Shaping the energy utility of the future

Business model innovation of electric utilities: the role of corporate venture capital

P.E. Klei

Master Thesis

TU Delft

Shaping the energy utility of the future

Business model innovation of electric utilities: the role of corporate venture capital

by

P.E. Klei

to obtain the degree of Master of Science

in

Sustainable Energy Technology

at the Delft University of Technology,
to be defended publicly on Thursday April 15th, 2021 at 3:00 PM.

Student number:	4324471	
Project duration:	June 1, 2020 – April 15, 2021	
Thesis committee:	Dr. L. M. Kamp,	TU Delft, daily supervisor
	Dr. H. K. Khodaei,	TU Delft, second supervisor
	Dr. J. R. Ortt	TU Delft, chair

An electronic version of this thesis is available at http://repository.tudelft.nl/.

Delft University of Technology

Preface

This research focuses on the emerging research areas of business model innovation and corporate venture capital, in the context of European electric utilities. The project has been carried out to obtain the degree of Master of Science in Sustainable Energy Technology from the Delft University of Technology.

When I started my thesis after the first three months of the COVID-19 pandemic, I could not have imagined it would last for such a long time and I would finish my thesis still in the pandemic. As such, I have spent most of the past ten months in my own sleeping room, and I cannot deny the walls have sometimes been closing in on me. While I had pictured the end of it somewhat different, I will always look back happily and proudly at my time as a student in Delft.

Although I have never met with any of my supervisors in person, this does not mean at all that I am solely responsible for the quality and form of this thesis. In fact, I could not have achieved this on my own. First and foremost, to my first supervisor Linda Kamp, thank you for all your efforts and support throughout this project. While first starting in a less active role as second supervisor, I am truly grateful for your willingness to take over the role of first supervisor and provide me with excellent and active guidance. Your quick responses, useful comments, and our fruitful discussions in countless Zoom-meetings have really taken this work to a higher level. Secondly, I would also like to express my gratitude to my second supervisor Hanieh Khodaei and chair Roland Ortt. Your positive attitudes and detailed knowledge on the subject helped me seeing things in an additional perspective and further improved the quality of the work. Also, I would like to thank the energy industry experts and interviewees for their practical insights and valuable contributions.

To my friends, family and of course Fré, a big thanks for your unconditional support, distraction, and putting things into perspective. Finally, a special thanks to my father for helping me navigate through multiple hurdles along the way. I am truly grateful for your willingness to take my frequent calls, your valuable advice, and the many discussions about my work we have had. I am proud to become the third generation of Delft-educated engineers in our family!

Paul E. Klei
Amsterdam, April 2021

Executive Summary

The European electric power sector is undergoing fundamental transformation. Where this sector used to be very stable, characterized by a straightforward value chain in which power flows one way and money the other way around, this is now rapidly changing. A combination of policy, technological and customer behaviour changes creates the need for a highly modified power system. Obviously, many of these changes are related to the energy transition. The European Commission has the ambitious plan for Europe to become the first completely climate neutral continent by 2050, captured in the European Green Deal. In this decarbonization journey, the power sector has to play a key role, especially with increased electrification of end-use sectors such as mobility and heat, which further increases the already rising demand for electricity. Moreover, not only must energy suppliers adapt to an increasing demand for renewable energy, also a range of other trends can be observed, not to mention to challenges posed to the power grid due to the variability in renewable energy production.

As a result, the whole playing field in the energy sector is changing. The industry used to be dominated by a few large, incumbent utilities with a straightforward Business Model (BM) based on the bulk sale of metered units of energy and characterized by a highly standardized nature (the *Traditional Utility* model). However, this model has come under pressure. As a result of all developments, new market entrants saw opportunities to challenge the future viability of traditional utilities. Consequently, traditional utilities will have to come up with new ways to generate and deliver energy. Moreover, they have to do that all in an environmentally sound way, and simultaneously respond effectively to other changes in technology, policy, and customer behaviour. In other words, these developments and competitive threats result in a need for fundamental Business Model Innovation (BMI) for incumbent utilities.

However, incumbent utilities will in all probability not be able to realize this fundamental business model innovation on their own. In that respect, the collaboration with external startups and scale-ups has been identified as an essential component in the overall BMI strategy of incumbent utilities. More specifically, during the past years most large European utilities started pursuing Corporate Venture Capital (CVC) activities, in which they invest in innovative startups and scale-ups whose activities are in any way related to the future energy system. However, although this approach has been rapidly gaining popularity, it seems that its specific potential contribution to stimulate BMI of incumbent utilities is at this stage highly unclear. As this is exactly the rationale of utilities in pursuing Corporate Venture Capital (CVC) activities, it will be essential to analyse this potential contribution. Such an analysis could clarify the benefits that utilities can reap with CVC, and also the subjects that CVC will not be able to address. Hence, the following research question is formulated:

How can Corporate Venture Capital contribute to Business Model Innovation of electric utilities in response to the developments in the energy sector?

The objective of this research is to improve the understanding of the potential contribution of Corporate Venture Capital activities to Business Model Innovation of European electric utilities. This objective mainly results from the highly limited state of knowledge on this subject. As such, the aim is to provide first insights into these emerging phenomena, rather than providing conclusive answers to a specific problem. Therefore, an exploratory qualitative research approach has been taken, combined with a case study approach.

After a thorough literature review, it turned out that besides the Traditional Utility, during the past decade three other types of business models for electric utilities have been emerging: the Green Utility, the Cooperative Utility, and the Prosumer Utility. Their emergence was stimulated by a range of developments, among others the global shift towards a more sustainable energy supply. More specifically, six major developments emerged. These developments include the ”Three D's”: decarbonization of the energy system, a shift to decentralization of energy generation and management, and digitalization

of the energy system. Furthermore, electrification of end-use sectors as heat and mobility is visible, as well as an increased need for energy system flexibility due to the variability of renewable energy sources. Finally, an increased focus on energy efficiency was identified, which addresses efficiency at the consumption side.

To provide an idea of where European utilities currently stand, two external industry experts were asked to score the four different business models based on their current alignment with the six developments. It became clear that for each utility model, there is sufficient room for improvement. However, especially for traditional utilities the current alignment was found to be limited, as they scored the worst – although sometimes together with other utility types – on four of the six developments (decarbonization, decentralization, energy system flexibility, energy efficiency). Taken together, this validates the general observation in other research that incumbent utilities are in a need for fundamental business model innovation, in order to be able to better adapt to the developments and maintain a competitive position. Also, a range of potential future BM opportunities for utilities emerged.

However, BMI is a highly complex process, subject to many potential barriers. An extensive literature study – ranging far beyond general BMI literature – led to a first list of 31 mutually exclusive potential barriers that can hinder BMI of incumbent, traditional utilities. These barriers include both generic barriers hindering all BMI in general, despite sector or company differences, and specific barriers hindering BMI of incumbent utilities in one or multiple specific domains, related to the six energy sector developments. This relation was based on both literature insights and insights from the two external industry experts. Furthermore, five categories of barriers became clear.

First of all, there are organizational and company resource barriers (mostly including the generic barriers), for example *conflicts with existing assets and BMs* and *lengthy innovation proceses*. This category also includes a more substantive component of BMI (e.g. addressing the right types of BM innovations), through *lack of competencies to build and manage new capabilities* and *gaps in the product and service portfolio*. Secondly, financial and profitability barriers can include *profitability problems and high initial investment costs for customers*. Thirdly, awareness and behavioural barriers refer to *behavioural barriers and concerns*, and a *lack of customer demand in certain domains*. Fourthly, regulatory and institutional barriers for example include *shortcomings of the legal framework* and *misplaced incentives*. Finally, technological barriers can address factors as a *limited grid capacity* and *system performance risks*. The latter four categories mainly included the specific barriers that hinder BMI of utilities in certain areas that reflect different energy sector developments.

Subsequently, the Corporate Venture Capital domain was assessed. Based on a literature study and consultation with the two industry experts, a first list of 21 mutually exclusive potential benefits of CVC activities was identified. Besides the fact that CVC can lead to financial gains, in line with its purpose as instrument for stimulating BMI the remaining 20 benefits are strategic. These benefits can be classified as market-level learning, venture-specific learning, indirect learning, options to acquire companies, options to enter new markets, options to exploit external business model innovations, leveraging own technologies and platforms, leveraging own complementary resources, and branding. The most apparent specific examples of these benefits include *identification of, monitoring of, and exposure to new technologies, markets, and BMs*, *promote entrepreneurship in the corporate culture*, and *access and exploit new or complementary BMs, technologies, and services*.

Hereafter, both subjects were integrated and 29 potential relationships between individual CVC benefits and BMI barriers were identified, affecting thirteen benefits of CVC and twelve barriers to BMI. For example, *exposure to new technologies, markets, and BMs* can contribute to overcome a *lack of competencies to build and manage new capabilities*, *search-related barriers*, and a *short-term focus*. Also, *access and exploit new or complementary BMs, technologies, and services* may help to overcome *gaps in the product and service portfolio*, *lengthy innovation processes*, and *conflicts with existing assets and BMs, among others.*

Finally, a case study was performed. This consisted of two different European incumbent utilities with CVC programs in place: Dutch utility Eneco with its venturing arm Eneco Ventures, and French utility ENGIE with its venturing arm ENGIE New Ventures. Both cases included three interviews, of which two addressed the incumbent utility (Strategy/Innovation) perspective, and one addressed the CVC perspective.

The interviews delivered detailed insights on multiple subjects. First of all, all six energy sector developments were acknowledged, and no additional developments emerged. Secondly, with respect to the current alignment of utility BMs to the six developments, the traditional utility BM was evaluated much better than was the case with the two external industry experts. Nevertheless, the need for fundamental BMI for traditional utilities was clearly recognized. Of the list of 31 potential barriers to BMI, 28 were acknowledged as relevant. A *lack of knowledge and information by utilities about markets for Renewable Energy (RE) and potential customers*, *lack of standard procedures for grid connection*, and *metering issues* were found irrelevant. This could be explained by the fact that these issues rather reflect early-stage barriers of the energy transition, which have been surpassed.

Further, of the 21 potential benefits of CVC, eleven were found to be relevant, which mainly included the highest externally strategic benefits, such as the three described above. Less externally strategic important benefits as *improve internal venturing* and *utilize excess plant space, time, and people* were not found relevant. Finally, of the 29 potential relationships between CVC benefits and BMI barriers eighteen were confirmed, affecting seven benefits and eleven barriers. Examples include all relations described above, as well as that *promotion of entrepreneurship in the corporate culture* can contribute to overcome *non-supportive organizational values, culture, and design* and *non-supportive human capital, skills, and psychology*. Also, a more general accelerating effect of CVC on BMI was found.

In addition, an analysis of the venture portfolios of both CVC units was performed. Indeed, it is highly relevant in which types of ventures utilities invest, which is related to the two barriers that together reflect the substantive component of BMI. It turned out that both venture portfolios consisted of ventures whose (combined) activities addressed all six energy sector developments.

A more general comparison of case study results with literature results showed that despite several subtle differences, the potential contribution of CVC to remove or circumvent barriers to BMI of incumbent utilities can be clearly seen in practice. This also includes the substantive component of BMI and CVC, as the visible BMs in both venture portfolios corresponded very well to the future BM opportunities for utilities that emerged from literature. After combining all findings, a conceptual framework has been proposed that captures all relevant subjects of this research and provides a clear, graphical overview of the potential contribution of CVC to remove or circumvent the barriers to BMI of European incumbent utilities.

Also, an answer to the main research question could now be formulated. Corporate Venture Capital can deliver a valuable contribution to Business Model Innovation of incumbent utilities, by helping them to overcome multiple important barriers to BMI. These barriers mainly include organizational and company resource barriers, but also one of the two financial and profitability barriers, one awareness barrier, and one institutional barrier. Also, CVC can have a general accelerating effect on BMI. However, the contribution of CVC does not extend to most regulatory, technological, and awareness barriers to BMI.

This research provided interesting first insights into the rather new phenomena of BMI and CVC in the energy sector. From a scientific perspective, this research thus contributes to advancing the knowledge on these subjects in general, and more specifically to bridge the gap in integrated knowledge of BMI and CVC (combined) in the energy sector. Future research could take these findings to the next level and extend the analyses by including multiple other subjects, for example addressing the relative importance of BMI barriers and CVC benefits. Also, the conceptual framework proposed in this research could be further improved or applied in another industry.

For utility and CVC managers, the findings of this work could help them to improve or re-evaluate BM innovation strategies, and make sure the CVC activities are well aligned with the BM innovation goals of the incumbent utility. Finally, it is called upon policy makers and society to address the barriers that affect them, and which cannot be overcome by CVC activities.

Acronyms

O&M Operation and Maintenance. 24, 30, 34, 54, 55, 57, 58, 70, 72, 98, 99, 101, 103, 106, 117

P2P Peer-to-Peer. 32, 34, 37, 41, 46, 47, 113

PR Public Relations. 27

R&D Research and Development. 7, 24, 34, 65, 67, 69, 71, 74, 90–92, 97, 105, 116, 167

RDEG Renewable Distributed Energy Generation. 32

RE Renewable Energy. vii, 46, 54–57, 59, 69, 83, 87, 89, 101, 104

RES Renewable Energy Sources. 20, 37, 39–41, 49, 60, 113, 114

TSO Transmission System Operator. 20, 24, 27, 30, 34, 47

VC Venture Capital. 7, 62–67, 91, 96, 104, 131, 165–167

VPP Virtual Power Plant. 32–34, 37, 46, 47, 113, 159

VRE Variable Renewable Energy. 25, 44, 57, 99, 103, 158

Contents

List of Figures

List of Tables

1 Introduction

The electric power sector has embarked on a journey of fundamental transformation [147]. Besides the existing challenges on reliability, affordability, and sustainability, a combination of policy, technology and customer behaviour changes is increasingly disrupting the electricity sector [143], [144]. Not only must traditional energy suppliers adapt to an increasing demand for renewable energy, but also other trends as distributed generation, digitalization, demand side management, smart grid technology, and other technological developments are playing an increasingly important role [142]. As a result, business models of power utilities will be subject to important changes, or even complete transformation [142].

So, electric utilities will have to find new ways to improve their products and manage their businesses, and since they are central actors in the energy transition, do that all in an environmentally sound way [111], [113]. The fundamental nature of these power sector changes calls for business model innovation, innovation that affects multiple components of the business model of utilities [65], [144]. Simultaneously, there seems to be only a limited period of time for utilities to devise and implement the required strategies and capabilities for this BMI, otherwise they might lose their competitive position [144]. This makes the call for fundamental business model innovation even more urgent. However, utilities are exposed to the significant challenge "that business model innovation, security and reliability all keep pace with technology innovation" [111]. Therefore, it is not a surprising matter that only a few utilities seem to be on track in the transformation of their business models [144].

To foster BM innovation and improve their competitive position, there are various activities that firms can undertake, which are captured under the collective term *Corporate Entrepreneurship (CE)* [108]. Also, different approaches are possible. An approach recognized to have a significant positive impact on business model innovation is *open innovation* [92]. In this approach, ideas and innovations cross organizational boundaries, thereby increasing the speed and impact of BM innovations and reducing development costs [111], [127]. As opposed to closed innovation, open innovation thus implies both internal and external collaboration [127].

Also electric utilities are increasingly pursuing open innovation, more specifically through an external Corporate Venturing (CV) approach, which is one of the forms of CE. While also acknowledging the simultaneous application of other vehicles for CE and CV, most large European utilities have established a Corporate Venture Capital (CVC) program, through which they invest in innovative start-ups whose activities are related to the (future) electricity sector in its broadest form. In this way, they aim at keeping the lead in a rapidly changing industry and search for future viable business models [111].

In this research, it is chosen to focus specifically on CVC, as in the eyes of large European utilities this seems to be the one of the promising methods to stimulate the demanded business model innovation [111]. As this research involves a few different subjects, it can be insightful to visualize the coherence between them. As such, in Figure 1.1 the core concepts are presented.

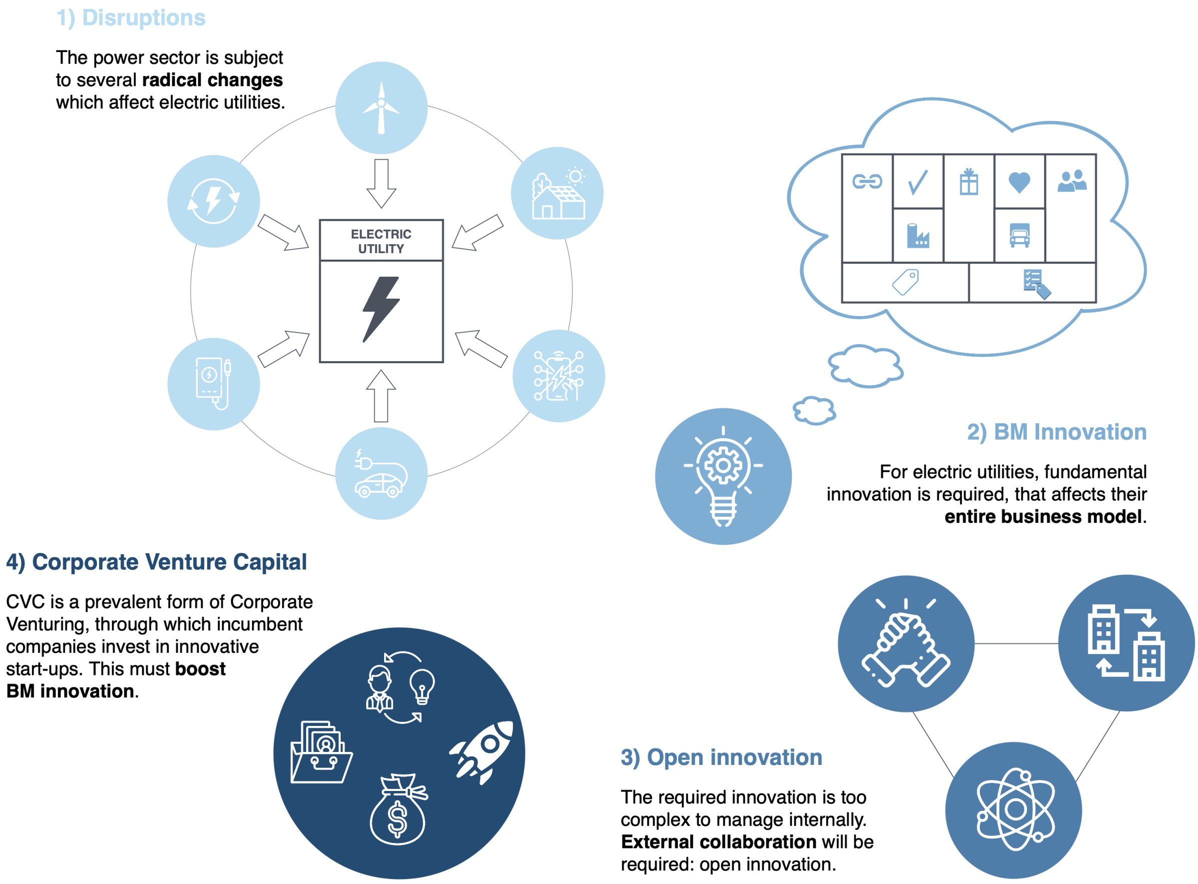


Figure 1.1: Description of main subjects of this research and their coherence. Own illustration.)

