to outline relationships between the components. Thus, the BMN is excluded from further analysis.

III. CLASSIFICATION OF BUSINESS MODELS

In the next step, the methods described above are tested by a variety of innovative business models of the energy sector. Thus, several issues become apparent. Further analysis reveals that these mainly can be attributed to the following two aspects. Firstly, problems arise when customers can swap their roles, i.e. they can be supplier and consumer of values in one and the same business model. For instance, customers of an electricity platform can both sell – deliver – and buy – consume – electricity over the platform. Secondly, issues are caused when customers have customers themselves. Again in case of the electricity platform, electricity consumers are customers of electricity generators, whereas both actors are customers of the platform. Consequently, the business models are classified according to these aspects which results in the 2x2 matrix illustrated in Figure 4.

Classification matrix:

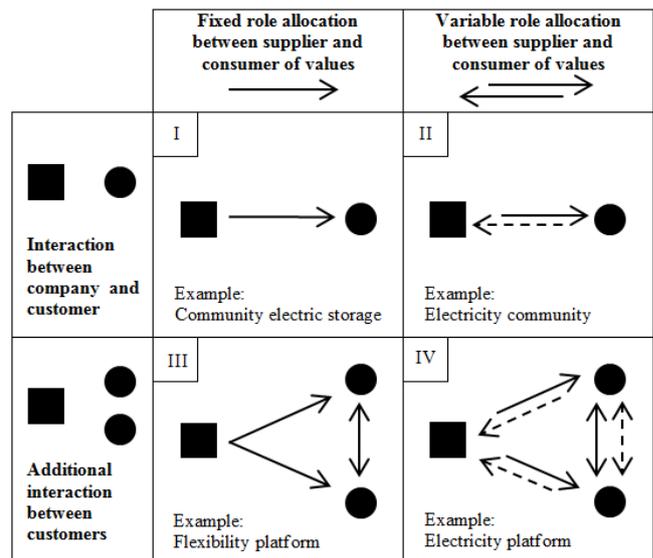|	Fixed role allocation between supplier and consumer of values →	Variable role allocation between supplier and consumer of values ←
Interaction between company and customer	I — Example: Community electric storage	II — Example: Electricity community
Additional interaction between customers	III — Example: Flexibility platform	IV — Example: Electricity platform

Figure 4.   Classification of business models

The columns of the matrix distinguish between fixed and variable role allocation where role refers to supplier or consumer of values. The rows focus on the customers' relationships between each other. Business models in which customers are only connected to the company providing a value proposition are part of the upper row. In contrast, business models in which customers have customers themselves are located in the lower row.

Since the Business Model Canvas is originally designed for business models based on a linear value chain, examples of cluster I do not cause major issues. Thus, in the following the main focus is put on the remaining clusters.

IV. EVALUATION OF EXISTING METHODS

In a next step, one business model of each cluster is selected in order to test the qualification of the BMC, P-BMC and the S- BMC. Issues regarding the BMC are presented in great detail. Then, it is investigated to what extent these could be solved by the P-BMC or S-BMC.

A. Business Model Canvas

1) Actions and obligations of customers

In the BMC, the focus is on the company's activities and resources whereas actions and obligations of customers are not part of the illustration. However, these aspects are

crucial as they may be decisive for whether customers will participate or not. In other words, they influence the attractiveness of a business model to customers. For instance, if households sell excess electricity of their own photovoltaic plants via a platform, they are transformed into utilities and as such have to comply with the obligations of the EnWG. In order to completely capture the complexity and attractiveness of a business model these aspects should be included.

2) Visualizing customers that have different roles

An important aspect of business models in cluster II, III and IV is that customers have different roles. It is important to notice that this issue does not only refer to changing roles as in cluster III and IV. For instance, generators and consumers of electricity can be customers of one and the same business model. By using different colors as suggested by [3], it is possible to illustrate value propositions, revenue streams, and further aspects for different customers in one and the same canvas. However, business models of the energy sector typically comprise a large number of actors. Thus, distinguishing them by using different colors is possible to a limited extent only. Above a certain amount, the canvas may get complex and confusing.

3) Distinguishing between customers and partners

Classifying customers and key partners for business models of cluster II and IV as intended by the BMC turns out to be complicated. The crucial point is that the customers can also be regarded as key partners.

By definition, key partners are needed to realize the business model. In the case of the electricity platform the dilemma is as follows: Electricity consumers only participate if electricity generators participate. Thus, electricity generators are required to attract the customer segment electricity consumers and therefore, vital for the existence of the business model. Consequently, they are to be interpreted as partners. Certainly, they are also customers of the platform. One may argue that being part of customer segments and key partners at the same time is not a problem. However, then the division into these two components no longer appears reasonable. Eliminating key partners is not an option as there still exist further actors such as e.g. payment service providers that are definitely regarded as partners.