In the next section, a contextual background to the introduced concepts is provided. Subsequently, the problem is outlined and an academic knowledge gap is identified, thereby including a discussion of the scientific, managerial, and societal relevance. Thereafter, the research objective and research questions of this thesis are provided. Finally, the thesis scope and thesis structure will be outlined.

1.1. Contextual Background

In this section, the reader is provided with some contextual background information on the relevant subjects of this research, both in general and in relation to the focus industry of this thesis, the electric utility sector.

1.1.1. The European Electric Power Industry

In December 2019, the European Commission announced the European Green Deal, a comprehensive plan that must lead Europe to being the first completely climate neutral continent by 2050 [40]. The European Green Deal covers all sectors of the economy, and meeting all objectives will require an extensive and rapid transformation of the whole European economy. Since sectors such as transport and heating are expected to keep electrifying, the total European demand for electricity will rise [145]. At the same time, the total emissions of the power sector will have to decrease drastically. As a result, the role of the power sector in meeting the European Green Deal objectives will only become more important, especially when noting that the electric power sector is the largest Greenhouse Gas (GHG) emitting sector in Europe [2].

Fortunately, in line with this requirement, the European electric power sector is reported to play a leading role in the decarbonisation of Europe [145]. In 2019, the share of renewables in the European electricity generation increased to almost 35%, up more than 100% since 2013. For an important part, this result was driven by the increased economic attractiveness of renewables, mainly solar and wind

[145]. At the same time, coal plants are being phased out. During 2019, coal-fired electricity generation in the EU decreased by 24%, and more commitments have been made [145]. The positive impact of this trend is clearly extracted from the European power sector's CO2 emissions which decreased by 12%, equal to 120 Mt [145]. Despite these promising first results, it is yet to be proved whether this trend can be maintained. In that respect, only time will tell how the COVID-19 pandemic will affect the power sector. By all means, the climate challenge is clear.

Besides the energy transition, the last decade has shown that electric power companies are facing multiple other significant challenges. The traditional business model of electric utilities, centralized and large-scale power generation, is being rapidly and increasingly disrupted [151]. A comprehensive but concise description of the main drivers of this disruption was provided in [152] (p.4): "The forces of innovation and disruption led by technological advances and economic viability of several trends such as decentralized renewable energy, energy storage, digitalization/smartization of networks, electric vehicles, active policy making and regulation, and the influx of new market entrants in the power sector". To effectively respond to these ongoing changes, new, radically transformed business models will be required [80]. Power companies that are not able to sufficiently respond to these changes by acquiring the new required capabilities, will face being left behind [151].

A schematic depiction of the future energy system is provided in Figure 1.2.

1.1.2. Business Models and Business Model Innovation

Researchers use various definitions of what a BM exactly is. As will be further explained in Chapter 3, the leading definition in this thesis is the one provided by Osterwalder and Pigneur [136]:

"A business model describes the rationale of how an organization creates, delivers, and captures value."

Furthermore, Osterwalder and Pigneur [136] identify nine building blocks of a business model:

- **Value Proposition:** this describes the value that a company is creating for its targeted customer segments. This value can have different aims, but most can be related to either satisfying certain customer needs, or solving certain customer problems. Also, this value proposition can be both quantitative (pricing, cost reductions, performance improvement) and qualitative (improving design, higher usability). The offered value can be captured in a certain combination of products and services that differs per customer segment.

- **Customer Segments:** this block focuses on for whom a company creates value. The targeted customers can be clustered into different segments based on many different characteristics, ranging from common needs to income level, age, gender, etc.

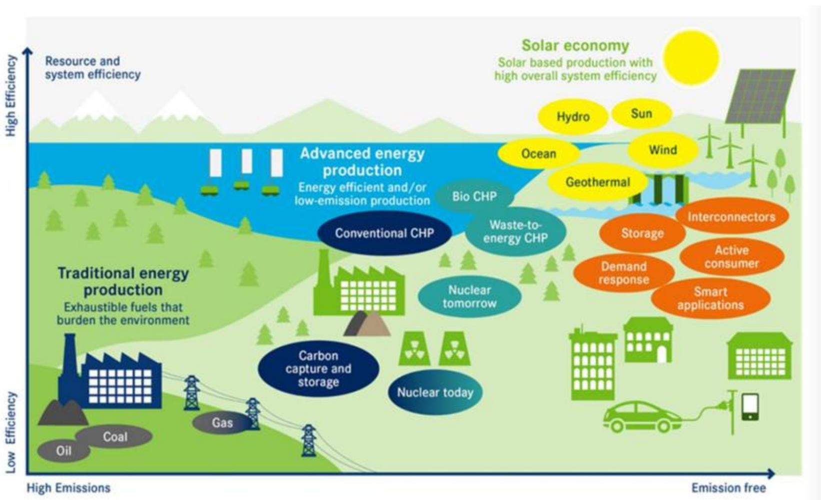


Figure 1.2: The future energy system. Adopted from Cheng, Zeng, and Huang [29].

- **Channels:** the channels block describes how a company aims to reach its targeted customer segments and deliver value to them. Channels can be direct or indirect, and can be owned by the company itself or by a partner. Five different channel phases can be distinguished: awareness, evaluation, purchase, delivery, and after sales.

- **Customer Relationships:** different types of relationships exist that a company can establish with its customer segments. Relationships can range from highly personal to fully automated, and can be driven from different aims as customer acquisition, customer retention, or increasing sales. Nowadays, many companies are also directly involving their customers by for example creating (online) communities or let selected customers co-create their product or service.

- **Revenue Streams:** this block describes how a company aims to earn money and generate cash flow from each customer segment. Revenue streams can be generated in many different ways, such as asset sale, usage fees, subscription fees, renting, licensing, brokerage fees, and advertising. Furthermore, revenue can be generated by one-time or recurring customer payments.

- **Key Resources:** every company will need (a combination of) certain assets to be able to do business, which is described by the key resources block. These assets can be physical (i.e. buildings, machines), intellectual (i.e. brands, patents), human, or financial (i.e. cash, credit lines)

- **Key Activities:** this describes the most important actions that a company must take to be able to do business. These activities are dependent on different business model types and can be categorized as production, problem solving, or platform/network.

- **Key Partnerships:** this block identifies a company's needed network of partners and suppliers. Four types of partnerships can be distinguished: strategic alliances, coopetition, joint ventures, and buyer-supplier relationships. Furthermore, three different motivations behind partnerships can be identified: optimization, risk reduction, and resource acquisition.

- **Cost Structure:** this describes the most important costs that a company has to incur to do business. A business model can be either cost-driven (focusing on minimizing costs) or value-driven (focusing on creating value and thus implying higher costs). Furthermore, costs can be divided into fixed and variable. Cost reductions can be achieved by either economies of scale (lower costs with increasing output), or economies of scope (lower costs with increasing scope).

All nine building blocks interact with each other and together form one comprehensive business model. There are multiple tools to visualize that business model. Well known is the *Business Model Canvas (BMC)*, first introduced by Osterwalder & Pigneur [136] and presented in Figure 1.3.

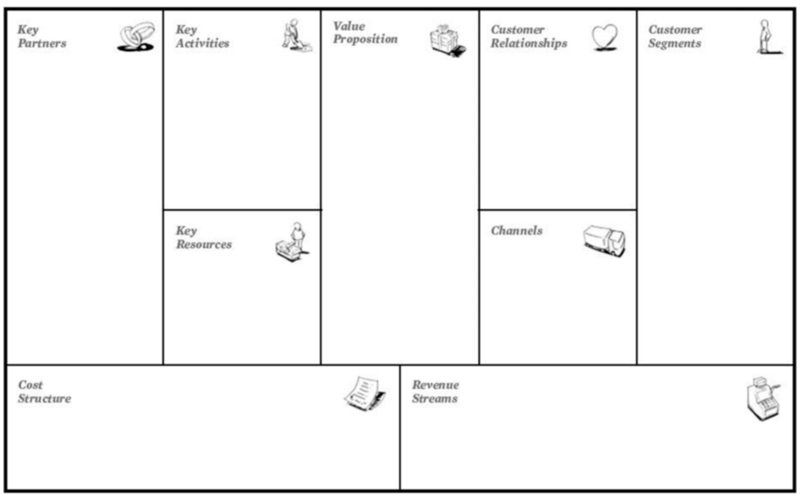


Figure 1.3: The Business Model Canvas. Adapted from Osterwalder & Pigneur [136].

Where there is a large amount of literature on BMs, there are not many researchers who have provided a clear definition of the concept of Business Model Innovation. Therefore, in this thesis a definition will be used that is derived from so-called 'grey literature'. In that respect, Lindgardt, Reeves, Stalk, and Deimler [110] point at the importance of acknowledging the differences between product, service, or technological innovation and BMI, and argue that BMI involves a "multidimensional and orchestrated set of activities". Therefore, they define business model innovation as:

"Innovation becomes business model innovation when two or more elements of a business model are reinvented to deliver value in a new way."

Business model innovation is identified as a valuable concept specifically in times of instability - for example an industry subject to regulatory and technological disruptions [110]. Despite being more challenging than 'normal' product or process innovation, business model innovation has the potential to deliver significantly higher returns. Moreover, if managed successfully, business model innovation can increase a company's resilience to change and lead to a long-term competitive advantage [75].

As discussed in the previous sections, business model innovation has become an urgent matter for the (European) electric power industry. To respond appropriately to the significant change in the way energy needs are met, it will be pivotal to develop new business models offering higher financial benefits as well as more convenience than the current model [65]. Power sector business models are "set to evolve from an analogue, scale-driven, centralised and standardised model to one that is digital, distributed and personalised" [144]. However, although the vast majority of industry leaders recognize the importance of business model innovation, the actual action lags behind. In its 15th Global Power & Utilities Survey, PwC investigated the pace of business model transformation [144]. The results are presented in Figure 1.4.

As can be seen in the figure, globally only 25% of respondents reported a significant change in their business models, and 21% reported no change at all. In Europe, the numbers are somewhat more positive with 33% of respondents reporting significant change and only 13% reporting no change at all. However, these results imply that many incumbent utilities are not yet on the right track, increasing the risk of losing their competitive position. As a result, the traditionally conservative power sector companies need to further embrace innovation and embed it in their core strategies.

The industry survey of PwC [144] shows evidence of a shift in the industry attitude towards BM innovation, as can be seen in Figure 1.5. As the figure shows, globally 31% and 15% of respondents reported a radical and breakthrough innovation focus, respectively, which both indicate BM innovation instead of incremental product innovation. For Europe, 35% of respondents mentioned a radical focus, and 26% a breakthrough focus. These results suggest that BMI is being increasingly put at the top of power companies' priority lists.

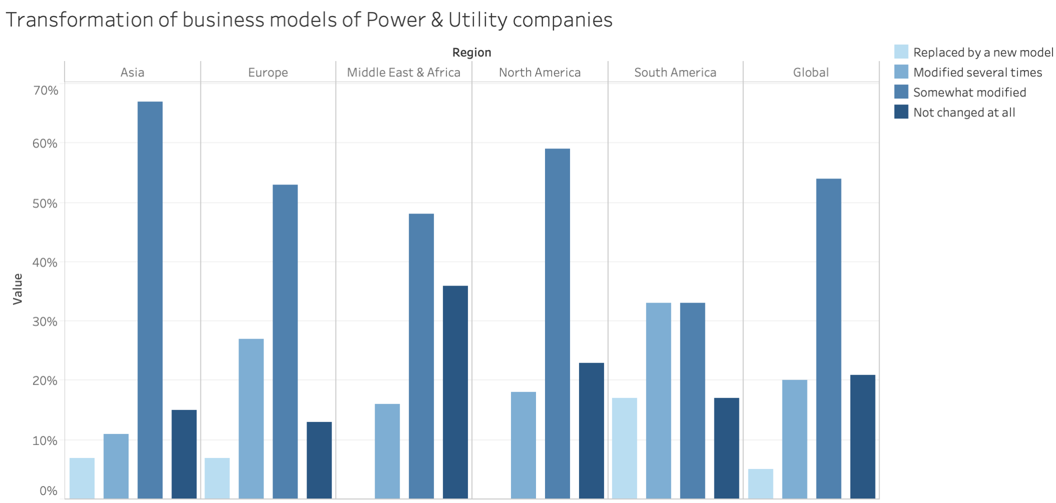


Figure 1.4: Transformation of business models of Power and Utility companies. Adapted from PwC Global Power & Utilities Survey 2018 [144].

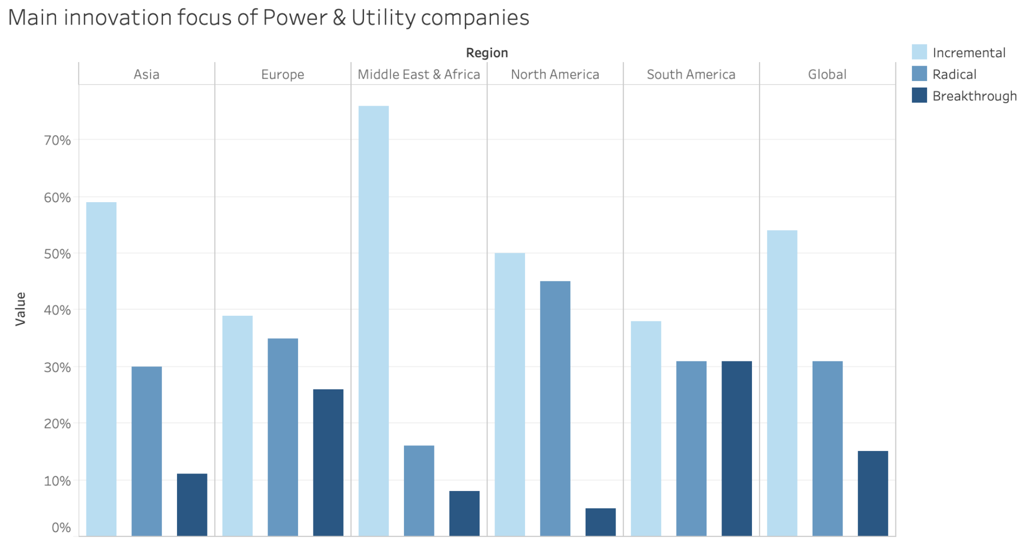


Figure 1.5: Main innovation focus of Power and Utility companies. Adapted from PwC Global Power & Utilities Survey 2018 [144].

1.1.3. Corporate Entrepreneurship and Corporate Venture Capital

So, the need for (BM) innovation is clear. But how can corporations foster innovation? This question is addressed by the concept Corporate Entrepreneurship (CE), which captures various means for innovation at the firm level [81]. A clear definition of the term was provided by Li Vigni [108] (p.31):

> *"Corporate Entrepreneurship is a paradigm encompassing new entries, entrepreneurial recombination of existing resources or, broadly speaking, business-oriented innovations which purposefully energize the organization in an attempt to improve its competitive standing."*

An overview of the different forms of CE is presented in Figure 1.6. As can be seen, the term consists of three highly related dimensions, namely strategic renewal, corporate venturing, and innovation [182]. The main distinction of Corporate Venturing with respect to the other dimensions is the fact that it mainly focuses on creating and integrating new businesses in the overall portfolio [129].

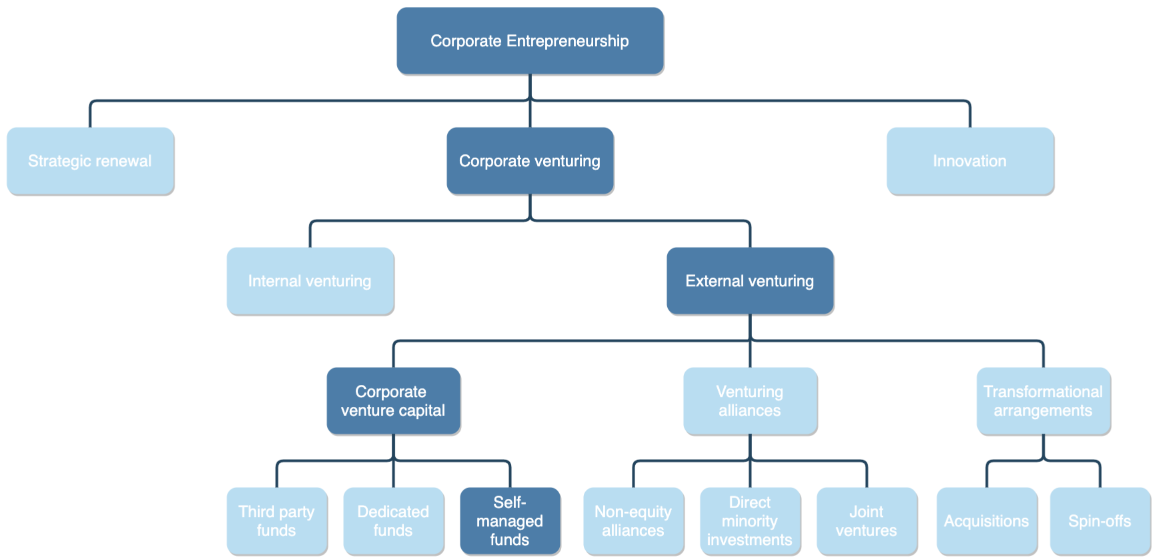


Figure 1.6: Different modes of Corporate Entrepreneurship, with the specific focus of this thesis highlighted. Own illustration, partly adapted from Maula [122], and extended based on Urbaniec & Żur [182].

Basically, two approaches towards CE exist, being *closed innovation* and *open innovation*. In the former case, corporations innovate from within the company, and all ideas and innovations stay between corporate borders [30]. On the other hand, in an open innovation approach, ideas and innovations can also originate and go to market externally [185]. This distinction also holds for Corporate Venturing – which focuses on creating and integrating new businesses in the overall portfolio [129] – as this can be subdivided into internal venturing and external venturing. The latter can again be subdivided into three different forms. However, a detailed description of all forms is beyond the scope of this research. This thesis focuses specifically on Corporate Venture Capital, as this is the approach that has been adopted by many large European electric utilities. Through CVC, they invest in innovative start-ups whose activities are related to the (future) electricity sector in its broadest form. In this way, they aim at keeping the lead in a rapidly changing industry [111].