Interpreting both electricity generators and consumers only as customers does not seem correct either. The contribution of the former is not only attracting electricity consumers but also delivering electricity which is another reason for categorizing electricity generators as partners.

Naturally, this could be an issue for many business models. However, business models of the energy sector typically are characterized by a vast number of partners. Therefore, the described problem appears even more critical in this case.

4) Actors can swap roles

Another important issue arises when the actors involved can swap roles (see business models in cluster II and IV). An essential characteristic of new business models in the energy sector is that actors offer their resources – e.g. excess electricity or charging stations – for joint usage. In this context, customers can be providers and consumers at the same time. It is important to consider this aspect since

relationships and channels differ between these two kinds of actors. It cannot be integrated in the BMC though.

5) Customers bear entrepreneurial risk

The BMC reaches its limits when customers or partners have customers themselves. For instance, in the electricity platform (example of cluster IV) both generators and consumers are customers of the platform operator. Additionally, consumers can be regarded as the generators' customers as they buy electricity from them. This aspect cannot be indicated in the BMC. One may argue that it is not relevant though, since the corresponding transactions are realized by a central entity – in this case the platform operator. However, to some extent this constellation entails entrepreneurial risk for generators because they can only sell their excess electricity in case of corresponding demand. The same applies to business models of cluster III, e.g. the flexibility market. Providers of flexibility can only sell their flexibility in case it is in demand and hence, also bear some risk. It is important to incorporate this aspect in the evaluation as it influences the threshold for participating and thus, the viability of a business model.

6) Benefits offered to all actors invloved

The issue described above also relates to the value a business model provides to all participating actors. The pivotal point of business models in cluster II, III and IV is that all actors involved benefit from each other. If this condition cannot be fulfilled, certain actors have no incentive to participate and consequently, the business model fails. Thus, the value added for all participants needs to be indicated. The BMC cannot fulfill this requirement. Due to the typically large number of actors involved this problem again is more significant for business models in the energy sector.

7) Integration of information flows

The focus of the BMC is on financial and physical flows. However, information additionally plays a pivotal role. Firstly, there exist actors that need to be informed without actively contributing as key partners. For instance, the balancing group manager or regulatory authority have to be notified in some cases without actively being part of a business model. A solution would be to include this kind of actors as key partners. For this purpose, the component could be divided into direct partners – which are key partners in the original sense – and information partners. However, considering the large amount of partners that is typically involved in business models of the energy sector, this approach may inflate the canvas and create complex and incomprehensible illustrations. Thus, a trade-off between the level of detail and clarity has to be made.

Secondly, the explicit flow of information needs to be integrated. This means it needs to be depicted who requires which information and who has to provide it.

B. Platform Business Model Canvas

Theoretically, business models that are based on a linear value chain (cluster I) could be visualized in the P-BMC. However, these business models are not the initial objective of the P-BMC. Due to the circular structure, depicting them in the P-BMC could not deliver intuitive presentations. Nevertheless, it is considered in the further analysis since it solves some of the issues encountered when testing the BMC with business models of cluster II, III and IV. The main differences to the BMC are the separation of customers

into producers and consumers and the inclusion of value transactions.

1) Actions and obligations of customers

It is not intended to visualize actions and obligations of customers. Therefore, including these aspects would reduce the clarity of the canvas.

2) Visualizing customers that have different roles

The separation of customers into producers and consumers allows distinguishing between customers with different roles. Suppliers of values are classified as producers and consumers, obviously, as consumers. This provides more clarity, especially in case of many actors.

3) Distinguishing between customers and partners

For the same reason as described above, the problem between partners and customers is eliminated. Suppliers of values are regarded as producers. Thus, the problem whether to categorize them as customers or partners is no more relevant. Partners in the P-BMC are e.g. providers of ancillary services of the company operating the business model.

4) Actors can swap roles

The fact that participants can swap roles cannot be demonstrated in the P-BMC.

5) Customers bear entrepreneurial risk

The illustration of value transactions by applying different colors for each actor in combination with the separation between producers and consumers provide an advantage: It emphasizes the fact that consumers are customers of producers by visualizing corresponding cash flows via the value transactions. Hence, it could solve the problem of entrepreneurial risk. However, similar to the application of different colors in the BMC, the success of this approach is limited. Above a certain number of consumers and producers the clarity of the canvas suffers.

6) Benefits offered to all actors invloved

By including value transactions in different colors, cash flows between all actors involved and thus, their individual benefits provided by the business model can be illustrated. The success of this solution also depends on the number of participants though.

7) Integration of information flows

Moreover, value transactions can also be used to capture information flows analogously to cash flows. However, this approach does not correspond to the original meaning of value transactions. Similar applies to information partners. They could be included in the partner quadrant. But, again, this approach may inflate the canvas.

8) Issues regarding partners of the business model

Firstly, the number of partners is limited due to the circular structure. Certainly, the quadrant can be subdivided in order to integrate more than one partner. In order to maintain clarity, the number of partners is limited though. Considering the fact that business models in the energy sector usually require a large number of partners, this is a major drawback of the P-BMC.

Secondly, it is not possible to show who interacts with certain partners. In the BMC it is clear that all partners listed as key partners are partners of the company. In the P-BMC all partners are simply partners of the platform and hence, it is not entirely clear who interacts with them. Certainly, this could be indicated by using different colors. But again, the vast number of partners is hindering.

9) Loss of information compared to BMC

On the one hand, the P-BMC provides more information compared to the BMC. Especially, transactions between different actors can be outlined in more detail. On the other hand, some components and thus, information are omitted. Certainly, key platform components may comprise key activities and key resources of the BMC. However, it remains unclear how these components are provided.

C. Service Business Model Canvas

1) Actions and obligations of customers

The S-BMC includes activities carried out by the customer as own component. This is a clear advantage compared to the BMC because the amount and complexity of these activities can serve as indicator for the participation threshold. Moreover, this component could be extended by obligations that e.g. result from regulations or laws.

2) Visualizing customers that have different roles

In the original version of the S-BMC it is not possible to depict customers with different roles. To some extent, this problem could be solved by adding an additional line for each type of customer. However, this approach is similar to using different colors in the BMC. Due to the significant number of actors involved, the clear structure of the canvas would suffer.

3) Distinguishing between customers and partners

The issue regarding the distinction between customers and partners cannot be eliminated by the S-BMC. Again, inserting individual rows for different types of customers provides some improvement. Clearly, then all customers would be classified as customers and not as partners. However, by filling in the components resources and activities, it would become clear at which part of the value chain they are to be positioned. As described above, the expedience of this approach is limited by the number of actors involved.

4) Actors can swap roles

Analogously to the BMC and the P-BMC it is not possible to visualize actors that swap roles because each actor is represented in an individual line.

5) Customers bear entrepreneurial risk

Depicting costs and revenues for customers can indicate whether a business model is economically viable for them. However, the fact that customers have customers themselves can be integrated to a limited extent only. Again, inserting an own line for customers of customers could be a solution but then it is not recognizable anymore that these are also customers of the company itself. Concluding, this issue can only partly be solved by the S-BMC.

6) Benefits offered to all actors involved

Splitting the canvas into different perspectives allows showing value propositions, revenues and costs for all actors involved and thus, assessing their benefit from the business model.

7) Integration of information flows

Following the approach suggested for the BMC, separating the partner perspective into direct partners and information partners partly solves the issue of incorporating

information. Specific information flows cannot be integrated though.

8) Inflated illustration compared to the BMC

The S-BMC separates all components of the original BMC into the company, customer and partner perspective. Not all parts are required for business models of the energy sector though. Especially, separating relationship and channels into three perspectives does not provide additional information. Thus, the number of components should be reduced. Moreover, for business models of cluster I, the separation into perspectives generally appears to be too detailed.

V. RESULTS AND DISCUSSION

The analysis shows that the existing evaluation methods cannot fully capture the complexity of business models of the energy sector. Firstly, none of the methods can visualize business models in which actors can swap roles. Regarding the remaining issues, always at least one method provides improvement. Secondly, each method features advantages in certain aspects and drawbacks in others. For instance, on the one hand, the P-BMC solves issues that neither the BMC nor the S-BMC can solve. On the other hand, it is not qualified for business models of cluster I though. Thirdly, the analysis reveals the large amount of actors in the energy sector as the main issue. The results are summarized in TABLE I.

TABLE I. SUMMARY OF RESULTS

Issue	BMC	P-BMC	S-BMC
Qualified for business models of cluster I	✓	X	–
Actions and obligations of customers	X	X	✓
Visualizing customers that have different roles	X	✓	– [a]
Distinguishing between customers and partners	X	✓	– [a]
Actors can swap roles	X	X	X
Customers bear entrepreneurial risk	X	– [a]	–
Benefits offered to all actors invloved	– [a]	– [a]	✓
Integration of information flows	X	– [a]	–

a. Limited by number of actors

In a next step, these findings can be used in the course of developing an appropriate canvas for the energy sector. Therefore, in an iterative process, advantages of BMC, P-BMC and S-BMC need to be combined. Additionally, further elements will be added in order to cope with large numbers of actors. In this context, it needs to be noted that most business models comprise similar actors.

Consequently, it appears reasonable to already include common actors in the structure of the canvas. Ultimately, achieving a concise and clear structure will require a trade-off between aggregating information and fully considering all details.

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