The leading definition of Corporate Venture Capital in this thesis is adopted from Dushnitsky [53]:

"[Corporate Venture Capital is] a minority equity investment by an established firm in an entrepreneurial venture that seeks capital for growing its operations."

Where in the past companies were mainly engaging in CVC investments to boost their financial performance, nowadays their approach has changed [21]. To be able to respond to several industry reshaping trends, companies are using CVC and other venturing tools to drive innovation. Moreover, as Casey et al. (2019, p.10) state in a Deloitte report about the future of CVC: "CVC is no longer an instrument to only explore new technologies and business models. Together with business transformation and Disruptive Mergers and Acquisitions (M&A), CVC is becoming a growth instrument to fuel new business opportunities in both the core business and adjacent sectors and drive transformation." In other words, CVC is becoming increasingly recognized as pivotal in driving multiple forms of innovation.

This trend is clearly reflected in the amount of CVC investments over time. Dushnitsky [52] found that CVC investing follows wave patterns in which the activities increase and decrease accordingly over time, and that since 2003 the fourth large wave has begun. Where the three previous waves are identified with the described purely financial orientation, the current one will be different as CVC is becoming a well-established development activity besides Research and Development (R&D) and M&A [21]. The increasing importance of CVC investments is reflected in the amount of total Venture Capital (VC) money invested during the past years, presented in Figure 1.7 [96].

As can be seen, both CVC-backed funding and deals have been strongly increasing during the past years. Besides the absolute growth of CVC activities, also the share of CVC in total VC activity has increased [96]. In Europe, CVC-backed funding and deals increased with even larger numbers. Europe now makes up 19% of total global CVC activity, led by the UK and Germany [96]. In the Netherlands, CVC activities are still on a relatively low level, but a clear growing trend is visible as well [26]. Seven percent of Dutch CVC investments during the past decade are in the New Energies sector; most of them happening between 2016 and 2018 [26].

This increasing investing trend for the energy sector is clearly reflected in the amount of corporate spending in energy technology companies, presented in Figure 1.8 [4]. Besides the fact that overall investment is growing, it stands out that these investments are not only made by energy companies, but also by companies from the Information and Communication Technology (ICT) and transport sectors. Although this trend may seem surprising at first, it perfectly reflects the transforming energy sector. As the International Energy Agency (IEA) [3] puts it: "The growing presence of these firms in the development of energy technologies reflects a blurring of the boundaries between 'traditional' and 'non-traditional' energy companies, largely driven by the types of new technologies that are expected to shape our energy future."

So, it has become clear that companies are increasingly pursuing Corporate Venture Capital activities as a component of their open innovation strategy [3]. In a rapidly and fundamentally changing energy landscape, traditional energy companies will have to innovate and transform their business models into one that fits the future energy system. The collaboration with start-ups through Corporate Venture Capital has turned out to be a promising means of achieving that, and is already becoming a conventional corporate development strategy [21]. However, the success of these activities depends on multiple factors and cannot be a priori guaranteed. In the next section, the central problem statement of this research will be outlined.

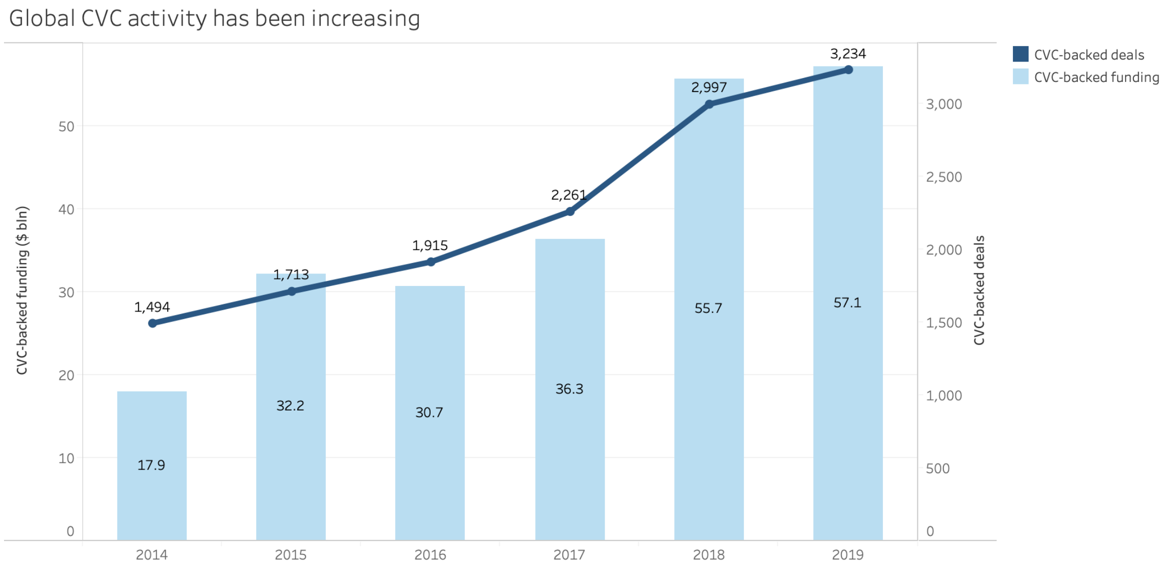


Figure 1.7: Global CVC-backed funding and deals between 2014 and 2019. Adapted from CB Insights [96].

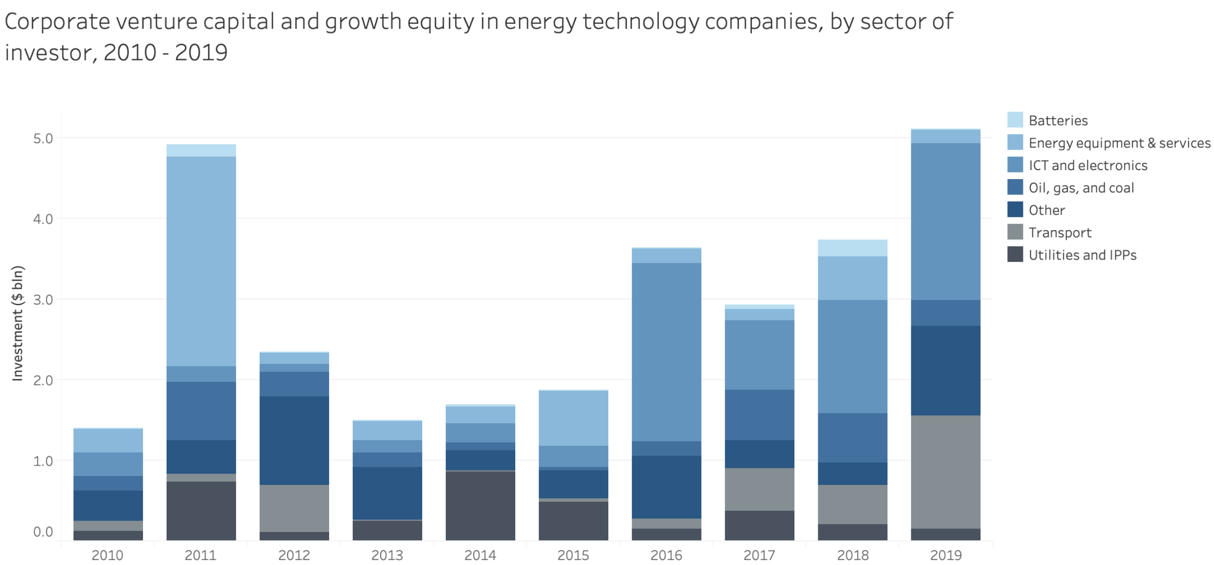


Figure 1.8: Global Corporate Venture Capital and Growth Equity investment in energy technology companies between 2010 and 2019, by sector of investor. Adapted from IEA [4].

1.2. Problem Statement

Having obtained more insight into the challenges that lay ahead for the European electric power sector, the first problem already arises. With the introduction of the European Green Deal in 2019, the European Commission has taken the agreements of the 2015 Paris Climate Convention to the next level by setting even more ambitious objectives to decrease carbon emissions and drive the energy transition [40]. Meeting all objectives will be a huge challenge, and the electric power sector will have to play an important role. Moreover, besides the energy transition the power sector has to cope with multiple other challenges as digitization, decentralized generation, and energy storage [152]. All these trends pose potential threats to the traditional power company business model, therefore creating a need for new, fundamentally transformed business models. Power companies failing to acquire these new capabilities will have to fear the risk of losing their competitive position and ultimately even bankruptcy [151], [152].

Now the strong need for business model innovation in the power sector is clear, the next problem arises. The power sector is changing at a fast pace, so concrete actions have to be taken as soon as possible [144]. However, despite the fact that most industry leaders seem to recognize the importance of fast business model innovation, real action appears to be lagging behind. Although being ahead of most of the rest of the world, only 33% of European power industry leaders reported significant change to their business models [144]. If the other 67% do not follow shortly, they might miss the boat [144].

In search for future business models and to drive innovation, an increasing number of power companies has started Corporate Venture Capital activities [111]. Where these activities used to be mainly focused on financial benefits, during the past years a more strategic focus has gained a lot of ground [21]. In that respect, CVC is not only recognized as a means to explore new technologies and business models, but even identified as fueling new business opportunities and drive transformation [26]. This vision is reflected in the steeply increasing trend in the amount of CVC activity during the past decade, as was shown in Figures 1.7 and 1.8 [4], [96].

However, establishing a CVC program does not automatically imply successful business model innovation. Many collaborations between a parent company and its ventures do not work out well, and CVC programs in the European energy sector have failed before [180]. On the other hand, utilities have only recently put their focus on fundamental innovation, and more specifically, on open innovation [111]. In that sense, the current situation differs from the past. Since in the past CVC activities used to be mainly aimed at generating financial returns, their success was mainly evaluated in financial terms as well [52]. Nowadays, the focus has shifted to generating strategic benefits, e.g. CVC as an instrument to drive (BM) innovation and fuel new business [21], [26]. As a result, their means of evaluation will probably have to change as well, in a way that better suits the changed purpose of these activities. In that respect, both for researchers and for power utility managers it could be insightful to have a clear overview of how CVC activities can exactly contribute to Business Model Innovation. After all, that seems to be the most prevalent reason why most European electric utilities have established CVC programs [111]. However, as a result of the emerging nature of these phenomena, in research it is not yet clear how CVC activities can exactly contribute to business model innovation of electric utilities.

So, the problem that this research will address consists of multiple layers, but is specifically focused on the unclear potential contribution of CVC to business model innovation. Therefore, the problem can be captured in the following statement:

It is unclear how Corporate Venture Capital activities of electric utilities can exactly contribute to innovation of their business models, which is required as a result of the rapid changes in the energy sector.

Hereby, it must be noted that in this research the terms ’power sector’ and ’energy sector’ are used interchangeably. The next section will address the state of literature on these subjects, resulting in an academic knowledge gap.

1.3. Knowledge Gap and Relevance of the Research

The results from a literature review suggest that academic literature on business model innovation, Corporate Venture Capital, and the two subjects combined, leaves considerable space for additional research, especially for the energy sector.

As acknowledged by Richter [147], [148], the current knowledge on business model innovation in the energy sector seems to be limited but can be of high importance for utilities to respond to the external challenges of a changing industry. The same goes for Corporate Venture Capital, as confirmed by Livieratos and Lepeniotis [111]. They were the first to concern CVC programs of European electric utilities, and linked it to open innovation. Further, they explicitly acknowledged that the current knowledge on this subject is very limited. Moreover, integrated studies on the combination of CVC and (business model) innovation has attracted only minor attention from researchers, as was confirmed by Loredo et al. [113] who called upon researchers to integrally explore (business model) innovation and external venturing activities of utilities: ”Finally, due to their traditional monopolistic organizational cultures, utilities are relative newcomers in the open innovation paradigm. Nevertheless, many large utilities are now common players in the external corporate venturing market. They actively seek for ideas and startups that could complement their knowledge portfolio. This new reality opens a promising window for future research." (p.10).

To verify this lack in academic research, a search in Scopus was performed with keywords ("business model innovation" AND "corporate venture capital"). This resulted in only two hits, of which the first focused on e-service innovations and corporate entrepreneurship in general, while the second focused on an analysis of all Corporate Venture Capital activities in Germany between 2000 and 2003. As a result, both were found to be irrelevant to the focus industry. Also, both papers were not published recently (2003 and 2006). This irrelevance was confirmed by two other searches with keywords ("business model innovation", "corporate venture capital", energy) and ("business model innovation", "corporate venture capital", utilities), which both resulted in zero hits.

So, to the best of author's knowledge, this research would be the first to explicitly relate Corporate Venture Capital programs of (European) electric utilities to their business model innovation aspirations. Therefore, and given the limited state of academic literature on the separate subjects, this research could be a valuable contribution to these fast-growing phenomena.

This research is conducted as the final part of the Master's program Sustainable Energy Technology at the Delft University of Technology. The field of Sustainable Energy Technology captures all activities related to renewable energy sources and efficiency improving energy technologies [42]. Fundamental innovations will be required to shape a sustainable energy future, but only developing these innovations is not sufficient. Knowledge of natural sciences and engineering must be integrated with insights from economics, the humanities, and the social and behavioural sciences. In this respect, this research takes an integrated approach and touches important subjects as the future energy system, technology-based entrepreneurship, and business model innovation. The outcomes of this research will have both scientific relevance and managerial relevance, as well as societal relevance.

First of all, in a scientific perspective, this thesis contributes to research on business model innovation and Corporate Venture Capital, both in general and in the electric power sector in specific. A literature study has shown that the current state of (integrated) literature on these subjects leaves considerable space for additional research. In that sense, all further research will be a valuable contribution, but the outcomes of this research will particularly fill the identified research gap: the unclear contribution of Corporate Venture Capital activities to business model innovation of electric utilities.

Secondly, the outcomes of this research will have managerial relevance. As many CVC programs are established in a (business model) innovation perspective, this research would be useful to any - particularly European - electric power company, both with and without Corporate Venture Capital programs in place. By shedding a new light on the actual potential contribution of CVC activities and business model innovation, companies with CVC programs in place could re-evaluate their activities to make sure they are well aligned with the long term goals of fundamental innovation, the energy transition, and other identified key changes in the power sector. On the other hand, power companies without CVC programs in place could use the outcomes of this research to assess their own actions to achieve business model innovation, and compare the expected outcome of those with pursuing CVC activities.

From a start-up point of view, a more clearly defined relation between CVC programs and business model innovation of incumbent utilities, leading to better insight in their rationale behind CVC, may lead to better assessment capabilities in their search for funding. The outcomes of this research could help start-ups to find an investing company that matches their own. In this way, the chances for a positive parent-venture collaboration could increase, leading to higher success rates of CVC programs and increased overall investments; all meaning an eventual important contribution to the energy transition.

Thirdly, the outcomes of this research will have societal relevance. What is already captured in the term 'utility', is that the subject of concern is relevant to every human on this planet. In that sense, the changes in the power sector directly affect the way of living and working of each and every citizen. For example. a continuously increasing share of the population has some level of demands regarding the carbon footprint of the electricity they consume. Also, more and more customers are interested in generating their own electricity, or buying an electric car. By boosting business model innovation of incumbent utilities through CVC, these goals might be faster or more efficiently achieved.

Now the knowledge gap and relevance have been discussed, the research objective and research questions can be addressed, which is done in the next section.

1.4. Research Objective and Research Questions

In respect to the problem described in section 1.2, and taking into account the academic knowledge gap in the subjects addressed in section 1.3, the objective of this research is *to improve the understanding of the potential contribution of Corporate Venture Capital activities to business model innovation of European electric utilities*. As we have seen, the need for business model innovation of electric utilities results from a variety of developments (e.g. the energy transition) that are changing the energy sector as a whole.

From this objective, the following main research question is derived that this thesis will address:

How can Corporate Venture Capital contribute to Business Model Innovation of electric utilities in response to the developments in the energy sector?

The process towards answering the main research question will be shaped by several sub research questions. Through the chronological answering of these questions, eventually the main conclusion will be derived. The sub research questions are formulated as follows:

1. ***What are the currently existing types of business models for electric utilities?***
2. ***What are the major developments in the energy sector and to what extent are current electric utility business models adapted to these developments?***
3. ***What are the barriers to Business Model Innovation of traditional electric utilities in order to adapt to the energy sector developments?***
4. ***What is the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments?***
5. ***To what extent can the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments be seen in practice?***

To be able to answer each of the presented sub research questions, a varying methodology will be required. This will be more extensively outlined in Chapter 2. Furthermore, time and resource constraints will lead to the exclusion of parts of the analysis. In that respect, the research scope of this thesis is clarified in the next section.

1.5. Research Scope

This research studies the relationship between Corporate Venture Capital programs and business model innovation of electric utilities. Inevitably, this induces exclusion of in-depth analysis of certain elements because of strict time and resource constraints.

First of all, the scope is defined in a sectoral manner, which is graphically represented in Figure 1.9. As can be seen, this research is strictly limited to electric utilities, of which a leading definition will be provided later. Furthermore, the scope of this thesis has been limited to the following content:

- **Spatial:** Only European electric utilities will be assessed
- **Corporate Entrepreneurship activities:** only Corporate Venture Capital activities will be assessed, and no other types of CE or CV activities
- **Innovation types**: Only business model innovation will be assessed, and no other types of innovation

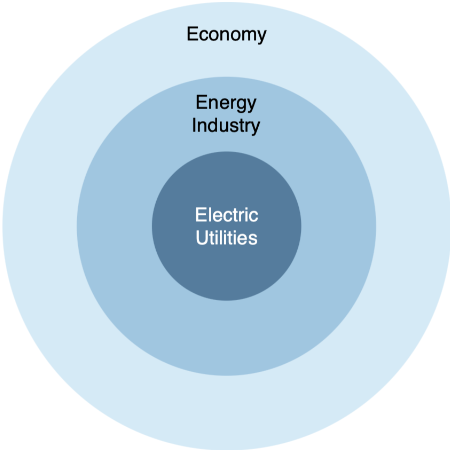


Figure 1.9: Sectoral scope of this research: electric utilities.

1.6. Thesis Structure

The remainder of this thesis is structured as follows. In the next Chapter 2, the research approach and methodology are described. Then, in Chapter 3, the current types of business models of electric utilities are addressed. Subsequently, Chapter 4 goes into detail on the major developments in the power sector and addresses current alignment of utility business models with those developments. In Chapter 5, the process of business model innovation of electric utilities is addressed, where after Chapter 6 discusses CVC activities of electric utilities, and relates them to the barriers of BMI. Then, the results of a case study will be discussed in Chapter 7, which also leads to a conceptual framework that addresses the contribution of CVC to BMI of electric utilities. Finally, in Chapter 8 the research questions will be answered, after which the results will be discussed in Chapter 9.

2 Methodology

The background information and first literature review on the subjects of this thesis have resulted in a clear problem statement and academic knowledge gap, based on which the research questions were devised. In this chapter, the research approach and methodology are outlined.

2.1. Research Approach

To be able to eventually answer the main research question, first a comprehensive approach must be chosen. The choice for an adequate research approach depends on the nature of the subject.

As discussed in Chapter 1, the current state of knowledge of both business model innovation and CVC activities of electric utilities is limited. Therefore, an exploratory qualitative research approach has been chosen as the most appropriate, as the aim is to better understand the nature of this evolving subject [158]. An exploratory approach allows a researcher to focus on gaining more insight into certain phenomena, rather than providing conclusive answers to problems [39]. A more extensive investigation on the subject is left for further, more in-depth research. Business model innovation and CVC activities of utilities are both quite new phenomena, with an uncertain future. As the focus here is indeed on better understanding both phenomena and their relationship, an exploratory qualitative approach is the most suitable.

Besides this, a case study approach has been chosen to conduct this research. The rationale for this is based on several factors. First of all, a case study is a useful approach when the focus is on an exploratory analysis of contemporary phenomena as business model innovation and Corporate Venture Capital, of which a part has not yet been described in literature [198]. Secondly, in this way a holistic view of the subjects can be obtained, and the emergent and inherent characteristics of rapidly changing contexts can be captured [111]. As both business model innovation and Corporate Venture Capital for electric utilities can be considered rapidly changing contexts, this suits the benefits of a case study approach quite well.

Also, it has been chosen to address two different cases, each concerning a traditional utility. The choice to assess two different cases was mainly based on the comparison opportunities that it would enable, while simultaneously still obtaining a sufficient level of detailed information. One case would have led to comparability issues, and three cases would have led to too little detail. Also, it was chosen to analyse two European traditional utilities that are both active in multiple countries, and of which one is even globally active. In this way, large differences due to geographic issues or company size issues would be avoided.

First, an extensive literature study has been conducted on each of the main subjects of this thesis: business models, business model innovation, and Corporate Venture Capital activities; all in the context of European electric utilities. Subsequently, two European electric utilities with Corporate Venture Capital programs in place have been taken as case study. It was chosen to select two utilities that are active in the Netherlands, the Dutch Eneco and the French ENGIE. The CVC program of Eneco, Eneco

Ventures is run from one office, located in Rotterdam, the Netherlands. The CVC program of ENGIE, ENGIE New Ventures is run from a few offices all around the world, but its head office is located in Paris, France. In Chapter 7, additional information about these utilities and their CVC funds will be provided.

As outlined in the previous chapter, the process towards answering the main research question of this thesis is shaped by several sub research questions. The answering of these sub research questions requires a different methodology. As such, the next section will address the methodology for each sub research question in more detail.

2.2. Research Methodology

In this section, the different methodologies are described that will be used to answer the different research questions of this thesis. In total, four different methodologies have been used: literature review, expert consultations, expert interviews, and desk research.

2.2.1. Literature Review

The objective of the literature review was to obtain a thorough understanding of the basic concepts of this research: business models, business model innovation, and Corporate Venture Capital - all in the context of (European) electric utilities. Based on the outcomes of the literature review, a case study has been conducted to illustrate and concretize these findings. Therefore, it is important that all concepts were first fully understood. The literature mainly consisted of articles, other master theses, and books. If the amount of literature happened to be insufficient, grey literature was added to the review.

As the analysis part of a literature review lacks a particular developed standard, the general objective was to critically examine the literature [163]. Moreover, it required a high level of conceptual thinking. To encourage this, at the end of each chapter a graphical representation of the progress made in that specific chapter is presented. In this way, the different components involved in the build-up of this research can be clearly distinguished.

2.2.2. External Industry Expert Consultations

Secondly, it was decided to consult with two external industry experts. The energy sector is a sector that is rapidly developing, which might rapidly decrease the current relevance of research that has been conducted in the past. Therefore, it is insightful to obtain additional insights on some subjects, which can be used to compare previous research with current insights from experts that possess a vast amount of industry knowledge. To avoid or decrease potential biases from the experts, two experts have been chosen that represent different perspectives of the energy sector. As such, one expert was selected from research institute TNO [48], who conducts in-depth research on all aspects of the energy sector, including utilities. Secondly, an expert was selected from Strategy& [187], a management consulting firm that consults large utilities, among others. In this way, a valuable combination of two different perspectives was obtained. So, the insights from experts on multiple relevant subjects of this thesis have been used to assess whether the literature study results are complete, consistent, and corresponding to current practice.

Besides a video conversation with each expert, which both had a duration of about one hour, also a short survey was sent after the conversations in which they were asked to assess the relevance of specific subjects that might have not been discussed during the conversations. A summary of the outcomes of the expert consultations is provided in Appendix B.

2.2.3. Desk Research

As first part of the case study, a desk research has been performed. On the one hand, this involved studying of general case-related sources for preparation purposes and obtaining a better grasp of the two utilities that have been assessed. On the other hand, the desk research served another, more specific purpose. As this research involves Corporate Venture Capital activities in the energy sector, the differences with CVC activities in other sectors had to become clear. In that respect, especially in line with the research objective of this thesis – analysing how CVC can contribute to stimulate BMI of electric utilities – it is highly important in which types of ventures the two utilities invest through their CVC funds.

Therefore, the desk research involved an analysis of the venture portfolios of both CVC funds. The results have been compared to previously obtained findings from literature and expert consultations, and have as such been a useful component of the case study.

2.2.4. Utility Expert Interviews

Finally, interviews with utility experts have been conducted. The objective of these interviews was to assess to what extent the findings obtained though the literature study and expert consultations could be found in utility practice. In total, six in-depth interviews have been conducted, three for each case. For both cases, these three interviews included two different perspectives. Per utility, one interviewee was selected from the CVC perspective, and two from the incumbent utility (Strategy or Innovation departments) perspective. In this way, a holistic approach has been guaranteed. Mainly due to the COVID-19 pandemic, it was not feasible to conduct the interviews face-to-face. Therefore, they have all been conducted via video call. To guarantee reliability, all interviews have been recorded as well, for which all interviewees have given their permission. Subsequently, they have been transcribed by using one of the many available software tools. To avoid errors in the transcription, the transcriptions have been reviewed by comparing them to the original recording, and have been corrected where necessary.

Of the existing types of interviews, the *semi-structured interview* has been selected to be the most appropriate, as semi-structured interviews are useful when in-depth information needs to be collected from multiple interviewees [58]. By using a set of predetermined questions, consistent, detailed and directly comparable results could be obtained, which has been beneficial for the validity of the analysis. The interview questions have been composed based on the previously obtained insights from literature study and expert consultations. Moreover, for each interviewee type (incumbent utility and CVC perspective), a different set of questions was composed. Obviously, these lists showed significant overlap, but more emphasis was put on the specifics of the roles they represented.

To increase the validity of the interviews, it is beneficial to have the interviewees answer a few exactly similar questions. Also, by asking open questions, some important and relevant subjects may be overlooked. Therefore, a short survey has been added to all interviews, in which all interviewees had to answer the same few questions. Also, by sending the survey in advance of the interviews, the answers could be further discussed during the interviews. The downside of this choice is that a bias might have appeared, which will be further addressed in Chapter 9. Finally, in line with the exploratory nature of this research, it must be noted that the aim of the survey has been in no way to provide statistically significant results, but only to provide a more clear and complete picture of the researched subjects.

As semi-structured interviews consist of open questions, the resulting amount of qualitative data has been considerably large. Therefore, a structured and careful analysis of the results was required. A more formal content analysis, for example coding, was not found to be necessary due to the limited number of interviews and the nature of the subject of this thesis, which does not require highly detailed, word-for-word analysis. So, the transcriptions have been analysed step-by-step, per major subject that they relate to.

The exact setup of the interviews, including more general information about the cases and a list of job titles of interviewees, will be further addressed in Chapter 7. Also, the interview questions are presented in Appendix A. However, a final important note has to be made, regarding the anonymity of the interviews. After the interviews, all interviewees were asked for their preferences with respect to this matter. Despite the fact that most interviewees did not have large issues with relating their sayings to the name of their company (and their own names), a few interviewees did explicitly not want this, and only gave their permission for including a general table with job titles. Therefore, it was decided completely anonymize all interview results, so they can be neither related to specific companies, nor to individual interviewees. In that respect, it was also chosen not to include interview transcripts or summaries in the appendix of this thesis.

Although sometimes anonymity can lead to less clarity in the analysis of results, according to author this has not been the case here. Therefore, it can be argued that the anonymity of the interviews does not decrease the contributing value and relevance of this research.

Now all different methods have been described, the next section addresses the research flow of this thesis, describing the methods with which each sub question is used.

2.3. Research Flow

In this section, the different steps are outlined that need to be taken to answer the main research question of this thesis:

How can Corporate Venture Capital contribute to Business Model Innovation of electric utilities in response to the developments in the energy sector?

This section describes all the needs for answering the sub research questions, including the required data, appropriate research methods, and the appropriate tools. Furthermore, the full research design will be presented in a research flow diagram.

1. ***What are the currently existing types of business models for electric utilities?***

Before being able to dive deeper into the subject of business model innovation of European electric utilities, first a thorough understanding of currently existing utility business models had to be obtained. This would provide the basis for the remainder of the research and has thus been part of the conceptual phase. The first appropriate research method for this part was a literature study, to obtain as much relevant information on this subject as possible. Besides this, it was decided to consult the two industry experts on this subject, to assess whether the literature on BM types for electric utilities was complete, consistent, and corresponded to current practice.

Furthermore, to be able to consistently analyse and compare different business model types of utilities, the Business Model Canvas has been applied. Besides this, the BMC was also used to provide a graphical representation of each BM type. With the outcomes of this analysis, the first sub research question could be answered. Furthermore, it has been used as input to the second sub research question of this thesis.

2. ***What are the major developments in the energy sector and to what extent are current electric utility business models adapted to these developments?***

To be able to assess the subject BMI of electric utilities, it had first to become clear why there would be a need for BMI at all. Obviously, the energy sector is subject to various important changes, of which the energy transition is a well-known example. However, this is not the only development that is changing the industry. In addition, after all important developments had been identified, it had to become clear to what extent the different currently existing business models of electric utilities were adapted to these developments. This second sub research question has provided the basis for the remainder of the research and has thus been part of the conceptual phase as well.

First, an extensive literature study was used to gather in-depth insights on the different major developments that are changing the energy sector, as well as a general evaluation of the current rate of adaptation of utility BMs with these developments. Secondly, to assess whether the literature study results are complete, consistent, and corresponding to current practice, the two industry experts were consulted on this subject as well. Moreover, with respect to the current rate of adaptation of utility BMs to all major developments, a more specific evaluation was required to provide a starting point for the further analysis. In that respect, the different BMs have been scored by the two experts on a five point Likert scale, which had to provide a good understanding of where the different utilities currently stand.

With the outcomes of this analysis, the second sub research question could be answered. Furthermore, it has been used as input to the third sub research question of this thesis.

3. ***What are the barriers to Business Model Innovation of traditional electric utilities in order to adapt to the energy sector developments?***

After the second sub research question has addressed the major developments in the energy industry and the current rate of adaptation of utility BMs with those developments, this third sub research question addressed the process of BMI in more detail. As such, it has analysed the different possibilities for limited adaptation of utility BMs to the developments, which have all been translated into potential barriers to BMI of electric utilities. The large, incumbent *traditional utility* was from now on the only type that was further assessed, because of the fact that this is the only type of utility that pursues CVC activities. The analysis for this third research question was still part of the conceptual phase of this thesis.

Again, first an extensive literature study was performed to gather in-depth knowledge of all potential barriers to BMI of electric utilities. Then, again the two industry experts were consulted, to assess whether the literature study results are complete, consistent, and corresponding to current practice. With the outcomes of this analysis, the third sub research question of this thesis could be answered. Also, it has been used as input to the fourth sub research question.

4. ***What is the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments?***

After assessing the potential barriers to business model innovation of electric utilities, the potential contribution of Corporate Venture Capital programs to overcome these barriers and better adapt to the energy sector developments could be assessed in more detail. This formed the fourth and final part of the conceptual phase.

Through an extensive literature study, the characteristics and, more importantly, the specific potential benefits of CVC activities for electric utilities have been identified. As this was no subject in which the industry experts had much expertise, the potential benefits of CVC were only generally discussed. Furthermore, based on all previously obtained insights, the potential contribution of these CVC benefits to remove or circumvent the barriers to BMI has been assessed. Together with the outcomes of the first three sub research questions, the outcomes of this analysis have been used as input for the empirical phase of this research, which relates to the fifth and final sub research question.

5. ***To what extent can the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments be seen in practice?***

This fifth sub research question formed the empirical phase of this thesis. In this phase, a case study has been conducted to assess the extent to which the potential contribution of CVC activities to overcome the barriers of BMI for electric utilities could be seen in practice. As explained in section 2.1, the case study involved two European electric utilities that are active in the Netherlands, and have a CVC program in place (not necessarily run from a Dutch office). The aim of the case study has been to illustrate and concretize the previous findings. In this way, the thoroughness of the research had to be increased. Also, the case study had to provide additional in-depth insights on the previously analysed subjects in the specific context of the two incumbent utilities.

First, a desk research has been conducted to study case-related sources for preparation purposes. The case study itself has been performed by conducting six in-depth expert interviews, three for each case, one from the CVC perspective, and two from the incumbent utility (Strategy or Innovation departments) perspective. After the results had been analysed, they have been compared to the previous findings that emerged from literature study and expert consultations. Thereafter, a conceptual framework was composed to illustrate all findings.

Eventually, all results have been taken to the analysis and conclusion phase, in which an answer to each research question has been formulated. Finally, the results have been discussed and theoretical and practical implications have been provided.

A schematic overview of the full research process is provided in a research flow diagram, as presented in Figure 2.1.

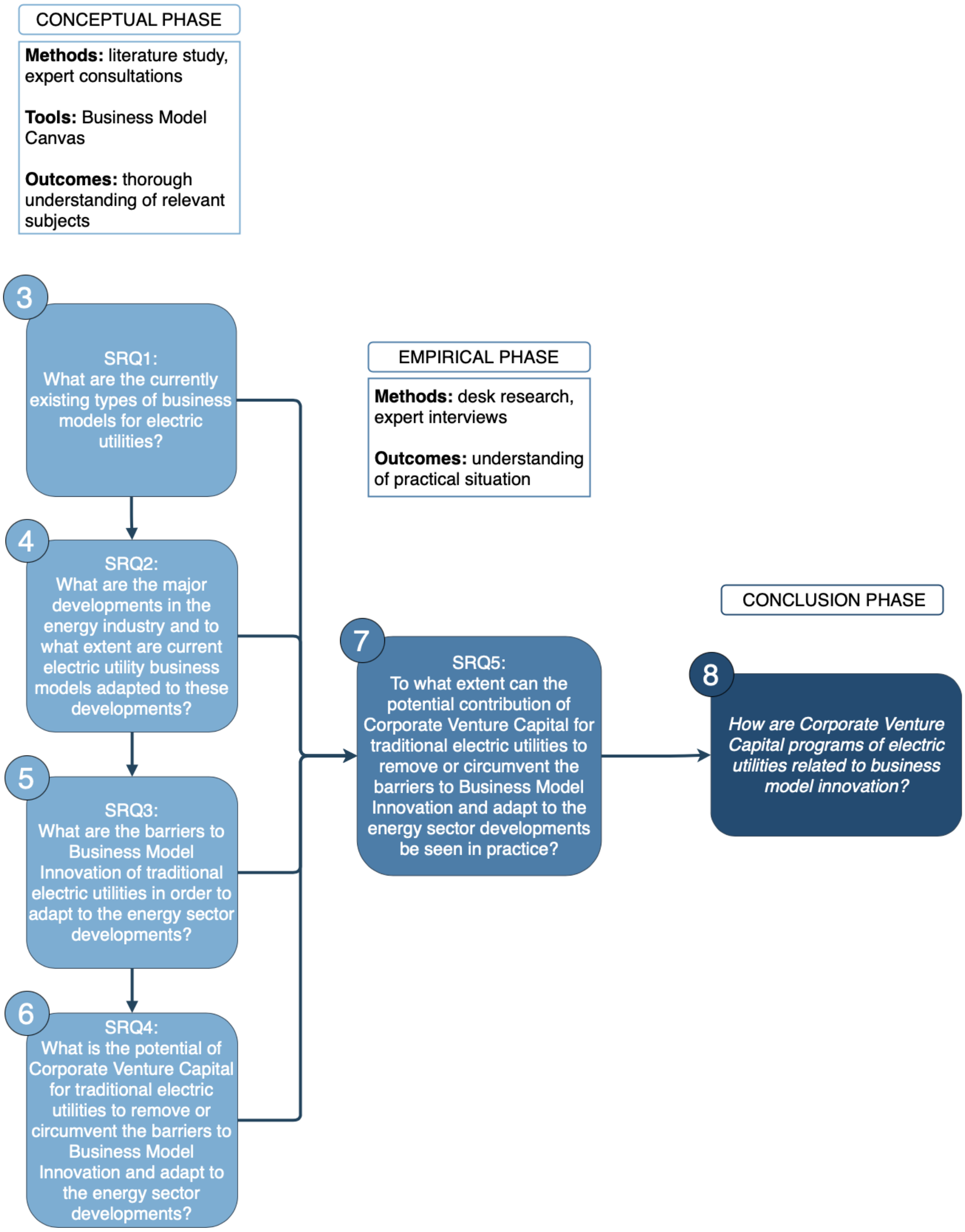


Figure 2.1: Research Flow Diagram of this thesis.

3
Business Models of Electric Utilities

After having described the research approach and methodology in Chapter 2, this chapter will address the first step towards answering the main research question of this thesis. It does so by analysing the currently existing Business Models of electric utilities in Europe. The findings of this chapter will be used to answer the first sub research question of this thesis:

What are the currently existing types of business models for electric utilities?

First of all, in section 3.1 the terms 'business model' and 'electric utility' will be defined. Hereafter in section 3.2, the methodology for comparing different types of business models will be discussed. When this has become clear, the traditional business model of an energy utility will be specified in section 3.3, followed by new emerging types of business models in section 3.4. Finally, a summary of the main findings of this chapter will be provided in section 3.5.

3.1. Business Models, Electric Utilities, and Electricity Value Chain

Throughout time, researchers have introduced various definitions and descriptions of a business model. To get a sense of what the term is about, an overview of some of the existing definitions of a business model is provided in Table C.1 in Appendix C.

As can be seen in the table, many different definitions exist and it can be concluded that a commonly accepted definition is still lacking [109]. However, one could say that it is widely agreed upon that business models are a conceptual link between strategy, business organization and systems [109]. Moreover, the purpose of a business model can be expressed as creating, delivering, and capturing value [109]. This purpose is also captured in the definition of a business model provided by Osterwalder & Pigneur [136]:

"A business model describes the rationale of how an organization creates, delivers, and captures value."

According to author, this definition does appeal the most to the imagination and perfectly expresses what the term is about. Moreover, the business model definition and concept of Osterwalder & Pigneur have been broadly tested in practice, including in the energy field [135], [147]. Therefore, this definition and concept will also be leading in this thesis.

However, the subject 'business models of energy utilities' demands not only clarification on the former part, but also on what an energy utility exactly is and what it does. Basically seen, as Talukdar et al. [172] put it, the purpose of an electric utility is "to deliver electric energy to its customers". According to author, this definition is reflecting the general nature of an electric utility quite well and will therefore be leading in this thesis. Despite this definition being watertight, it might demand some further clarification.

According to Stephens et al. [169], the historical purpose of an electric utility "has been to generate and distribute electricity to households, communities, businesses and other organizations, recovering their costs through rates charged". This gives already a better idea of the activities that electric utilities undertake, but it will be even more insightful to also take a look at the traditional electricity value chain, as presented in Figure 3.1 [146].

As can be seen in the figure, the traditional electricity value chain consists of five parts; generation, transmission, distribution, retail, and consumption. When electricity is *generated*, this means that primary energy resources are converted into electric power; *transmission* refers to the transport of that electricity over the transmission grid, implying long distances and with high voltages [146]. The responsible party for balancing supply and demand is the Transmission System Operator (TSO). Subsequently, the electricity is *distributed* to end-consumers via distribution networks, for which the Distribution System Operator (DSO) is responsible [146]. Finally, *retail* refers to the purchase of power from producers and the sale of it to end-consumers, after which the electricity is *consumed*.

Traditionally, electric utilities have been operating across the entire value chain [82], recovering costs for electricity generation, transmission, and distribution, by selling it to end-consumers [23]. However, the transformation towards a more sustainable energy production system based on Renewable Energy Sources (RES) has a large effect on the industry structure, as well as on the way how electricity is produced, transmitted, and sold [70], [146], [147]. Because it immediately speaks to the imagination, this new projection of the energy system can be best described graphically, as shown in Figure 3.2. As can be seen, the most important differences with the traditional value chain is the renewables-based generation, the two-way flow of power (and money), and a large increase of behind-the-meter options, for example distributed generation and storage, smart meters, and Electric Vehicle (EV) charging. Together, this can be roughly captured in Decarbonization, Digitalization, and Decentralization [44], [117].

Nine years ago, Schleicher-Tappeser [156] pointed at having reached the point of no return in the global energy transition towards distributed generation with renewable sources. Further, he argued that change could occur much more rapidly than expected, that the logic of electricity systems and markets would be fundamentally transformed, and that adapting to inevitable changes in time might become essential for competitiveness. Indeed, we have seen that these lines of reasoning have all become solid forecasts.

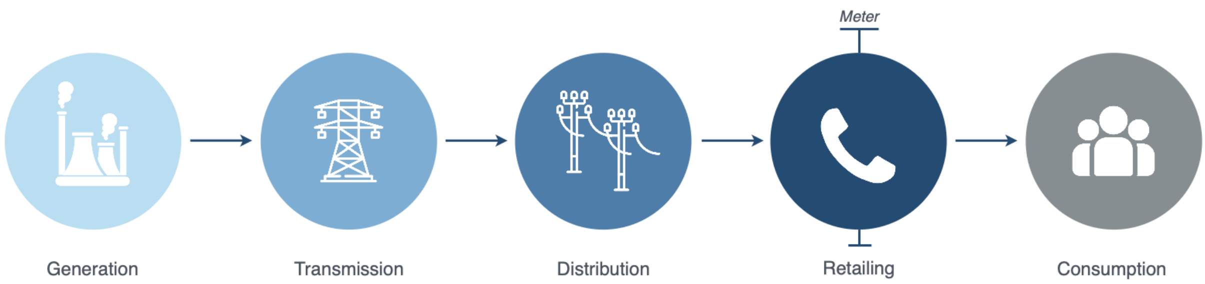


Figure 3.1: Traditional value chain of the electricity system. Own illustration, adapted from Critchlow (World Economic Forum) [41] and Richter [146].

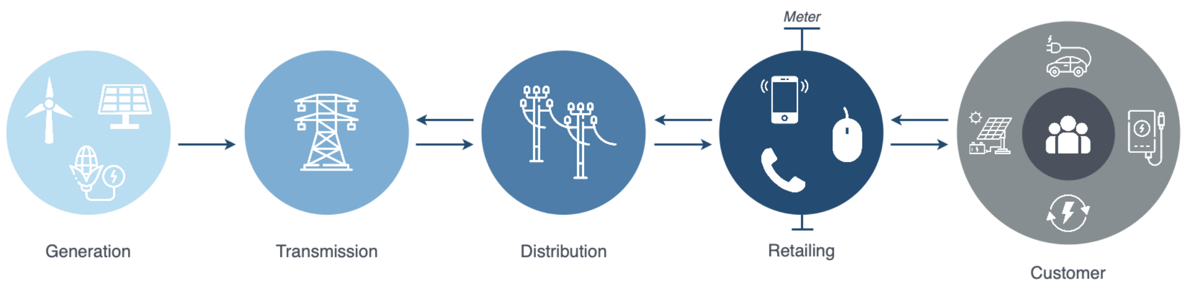


Figure 3.2: Future value chain of the electricity system. Own illustration, adapted from Critchlow (World Economic Forum) [41].

As such, it has turned out that the increasing share of renewable energy has threatened the traditional BM of electric utilities, resulting in a widely recognized need for alternative business models [23], [71], [79], [82], [85], [86], [146], [147], [148], [156], [197].

So, one type of the existing business models for electric utilities can already be distinguished: the *traditional electric utility business model*. Alternative types of business models that have been emerging during the past years have not been exactly defined yet, so those will require further analysis. However, directly comparing different business models requires a comprehensive, uniform method. As such, this method first has to be explained, which will be done in the next section. Thereafter, the traditional electric utility business model will be elaborated upon, followed by an analysis of other existing business model types.

3.2. Methodology for Comparing Different Business Models

To identify all different types of BMs of European electric utilities that are currently existing, an initial literature search was performed with a combination of the keywords ”electric utility”, ”business model”, and ”Europe”. While it was the intention to perform a range of other searches, using multiple scientific databases and various combinations of keywords, this initial search delivered one highly relevant result.

In that respect, it turned out that in 2018, a study was performed by Bryant et al. [23] that researched the existing types of business models for electric utilities in Europe, Asia, and Australia, in response to a knowledge gap on this subject. In line with the recent publication of this work, it was assumed that these findings would provide an excellent starting point for the analysis in this chapter. Obviously, the findings of Bryant et al. [23] were further assessed and verified with other literature. Nevertheless, it must be underlined that the basic distinction between different BM types was adopted from Bryant et al. [23], as according to author it would not have been relevant, both because of the recent publication and for the purpose of this research, to perform the same analysis again. However, for each BM type that was identified, additional literature was searched to assess the relevance of that specific type, and to assess whether no BM types were missed. Moreover, the business models were run by two industry experts [48], [187], which did not lead to any additional or different insights in this subject.

Furthermore, an instrument is adopted that enables the possibility to consistently compare different types of BMs. In that respect, the Business Model Canvas is seen as a valuable analysis tool by allowing for a structured comparison of companies and markets, both in general as in the energy sector [23], [85], [147], [166]. Also, it is considered to be ”the most widely adopted academic framework for business model innovation both among students and practitioners” [109]. This results from the fact that the BMC provides nine clear, different building blocks that together capture the essence of every organization. As such, it allows for structured comparison of building blocks between companies.

On the other hand, the BMC is also subjected to some criticism. For example, the Business Model Canvas is missing key dynamic elements of working business, coherence, the competitive position, and economic leverage points [64]. Therefore, it insufficiently addresses the flows and interrelationship between different business model elements [72], [153]. Furthermore, a few other drawbacks were discovered: too much simplicity leading to too little detail, and its fixed structure leading to less creativity [109]. Finally, the BMC has received the criticism that it implicitly de-emphasizes environmental and social value because of its more explicit economic value orientation [99].

For research purposes however, and more specifically, for being able to consistently compare the business logic across different organizations [23], the identified pros do seem to outweigh the cons. Therefore, the Business Model Canvas is chosen as the framework for analyzing and comparing different business models of electric utilities in this thesis. As such, the next sections will take the definition and conceptualization of the business model provided by Osterwalder & Pigneur [136] to the electric power industry to identify the existing different ways of how an energy utility aims to create, deliver, and capture their value. In addition, another benefit of the BMC is that it provides a clear graphical representation of a BM. An example of this, tailored to electric utilities, is presented in Figure 3.3.

Finally, besides a description of the different components of a BM, and graphical representation in a Business Model Canvas, for each utility type an overview of its specific position within the value chain will be provided, including flows of energy and payments.

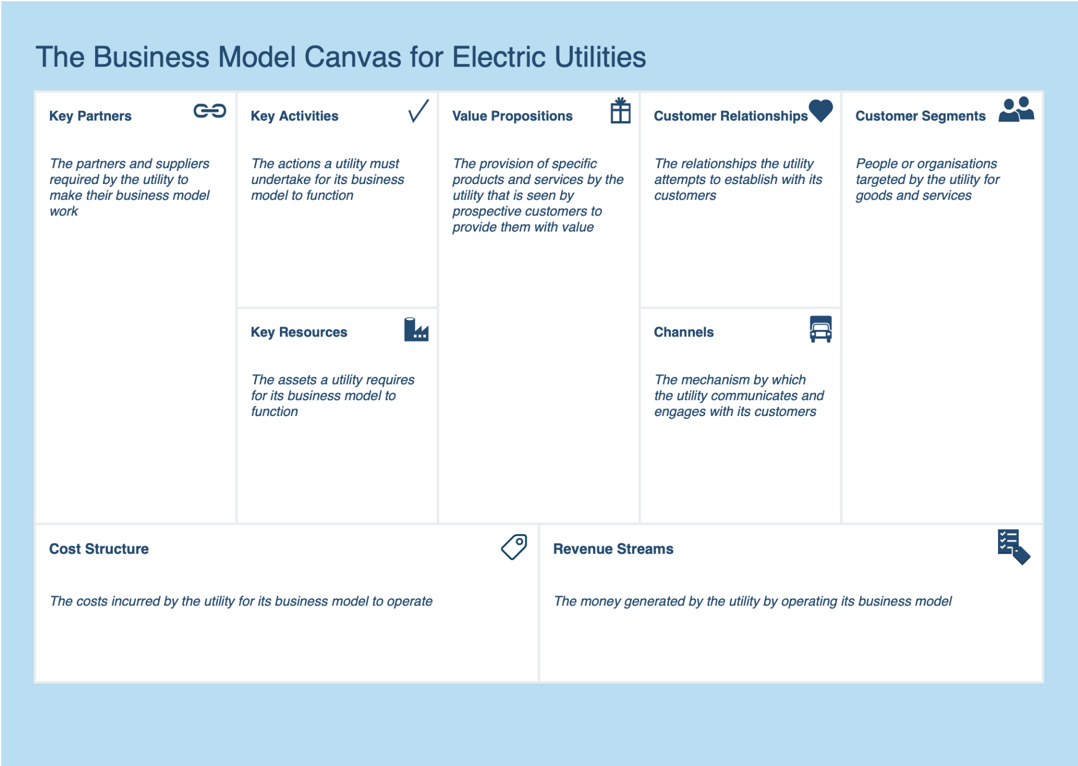


Figure 3.3: Business Model Canvas for Electric Utilities. Own illustration, based on Osterwalder & Pigneur [136] and Bryant et al. [23].

3.3. Traditional Electric Utility Business Model

As mentioned in section 3.1, it has become clear that there is one business model type that reflects the traditional electric utility. In that respect, a traditional electric utility is here defined as an incumbent company that generates and distributes electric power to its customers, recovering costs through rates charged [169], and operating across one or multiple segments of the (traditional) electricity value chain as was presented in Figure 3.1. In this section, the BM type of a traditional electric utility is analysed and elaborated upon in more detail, using the methodology described in section 3.2.

To ensure the thoroughness of the literature review, both scientific articles and theses were searched, using the five previously named different databases and various combinations of keywords. First, an initial set of papers was found by using combinations of ”business model” and ”electric utility” or ”energy utility”. This resulted in many articles, which were scanned to assess their quality and usefulness. Hereafter, a snowballing approach was taken, with which cited literature was assessed. Subsequently, other searches were performed using ”traditional utility business model”, ”traditional electric utility”, ”traditional energy utility”, and combinations of ”traditional business model” and ”electric utility” or ”energy utility” (or their plural forms). Also, the word ’traditional’ was replaced by ’incumbent’, ’historical’, and ’conventional’. After assessing the results, the most relevant ones were used for an analysis of the traditional business model of an electric utility. The results are described in this section.

Value Proposition

The description of the value proposition of a traditional electric utility is widely agreed upon in academic literature. Generally, it is defined as the supply of reliable, efficient, and low-cost electricity, gas, and heat [19], [23], [28], [85], [86]. Furthermore, especially the low-cost aspect is emphasized by noting that traditional utilities focus on centralized bulk generation in very high quantities of (kilowatt-hour (kWh) of) electricity, and incorporate high levels of standardization, [82], [85], [86]. Finally, Hannon et al. [85] point at a solid level of flexibility for customers because of the often short-term nature of contracts.

Customer Segments

The customer segments that are served by the traditional utility can be roughly described as nationwide individual households and businesses [19], [82]. More specifically, according to Bryant et al. [23] the customer segments include all societal aspects: the residential, commercial, and industrial sectors, as well as the state. Finally, Hannon et al. [85] complement this summation by also distinguishing the agricultural sector as main customer segment.

Channels

Although several scholars (e.g. [23], [28]) note that the traditional utility interacts with its customers primarily through the monthly energy bill and yearly meter readings, this seems to be an incomplete description. Hannon et al. [85] use a much more detailed description of all channels used by traditional utilities which, according to author, better reflects the full picture: 1) marketing, purchasing, metering, billing, and customer feedback online, via TV, telephone, by post, and door-to-door, 2) energy supply via a national transmission and distribution network, and 3) support via customer service call centre.

Customer Relationships

The relationship that a traditional utility wants to establish with its customers has two aspects: the nature of the relationship itself, and its image (how the utility wants to be seen). The nature of the customer relationship itself can be described as passive, impersonal, and highly standardised [85]. This impersonal relationship seems to stem from the era before the liberalization of European energy markets, in which customer loyalty was a given fact because they had no option to choose themselves [166]. Moreover, Helms [86] describes it as an 'automatic' business by pointing at the self-explanatory product and the short-term oriented and impersonal customer focus. Secondly, the image that the traditional utility wants its customers to perceive is centered around reliability and security [23].

Revenue Streams

Basically seen, the most important revenue stream of a traditional utility is generated through the sale of metered units of delivered electricity, gas, and heat [23], [28], [85]. Furthermore, depending on the rate of vertical integration, Böhm et al. [19] identify fixed pricing for grid access as another basic revenue mechanism. However, for example in the Netherlands, the electric utility in turn pays the grid operator for grid access of its customers, so this will not be generating revenue for the utilities themselves. Other revenue streams include energy trading [23], [85], distribution network operation payments [23], and energy sales to the wholesale market [82]. Further, in line with more recent developments as Renewables Obligation Certificates (ROCs), traditional utilities can generate a part of their revenue through payments for low-carbon incentives [85].

In literature also much emphasis is put on the nature of the revenue streams, for example the centralized, large-scale aspect of the electricity generation and supply [82], [156], and energy price calculation based on the return on investment on tangible assets (mainly the generators and network) [86].

Key Resources

The main asset that an electric utility requires to make its business model work is obviously its energy generation infrastructure [23], which is centralized, of large scale, and mainly fossil-fuels based [15], [16], [82], [85]. Furthermore, other *physical resources* include distribution technologies [85]. *Intellectual resources* of a traditional utility include mainly a large customer-base [23], energy demand forecast [82], and customer-facing services as a nationwide metering, billing and customer service network [85]. *Human resources* consist of technically, financially, and legally skilled personnel whom together are able to develop the required generation and distribution infrastructure [85], [86]. Also, a traditional utility has *financial resources*, for example access to bank finance [15], [16], [85]. Finally, a more abstract asset of traditional utilities is the dependence on them by the market due to their large size [23].

Key Activities

Key activities, of a traditional utility can be roughly divided into three categories: generation, supply, and transmission & distribution. First of all, generation-related activities include operation of the electricity generation, and deployment of new capacity [23]. However, Hannon et al. [85] are more thorough by describing it as to "finance, design, build, operate and maintain large-scale, centralised energy generation & distribution infrastructure" (p.1036). Secondly, supply-related activities mainly involve energy trading, retail sales of electricity and gas [23], and electricity supply metering and billing [85]. Traditional utilities rarely perform installation or maintenance behind the meter (customer-side) [85]. Finally, some traditional utilities may perform transmission and distribution related activities by another subsidiary in their vertically integrated organisation [85].

Key Partnerships
The network of partners and suppliers of a traditional utility mainly consist of Transmission System Operators, Distribution System Operators, and network regulators [23], [85]. Furthermore, partners can include national governments and original equipment manufacturers [23], and financial institutions, investors, and electrical power generation companies [85].

Cost Structure
The main costs incurred by a traditional utility are due to Operation and Maintenance (O&M) of infrastructure, and staff [23], [85]. Furthermore, costs can be incurred by deploying new infrastructure, Research and Development (R&D), customer administration, and wholesale energy purchases [23]. Finally, utilities may spend money on external contractors, marketing and communication, finance or investment repayments, and consultancy [85]. For clarification however, just as Helms [86] notes: the costs of a traditional utility are dominated by Capital Expenditures (CapEx) on the utility's tangible assets (i.e. generation and distribution infrastructure).

The above described findings are summarized and graphically represented in the 'Traditional Electric Utility Business Model Canvas', presented in Figure 3.4. Furthermore, an overview of the energy and money flows is provided in Figure 3.5.

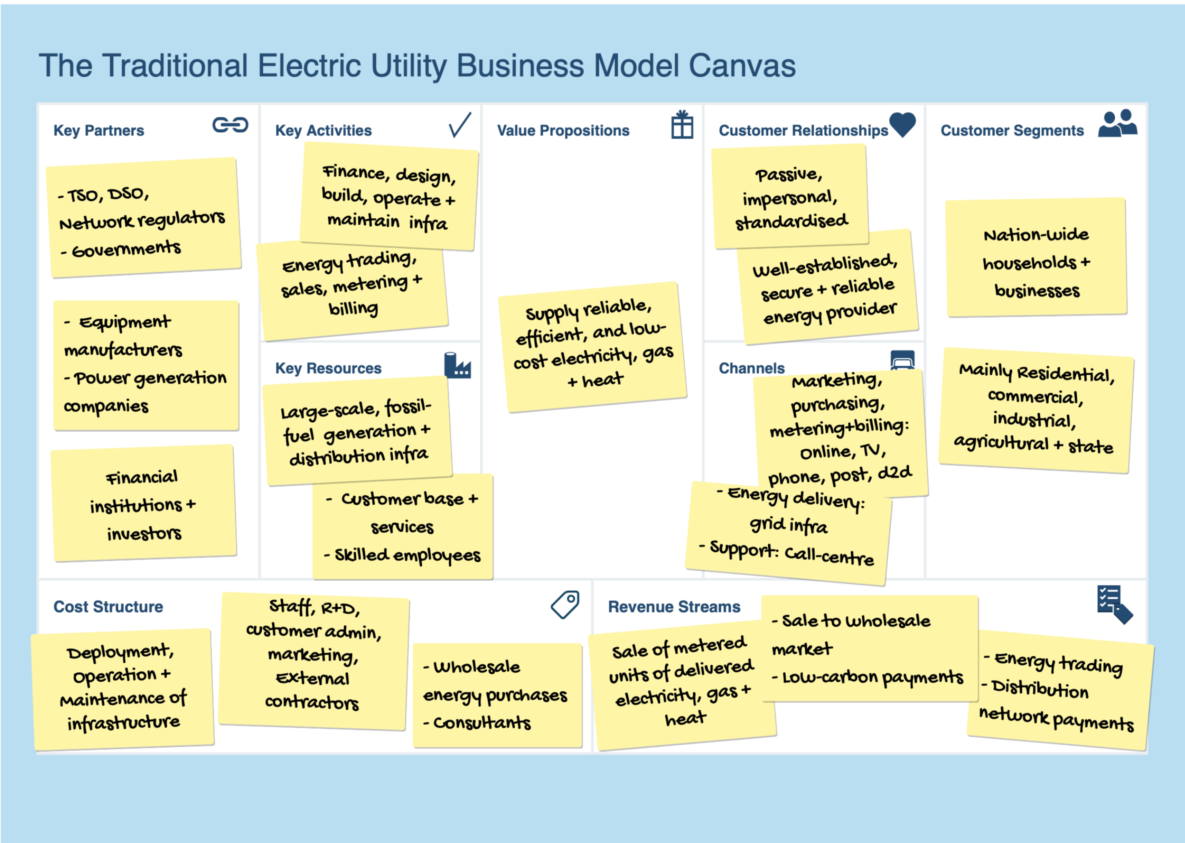


Figure 3.4: The Traditional Electric Utility Business Model Canvas. Own illustration, based on literature study findings.

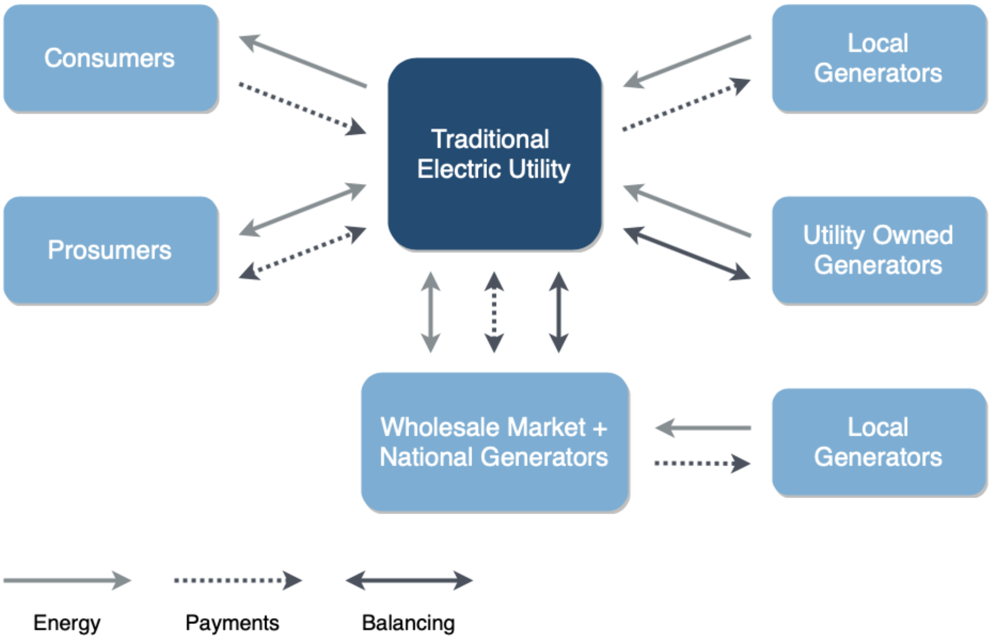


Figure 3.5: Energy and payments flows of the Traditional Electric Utility. Adapted from Bryant et al. [23] and Hall & Roelich [82]. The different colors are used as distinction between consuming parties, generating parties, and utility.

In Figure 3.5, also prosumers and local generators are incorporated. This can be attributed to the fact that the traditional value chain has already been developing into the future value chain for quite some years, and therefore traditional utilities have already adapted their business to facilitate the connection of prosumers and local generators to the system, however passively [23].

In the next section, new emerging types of business models will be addressed after briefly touching upon a few major developments in the energy sector. In Chapter 4 the developments in the energy sector will be addressed in more detail.

3.4. Emerging Electric Utility Business Models

For a long time, the electric power sector has been dominated by a few major utilities operating traditional business models. However, the traditional business model of an electric utility has been subjected to increasing pressure, which already started decades ago [161]. Notwithstanding, incumbent power companies have not felt the urgency of developing alternative business models until a few years ago, when several disruptive technologies were introduced. Since then, the energy sector is rapidly transforming from centralized, large-scale energy generation to decentralized, small-scale generation, and from thermodynamics to electronics [133]. Also, where prices used to be market-based, government intervention and subsidies are increasing [133]. To name a few of the described disruptions, one has to think of increased Variable Renewable Energy (VRE) generation with decreasing costs, digital solutions, changing demand, government regulations on carbon emissions and renewable energy, and the steady rise of 'prosumers' – consumers who simultaneously produce and consume energy [133], [138].

The change in energy demand can for a large part be attributed to, as Stephens et al. [169] put it, "growing opportunities for customers to generate and store their own electricity, purchase 'green' power, and reduce consumption through energy efficiency improvements and demand-side management" (p.69). Together, all these disruptions have posed a massive challenge to the traditional business models of electric utilities, resulting in a need for utilities to fundamentally innovate their business models and transform from being a commodity supplier to becoming a service provider for comprehensive energy solutions [86], [50]. Moreover, the collapse of the stock market in 2008, which marked the beginning of the Great Recession, also meant a collapse of the stock market values of many large European utilities, many of which not have been able to (fully) recover from until today [166].

During the past decade, new utility business models have been emerging [71], [79]. However, besides some scholars (e.g. [85], [86]) compared the traditional utility BM and a generalized Energy Service Company (ESCO) business model, and other scholars (e.g. [19], [28], [174]) focused on potential future business models for utilities, until recently there seemed to be a lack of understanding of all currently existing BM types for electric utilities. In 2018, Bryant et al. [23] acknowledged this gap and bridged it by performing a detailed analysis of currently existing BMs.

Therefore, the findings of Bryant et al. will be used as starting point for the identification of emerging electric utility business models. Obviously, for reliability purposes the results will be validated against other literature findings. In the next sections, each identified emerging business model is discussed.

3.4.1. The Green Utility Business Model

The first emerging business model that Bryant et al. [23] identified, is the *Green Utility Business Model*. Basically seen, this model is roughly similar to the traditional electric utility model, except for the fact that its delivered units of energy are predominantly renewable (or ”green”) [23].

To obtain a good overview of all existing relevant literature on this model, both scientific articles and theses were searched, using the five previously named different databases and various combinations of keywords. The specific keywords used for this section were combinations of ”green utility”, ”green energy utility”, ”renewable energy utility”, ”renewable utility”, ”sustainable energy utility”, or ”sustainable utility” (or their plural form) and ”business model”. Hereafter, the quality and usefulness of the results was assessed and cited literature was inspected. After analysing all results, the most relevant sources were used for an analysis of the different business model components of a green electric utility.

Value Proposition

The description of the value proposition of a green utility is for a large part comparable to a traditional utility [23], [146]. In that respect, it can still be defined as supplying reliable, efficient, and low-cost electricity, gas and heat. However, where in the traditional utility business model energy is mainly generated from fossil fuels or nuclear energy, the green utility focuses on generation of emissions-free, predominantly renewable energy [19], [23], [146]. So, it can be concluded that in case of a green utility the general value proposition - bulk generation of electricity fed into the grid - remains identical, but the quality of that value proposition changed and became more environmentally friendly [146].

Customer Segments

The customer segments served by the green utility differ considerably compared to a traditional utility. Where the traditional utility focuses on almost all sectors of the economy, the green utility focuses mainly on residential and small commercial customers [23]. More specifically, the focus is on environmentally conscious consumers who have affinity with the energy transition and thus find it important to move away from fossil fuels. Often, these consumers are willing to pay a bit more for that environmental value, which typically results in a small ”eco” price premium per unit of electricity [19], [23], [146].

Channels

The channels of a green utility are roughly similar to a traditional utility. The produced electricity is still delivered to the end-consumer via the existing grid infrastructure [146]. However, one additional way of communication is distinguished: *customer engagement updates* [23]. Furthermore, the findings of Hannon et al. [85] also apply to green utilities: marketing, purchasing, metering, billing, and customer feedback online, via TV, telephone, by post, and door-to-door; energy supply via a national transmission and distribution network; and support via a customer service call centre.

Customer Relationships

The customer relationship of a green utility has again two aspects: the nature of the relationship itself, and its image. Although not explicitly mentioned in literature, it is here assumed that because of the similar value proposition the nature of the customer relationship will remain roughly unchanged as well. As such, in this case the bulk generation and supply of (renewable) energy will again lead to a standardised relationship. However, it might be somewhat more active because of the sending of customer engagement updates, as was identified by Bryant et al. [23].

The image of a green utility will however fundamentally change with respect to the traditional utility image. A green utility wants its customers to receive the picture of an ethical alternative to the traditional utility [23]. This is also recognized by Richter [146], who found that renewable energy is often used for marketing and Public Relations (PR) matters, leading to an improved corporate image and increased level of customer trust. The latter is highly important, as customers have high concerns over energy-related matters as climate change, and expect efforts at the supply-side [1].

Revenue Streams
The traditional utility revenue model, selling electricity, gas, and heat to customers for a fixed price per unit, remains to a large extent unchanged [19], [23], [146]. However, the green utility can generate additional revenue by incorporating green electricity tariffs to customers (an ”eco” premium), or tax- or investment credits for renewable energy [146]. Furthermore, although not explicitly mentioned in literature, it is assumed that green utilities also generate revenue by sale to the wholesale market, distribution network payments, and energy trading. The latter is confirmed by inspection of green utility Ecotricity (identified in [23]) that has an energy trading department in place [59]. Moreover, it is also named as one of the key activities of the business model [23].

Key Resources
The most important assets of a green utility are mainly its renewable-based generation infrastructure, its customer-base, and green image [23], [146]. However, green utilities are relative newcomers in the energy field, and the costs for increasing the share of renewable energy in the generation mix are still relatively high [23]. As a result, the customer base and generation asset portfolio of a green utility are often much smaller than those of a traditional utility [23]. Furthermore, although not explicitly mentioned in literature, it is assumed that other *physical resources* include distribution technologies, other *intellectual resources* include the energy demand forecast, and customer facing services as a nationwide metering, billing and customer service network, *human resources* include skilled employees, and *financial resources* including for example access to bank finance.

Key Activities
The key activities of a green utility can again be roughly divided into three categories: generation, supply, and distribution & transmission. Generation-related activities include, using the extended description of Hannon et al. [85], the financing, design, building, operating, and maintaining of the current green energy generation infrastructure, as well as new renewable-based infrastructure [19], [23]. Supply-related activities mainly involve energy trading, and retail sale of green electricity and green gas [19], [23]. Furthermore, despite not explicitly mentioned, green utilities are also expected to perform metering and billing of their supplied energy. Because of their typically smaller size [146], it is not expected that green utilities perform transmission and distribution related activities.

Key Partnerships
The partners and suppliers network of a green utility is roughly similar to that of a traditional utility. It mainly consists of energy market regulators, TSOs, DSOs, and renewable energy suppliers [23]. Furthermore, partners can include the more general types: equipment manufacturers, financial institutions, and investors. An interesting side note is that for green utilities, the network of partners and suppliers is even more important than for a traditional utility due to its smaller size [23].

Cost Structure
Finally, the main costs that a green utility has to incur are due to operation and maintenance of the generation and distribution infrastructure, deployment of new renewable energy generation capacity, and staff [23]. Further costs can include customer administration, energy purchases at the wholesale market, and network charges. Finally, although not explicitly mentioned but assumed as general possibilities, green utilities may spend money on external contractors, marketing and communication, finance or investment repayments, and consultancy [85].

A summary of the findings on a green utility are summarized and graphically represented in the ’Green Electric Utility Business Model Canvas’, presented in Figure 3.6. Furthermore, an overview of the energy and money flows is provided in Figure 3.7.

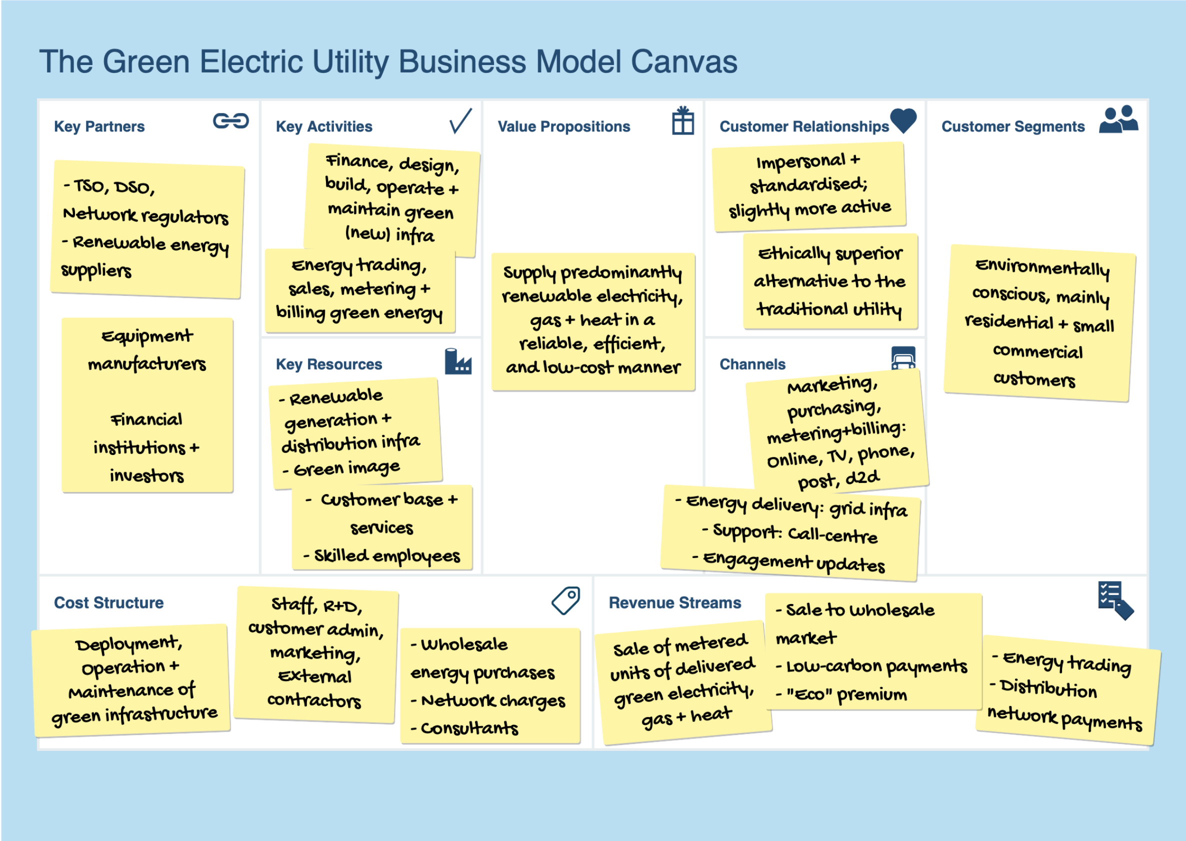


Figure 3.6: The Green Electric Utility Business Model Canvas. Own illustration, based on literature study findings.

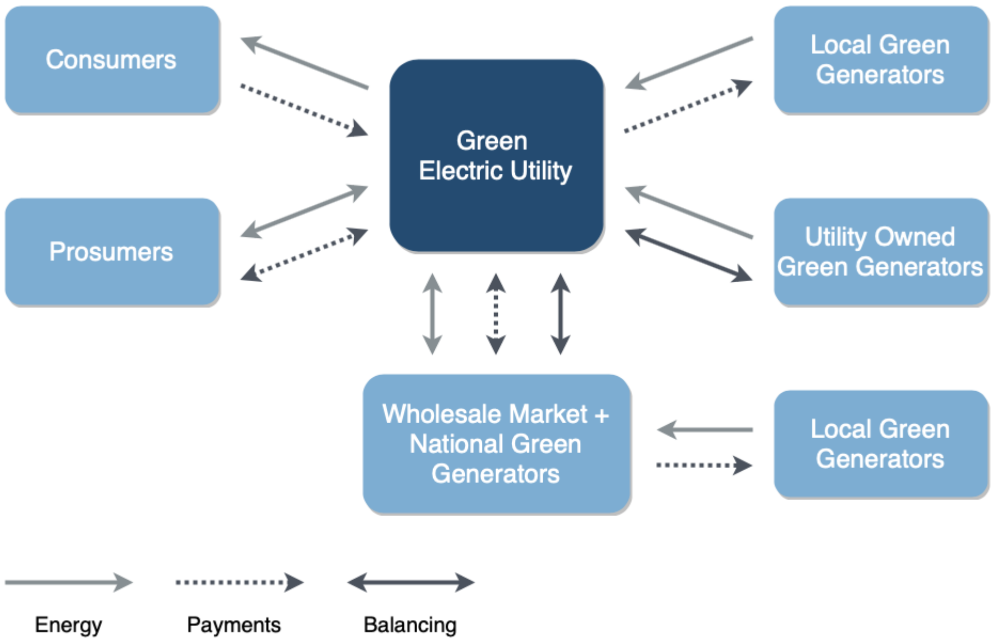


Figure 3.7: Energy and payments flows of the Green Electric Utility. Adapted from Bryant et al. [23] and Hall & Roelich [82]. The different colors are used as distinction between consuming parties, generating parties, and utility.

3.4.2. The Cooperative Utility Business Model

The second emerging business model identified by Bryant et al. [23] is the *Cooperative Utility Business Model*. The cooperative model in general may require a brief additional explanation. According to Diaz-Foncea and Marcuello [45], cooperatives can generally be defined as ”an organizational form in which: (a) the users or beneficiaries of the goods or services produced by the organization also have ultimate decision□making power; (b) the owners have an unusual transaction relationship with the enterprise, as they are not only investors, but also employees, suppliers and/or customers; and (c) organizational governance typically does not discriminate among members in terms of rights; in essence there is typically a one person/one vote rule” (p.240). In other words, every cooperative member is also partly owner of the cooperative organization, and has thus (equal) voting power [22], [90], [114].

In case of a utility, as Belgian cooperative utility Wase Wind [196] describes it, shareholders (so also members and customers) are purchasing electricity from the cooperative against favorable rates and conditions, have decision-making power, and receive dividend in case profits are generated.

To obtain a clear overview of all relevant literature, both scientific articles and theses were searched using the five previously named different databases. The specific keywords used for this section were combinations of ”cooperative utility”, ”cooperative energy utility”, ”cooperative electric utility”, ”renewable energy cooperative”, ”sustainable energy cooperative”, or ”green cooperative” (or their plural form) and ”business model”. Also, the combination ”renewable energy cooperative” and ”utility” was used. Hereafter, the quality and usefulness of the results was assessed and cited literature was inspected. Finally, the most relevant sources were used for an analysis of the cooperative utility business model.

Value Proposition

Similar to green utilities, the value proposition of a cooperative utility is the supply of predominantly green/renewable electricity, gas, and heat [23], [24], [90]. The biggest difference however lays in the fact that the focus of a cooperative utility is not on generating profit, but on providing low-profit or no-profit energy generation for its *community members* [23], [90], [114]. In case of profit, it is being used for local community development or paid as dividend back to the cooperative members [103], [173]. In summary, as Heras-Saizarbitoria et al. [88] put it: cooperative utilities ”deliver ‘triple bottom line’ returns, addressing environmental and social issues while also generating economic benefits for members and/or for members’ communities” (p.1037).

Customer Segments

The customer segments that are served by the cooperative utility are unique when compared to the previously described utilities. First of all, customers of the cooperative utility are at the same time owners of the company [114]. Due to their strong local nature, cooperative utilities target mainly residential and small commercial customers in specific local communities [23]. These customers are generally concerned about development of their local community, including the role of energy [103]. Furthermore, with respect to the green energy proposition, the cooperative utility also targets environmentally conscious customers who are not necessarily part of the local community [23].

Channels

Also the channels through which the cooperative utility tries to reach its customers differ from those of traditional and green utilities. Again, Bryant et al. [23] are highly limited in their description of the channels, by only naming the energy bill and customer engagement updates. However, as also follows from the key partners, the produced electricity is still delivered to consumers via the existing grid infrastructure. Furthermore, a few of the findings of Hannon et al. [85] will also apply to cooperative utilities. However, marketing, purchasing, metering, billing, and customer feedback is mainly web-based [88]. Also, although not being explicitly mentioned in literature, it is assumed that customer support will also still be offered through a customer service call centre.

Customer Relationships

The relationship of a cooperative utility with its customers can be recognized by a more personal and active nature, for example shown by regular customer engagement updates and a typically very low ’customer churn rate’ [23] - the rate at which customers are ceasing the subscription to a service [102]. Another confirmation of this fact can be extracted from the high level of involvement of every customer/member in the cooperative. Besides this, a cooperative utility often has an educating or informing role by trying to make consumers more aware of energy conservation [88], [173].

The image that a cooperative utility wants to portray is being an alternative with lower prices and better customer service [23]. Moreover, it is assumed that because of the green and locally-oriented value proposition, the cooperative utility also wants to be seen as ethically superior. This assumption is confirmed by evidence of the social impact that cooperative utilities make for local communities [173].

Revenue Streams
As mentioned before, the business model of a cooperative utility is not primarily focused on generating profits [23], [24], [114]. The cooperative utility still generates revenue through the sale of energy, but against lower rates than other types of utilities [23]. The produced energy can be consumed by the cooperative members or be sold to the wholesale market (against a so-called Feed-in-tariff (FIT)) [173]. On top of that, the cooperative generates revenue by customers buying-in to become a member. Also, although not explicitly mentioned in literature, it is assumed that the cooperative utility can generate additional revenue by (1) receiving tax- or investment credits for renewable energy, (2) by distribution network payments, and (3) by energy trading. The latter is confirmed by inspection of the activities of one of the cooperative utilities in Bryant et al. [23], which involves energy trading.

Key Resources
The most important assets for a cooperative utility are its renewable generation infrastructure, highly committed cooperative membership base, and locally-sourced image [23], [114]. However, the customer base and number of generation assets tend to be small because of the regional focus, which limits the ability for cooperative utilities to expand their business to other regions. Further, because of the absent profit-focus, cooperative utilities may be less attractive to financial institutions and other investors, which may lead to a lack of access to capital [88], [173]. This creates a need for skilled volunteers [88], [173]. Finally, although not explicitly mentioned in literature, it is assumed that other *physical resources* include distribution infrastructure and other *intellectual resources* include the energy demand forecast and customer facing services as a metering, billing and customer service network.

Key Activities
The key activities of a cooperative utility again include three categories. Generation-related activities include the financing, design, building, operating, and maintaining of the current green energy generation infrastructure, as well as new renewable-based infrastructure [23], [85]. Supply-related activities mainly involve energy trading and retail sale of green electricity and green gas [23], [24]. Furthermore, although not explicitly mentioned in scholars, cooperative utilities are also expected to perform metering and billing of their supplied energy. Because of their small size [146], it is not expected that cooperative utilities perform transmission and distribution related activities.

Key Partnerships
The network of partners and suppliers of a cooperative utility has two main differences with traditional and green utilities. Besides energy market regulators, TSOs, DSOs, and (renewable) energy suppliers, it also includes highly committed cooperative members [23]. Furthermore, the local municipality is a key partner, particularly to build trust in the local community and facilitate knowledge transfer between local actors [24], [114]. Also, financial institutions or other investors have been identified as potential partner, although subject to more difficulties than in case of traditional or green utilities [173]. Finally, although not being mentioned in literature, partners are assumed to include equipment manufacturers.

Cost Structure
The cost structure of a cooperative utility mainly consists of costs due to the O&M of the generation and distribution infrastructure, deployment of new renewable energy generation capacity, cooperative member pay-outs, and staff [23], [90]. Further costs can can be related to customer administration, energy purchases at the wholesale market, and network charges [23]. Finally, although not explicitly mentioned but assumed as general possibilities, cooperative utilities may spend money on external contractors, finance or investment repayments, and consultancy [85]. Due to its web-based nature, marketing and communication activities will in all probability not lead to high costs [88].

A summary of the described findings are summarized and graphically represented in the 'Cooperative Electric Utility Business Model Canvas', presented in Figure 3.8. Furthermore, an overview of the energy and money flows is provided in Figure 3.9.

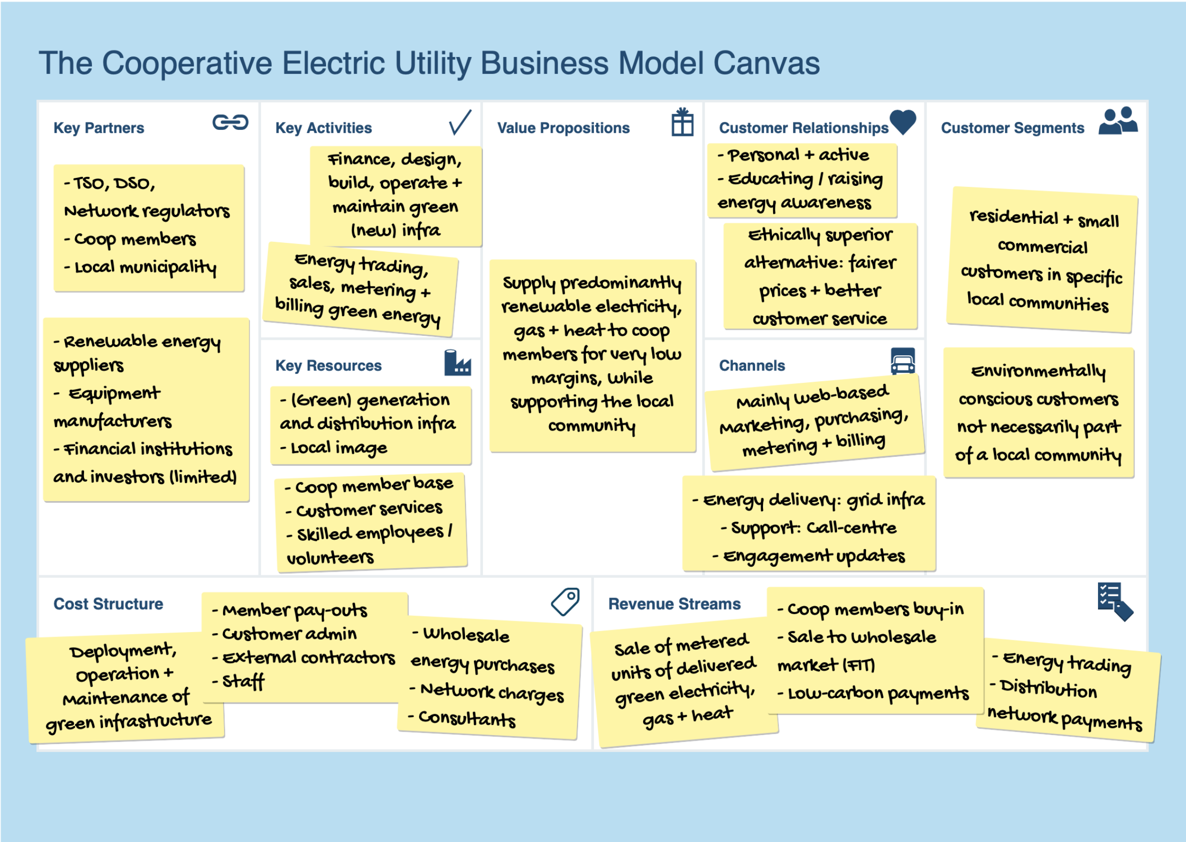


Figure 3.8: The Cooperative Electric Utility Business Model Canvas. Own illustration, based on literature study findings.

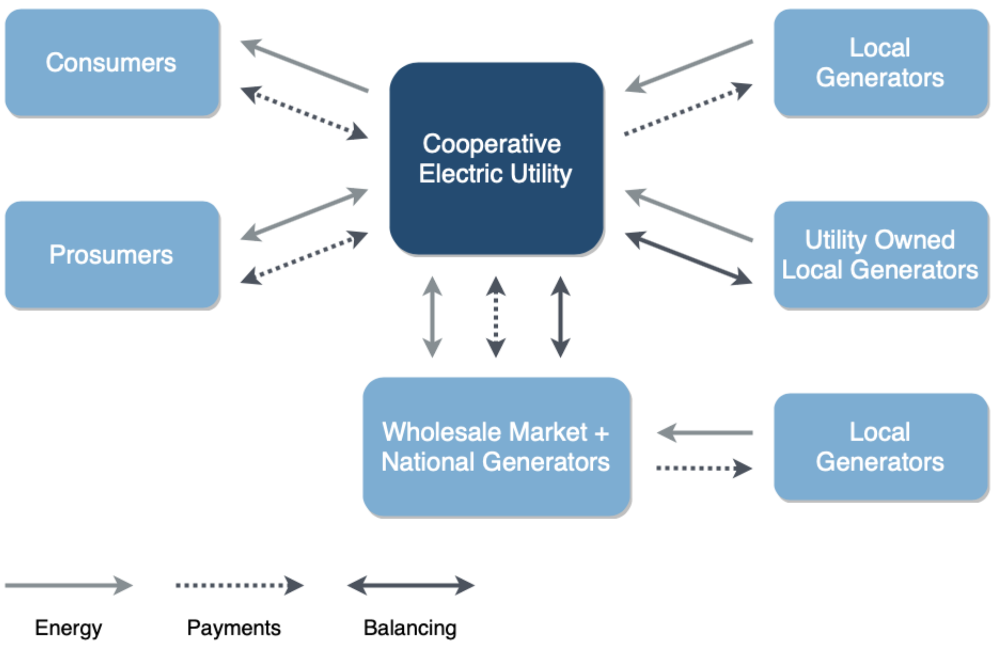


Figure 3.9: Energy and payments flows of the Cooperative Electric Utility. Adapted from Bryant et al. [23] and Hall & Roelich [82]. The different colors are used as distinction between consuming parties, generating parties, and utility.

3.4.3. The Prosumer Utility Business Model

The *Prosumer Utility Business Model* is the third emerging business model for electric utilities identified by Bryant et al. [23]. A description of its various components is provided in this section. However, as this model is centered around much more sophisticated technologies than the previous models, first the basic working principle will be addressed.

The prosumer utility model is built around providing consumers with (small-scale) storage equipment, while also encouraging them to become *prosumers* by installing self-generation equipment (i.e. rooftop solar PV) that they can sell or lease from the prosumer utility. In this way, the prosumer utility aims to build a large capacity base which it subsequently wants to access [23]. Besides this, Peer-to-Peer (P2P) energy trading software and distributed generation control processes are deployed to enable development of a so-called Virtual Power Plant (VPP).

First of all, the term P2P trading will be explained. In case a prosumer produces more electricity than it consumes, i.e. on a sunny day, it generates a certain amount of surplus electricity [200]. Then there are a few options: the prosumer can curtail generation, can store the electricity on a storage device (e.g. battery system), supply it into the power grid, or sell it to other consumers. The latter, direct energy trading between consumers and prosumers, is called P2P energy trading [200]. A 'peer' can be one or multiple local energy actors, including generators, consumers, and prosumers [200]. So, P2P energy trading is encouraging multi-directional energy trading within a local area [200], typically enabled by digital platforms, in turn driven by the rapid development of ICT systems [83].

Secondly, we have the Virtual Power Plant (VPP). As Asmus [9] puts it, ”VPPs represent an 'Internet of energy', tapping existing grid networks to tailor electricity supply and demand services for a customer, maximizing value for both end-user and distribution utility through software innovations” (p.75). In other words, the VPP aggregates resources as Renewable Distributed Energy Generation (RDEG), storage systems, demand response systems, and even Electric Vehicles into one virtual facility that allows for system optimization and grid stabilization without requiring large investments in infrastructure [9]. Or, as Bryant et al. [23] put it: VPPs ”allow the Prosumer Utility to sell-on any excess generation from customers' rooftop solar PV systems to other customers, generating payments for the owner of the system and for the utility” (p.1039). German prosumer utility Sonnen Group provides a clear graphic depiction of P2P trading and their VPP, as presented in Figures 3.10 and 3.11.

Now the basic working principle of the prosumer utility has been clarified, the different business model components can be described. Again, both scientific articles and theses from the five previously named databases were searched. The specific keywords used for this section were combinations of ”prosumer utility”, ”prosumer energy utility”, ”prosumer electric utility”, or ”energy service company” (or their plural form) and ”business model”. Also, the combination ”distributed energy generation”, ”utility”, and ”business model” was used. Hereafter, the results were scanned to assess their quality and usefulness, and relevant cited literature was assessed. Finally, the most relevant sources were used for the description of the different business model components of a prosumer utility.

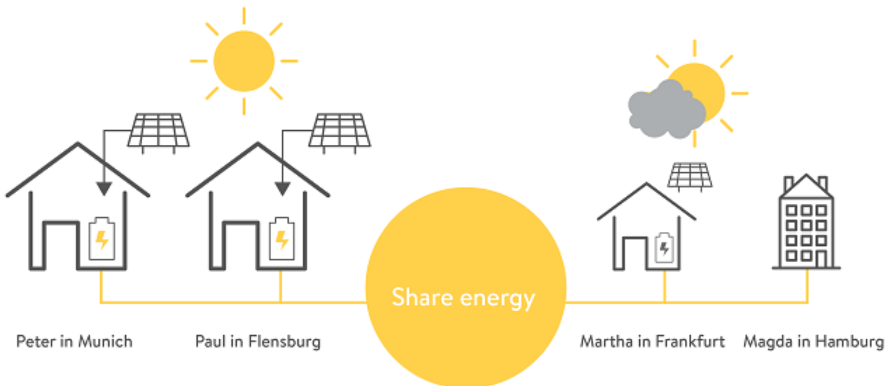


Figure 3.10: Peer-to-Peer (P2P) energy trading. Image adapted from Sonnen Group [78].

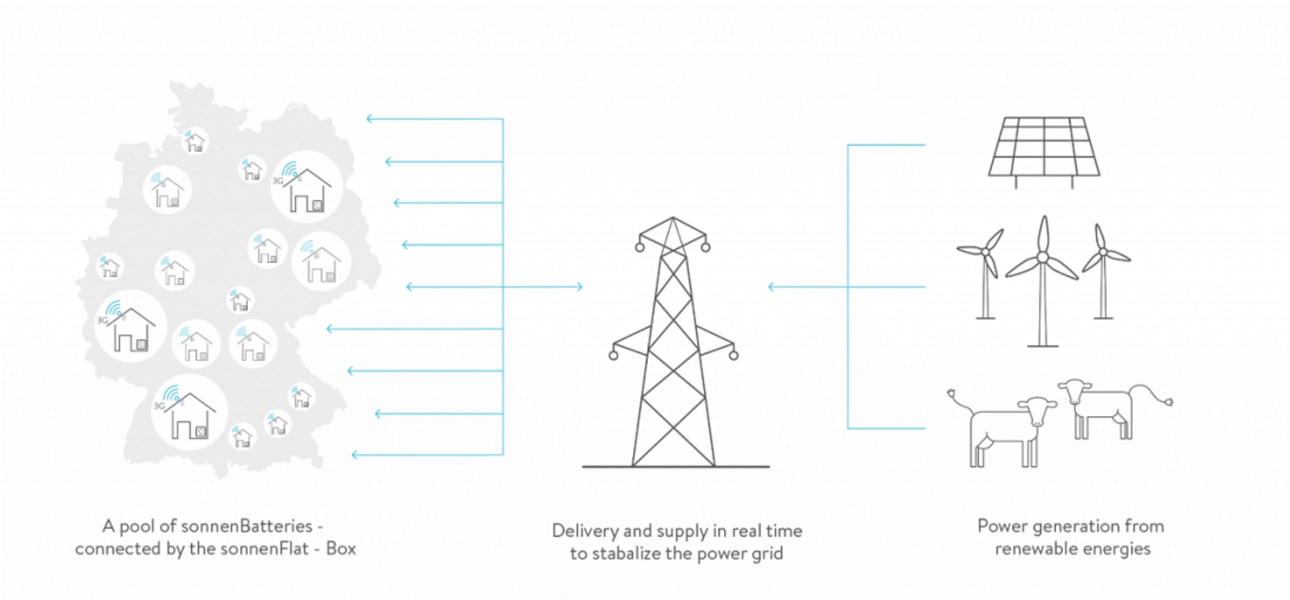


Figure 3.11: Working principle of a Virtual Power Plant (VPP). Image adapted from Sonnen Group [78].

Value Proposition
As follows from the working principle, the value proposition of prosumer utilities can be described as offering customers renewable, local, and self-produced electricity [23]. At the same time, prosumer utilities aim at maximizing their customers' ability to utilise owned or leased self-generation resources. With this value proposition, prosumer utilities are shifting away from the sale of a commodity product differentiated on price, towards sale of comprehensive energy services that are differentiated on quality [174]. Membership of the community enables complete independence from the conventional grid, enabling a local energy sharing economy [112]. Basically seen, prosumer utilities still provide their customers with electricity, but their business model is built around offering that value proposition in an entirely novel, service-focused way compared to traditional, green, or cooperative utilities.

Customer Segments
The customer segments targeted by a prosumer utility mainly include residential customers, preferably willing to produce energy [23], [19]. Furthermore, (small) commercial customers are targeted as well [112], [84]. Moreover, in line with the strong green and digital focus, it could be argued that a prosumer utility mainly targets customers who are efficiency-oriented, digitally connected, and environmentally and socially conscious [112].

Channels
Again, because of its unique value proposition also the channels through which the prosumer utility tries to reach its customers will be different from those of other discussed utilities. In this case, Bryant et al. [23] are somewhat less limited in their description of the channels, although (according to author) still incomplete. According to them, the communication methods include an energy bill, an energy community app or platform, and customer engagement updates. The energy community app or platform can be seen as highly important, as much emphasis is put on this feature. In such a community, members are able to share their self-generated excess energy with other members. Moreover, as the members are all committed to a cleaner energy future [78], this will create a strong community feeling amongst members. Other distribution channels of prosumer utilities include mainly their website, expositions, energy consultants, and certified electricians [112].

Besides these, as also follows from the fact that prosumer utilities have network regulators, DSOs, and TSOs as key partners [23], the electricity is obviously still distributed between consumers and prosumers via the existing grid infrastructure, and it is assumed that a few of the findings of Hannon et al. [85] will apply. Marketing, purchasing, metering, billing, and customer feedback will likely be mainly executed online or via the platform. Also, support will presumably still be offered through a customer service call centre.

Customer Relationships
As in the case with a cooperative utility, the relationship between a prosumer utility and its customers can be recognized by a more personal and active nature, for example shown by the customer engagement updates [23]. Another confirmation of this fact can be seen in the community aspect [112]. Furthermore, the image that a prosumer utility wants its customers to receive can be described as being a means for supporting local, green energy [23], [112]

Revenue Streams
The revenue streams of a prosumer utility differ considerably from what we have seen in the cases described before. First of all, an important revenue stream is the sale or leasing of distributed renewable energy generation and storage equipment, mainly solar panels and battery systems (often based on a 10-year contract including a warranty) [23], [112]. This also implies payments for installation and maintenance activities [112]. Further, to enable P2P energy trading, customers often first have to become a member of the 'community', which involves a membership payment (often based on a 1-2 year contract) [112]. Furthermore, the prosumer utility sells additional energy to customers and to the wholesale market [112], [150], and performs energy arbitrage [23], [150], which generates revenue by selling power purchased and/or stored during off-peak times at peak times (leading to a higher electricity rate) [194]. Lastly, the prosumer utility receives payments for energy balancing services [23], [112].

Key Resources
The most important assets of a prosumer utility are prosumer assets (i.e. residential solar PV and a battery system), and the P2P trading platform and VPP software which enables the optimization of energy usage and grid balancing services [23], [112], [28], [150]. Furthermore, a prosumer utility will benefit from its image as empowering consumers. Finally, other key resources include skilled employees, for example product and software developers, and access to finance [112].

Key Activities
As opposed to the earlier described utilities, the most important activities that a prosumer utility executes cannot be divided into the three categories distinguished by Hannon et al. [85] due to its complete different way of doing business. Key activities of a prosumer utility mainly include development, O&M of the battery systems, P2P trading system and Virtual Power Plant [23], [112], [28]. Furthermore, new prosumers must be signed into the network and must be provided with solar PV and storage equipment, which will also require installation and maintenance activities [23]. Other key activities include marketing, smart metering and billing processes [112]. Finally, with respect to the currently still emerging nature of most prosumer utilities, multiple revenue and cost factors need to be managed and the utility needs to get access to finance [112].

Key Partnerships
The network of partners and suppliers of a prosumer utility depends involves mainly the community members (allowing P2P trading and the VPP system to function properly), and the prosumer customers (supplying the required energy) [23]. Besides these two groups, other partners include the energy market regulator, the TSOs, and DSOs [23]. Furthermore, prosumer utilities often work together with other utilities for the management of energy data and optimization of production and consumption [112]. However, it is assumed that this is mainly due to their emerging nature. The same goes for financial institutions and investors, who are of high importance during the start-up phase. Finally, prosumer utilities can work with equipment manufacturers, sales partners, and certified electricians for installation and maintenance of equipment [112].

Cost Structure
The costs of prosumer utilities are mainly due to the O&M of the P2P trading system and VPP, the installation and maintenance of residential solar PV and battery equipment, network usage, and staff [23], as well as the development of hardware, inverters, and IT services [112]. Furthermore, other costs include R&D, marketing, customer administration, and energy sale from the wholesale market in case

of insufficient available energy within the community [23], [112]. Also, as follows from the key partners, prosumer utilities may spend money on external contractors (i.e. electricians), finance or investment repayments, and consultancy [112].

A summary of the described findings are summarized and graphically represented in the 'Prosumer Utility Business Model Canvas', presented in Figure 3.12. Furthermore, an overview of the energy and money flows is provided in Figure 3.13.

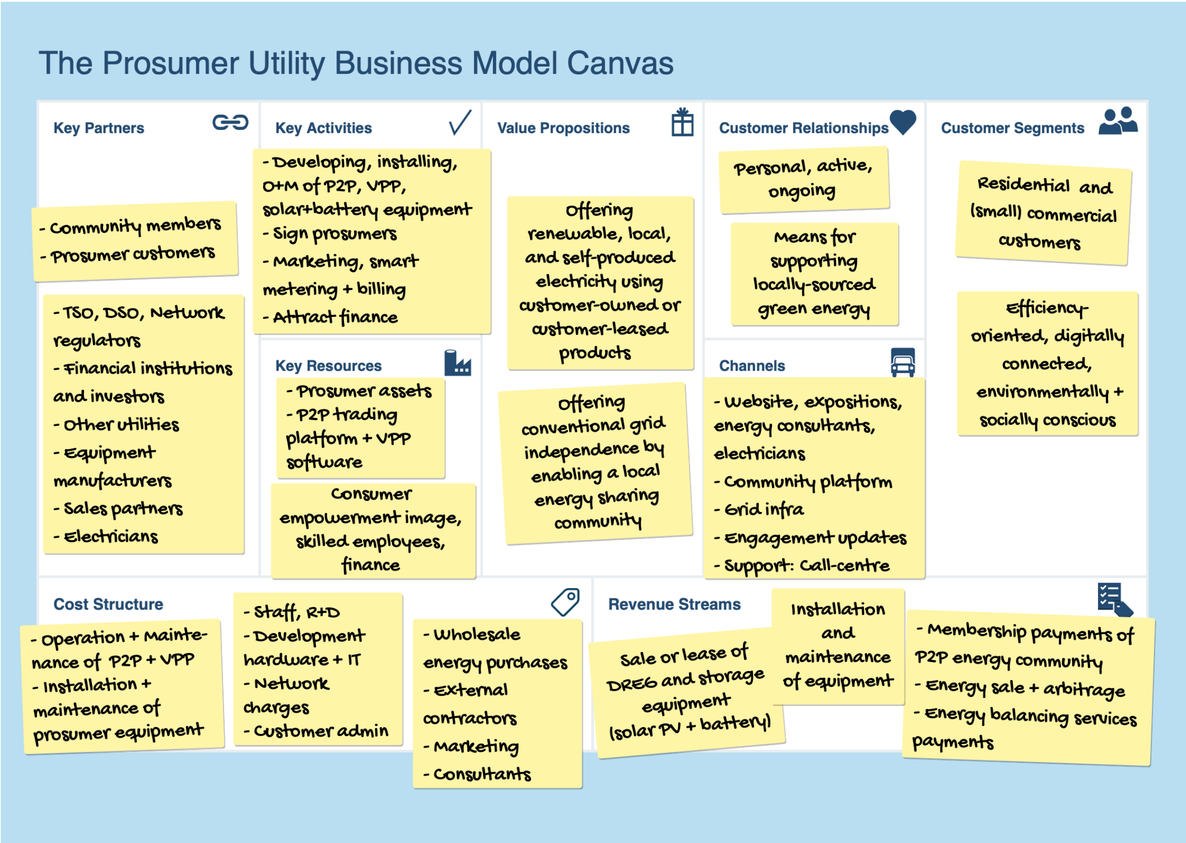


Figure 3.12: The Prosumer Electric Utility Business Model Canvas. Own illustration, based on literature study findings.

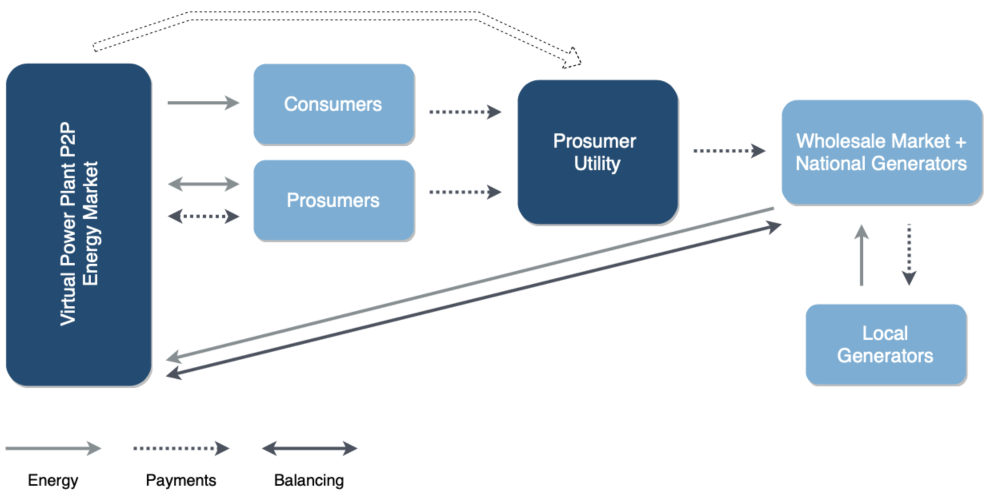


Figure 3.13: Energy and payments flows of the Prosumer Utility, adapted from Bryant et al. [23]. The different colors are used as distinction between consuming parties, generating parties, and utility.

3.4.4. The Prosumer Facilitator Business Model

The fourth and final emerging business model identified by Bryant et al. [23] is the *Prosumer Facilitator*. Its business model can be seen as the most distinctive, as it is focused on reducing grid-dependency of customers primarily by the sale or lease of rooftop solar PV and battery storage systems. Moreover, prosumer facilitators do not supply any energy to customers, resulting in the dependency on other types of electric utilities in case demand exceeds the distributed generation [23].

In that respect, as the scope of this thesis is strictly limited to electric utilities (see section 1.5), and as the provided leading definition of an electric utility is focused on the delivery of electric energy to customers (see section 3.1), the prosumer facilitator model does not meet the criteria. Therefore, this model will be excluded from further analysis.

3.4.5. Reflection on Identified Business Models

Now all currently existing business models for electric utilities have been identified based on the classification proposed by Bryant et al. [23], it can be insightful to reflect on these findings.

First of all, according to author this set of BM types can be considered mutually exclusive, in the way that they are sufficiently different. This is based on a few observations. Firstly, each BM type mainly focuses on a different customer segment. The Traditional Utility focuses on nation-wide households and businesses in general, while the Green Utility specifically targets environmentally conscious customers. Moreover, the Cooperative Utility focuses on customers in specific local areas, in which the customer is simultaneously shareholder. Finally, the Prosumer Utility focuses on efficiency-oriented and digitally connected customers that are open to innovative solutions. So, there are clear differences between the customer focus of the different models. Secondly, the value propositions and key resources with which the value is proposed also show significant difference. The Traditional Utility focuses on the supply of reliable and low-cost units of energy, offered through the bulk generation of mainly fossil-fuel based energy. The Green Utility offers metered units of energy as well, but delivers this value through renewable energy generation, highly different types of resources than the traditional utility. Furthermore, the Cooperative Utility offers local, renewable energy through small-scale, distributed renewable energy generation assets as a few wind turbines or a small solar farm. Finally, the Prosumer Utility does not generate any energy itself, but offers its customers the access to an aggregated virtual pool of local, renewable, self-generated energy. So, based on these eminent differences, the set is considered to be mutually exclusive. It must be stretched that this only means that the identified BMs are sufficiently different; not that they cannot be combined in practice.

Secondly, the question could be asked whether the identified set of business models for European electric utilities is complete. According to author, the answer to this question is affirmative. First of all, the study by Bryant et al. [23] analysed 40 different utilities active in Europe. So, this is a considerably large sample, addressing multiple utilities in a variety of countries. Also, a brief inspection of some randomly selected utilities in this list did not lead to other insights. Secondly, it must be highlighted that these identified BM types each represent a category, and not a singular business model. Therefore, differences in for example size should not be seen as a different BM type. Thirdly, the energy sector is rapidly developing, and many utilities (extending to all four BM types) introduce new BMs and various innovative solutions. However, the classification as one of the utility BM types is based on the 'core' model, based on the dominant, general value proposition. Therefore, traditional utilities that have recently started with offering green energy or residential solar PV panels (but of which the main customer base is still provided with large-scale, fossil-fuel based energy) are still evaluated as operating a traditional model. Finally, from the consultations with the two external industry experts emerged that the Netherlands have taken the European regulations on liberalization of the energy market considerably more seriously than other EU countries. In most other countries, utilities still tend to be more integrated, and many energy markets are still dominated by a few large incumbents. Therefore, it could be expected that the Netherlands would be a country with one of the most new market entrants. A brief inspection of multiple electric utilities in the Netherlands has also not led to any additional BM types. Therefore, it could be sufficiently substantiated that currently no significantly different business models for European electric utilities exist that would not fall either within one of the identified BM categories, or in the prosumer facilitator model that was not further addressed because of the scope of this thesis.

Finally, it is noteworthy that consultations with two industry experts [48], [187] did not lead to different or additional insights on this subject. As Bryant et al. were the first to conduct this type of study, no additional or other insights could be obtained from other literature. Seeing its recent (2018) publication, there is sufficient confidence that their classification will still suffice.

So, this chapter has identified four currently existing Business Model types for European electric utilities, of which three have been emerging in response to various developments that are changing the energy sector. The next chapter will address those developments in more detail and discuss the current alignment of the different utility BMs with these developments.

3.5. Chapter Summary

The goal of this third chapter was to obtain a thorough understanding of the currently existing business model types for electric utilities. An extensive literature review has delivered sufficient insights for answering the first sub research question of this thesis:

What are the currently existing types of business models for electric utilities?

Utilities are a part of the larger electricity value chain, consisting of generation, transmission, distribution, retailing, and consumption. Their activities can span from either one segment to across the entire value chain. Traditionally, the flow of power and money were one-way: power flowing from generation to consumption, and money flowing the other way around. This resulted in a straightforward business model for an electric utility: the Traditional Utility business model. Basically seen, the traditional utility model is based on the supply of reliable, efficient, and low-cost electricity, gas, and heat. This electricity is mainly produced by fossil fuels, and the revenue model is based on bulk supply.

However, the energy transition posed some threats to this model, among others due to increasing amounts of renewable energy, a shift towards decentralized electricity generation, and digitalization. As a result, during the past decade multiple new BMs for utilities have been emerging. The first one is the Green Utility BM, which is characterized by a quite comparable model as traditional utilities, except their offered electricity is completely generated by Renewable Energy Sources (RES). The second emerging BM is the Cooperative Utility. In a cooperative, each customer is also shareholder, and all shareholders have the same voting power. Cooperative utilities focus on providing renewable energy to their community members in a low-profit or non-profit way. In case of profit, it is used to support the local community. Finally, the third identified BM is the Prosumer Utility. This model is built around the provision of (smart) storage equipment to customers, while also encouraging them to install self-generation assets. In that way, prosumer utilities aim at building a virtual capacity base in which customers can trade energy with each other (P2P trading), which is called a Virtual Power Plant (VPP). This VPP aggregates all distributed generation and storage resources into one virtual facility that enables a local energy sharing community. So, basically seen, a prosumer utility still delivers (renewable and local) electricity to its end-consumers, but it does so in a completely different, digital, way.

So, it can be concluded that currently four basic business models for electric utilities exist. Of these four types, the prosumer utility model seems to be the most innovative.

4

Developments in the Energy Sector

In Chapter 3, it has become clear that currently four different business model types for electric utilities exist. Of these models, the traditional utility model is the most well-known, as it has existed without major changes for a long time. As we have seen, power companies have not felt the urgency of developing alternative business models until a few years ago, when several disruptive technologies were introduced. Since then, the energy sector is rapidly transforming from centralized, large-scale, fossil-fuel based energy generation to decentralized, small-scale, renewable energy generation, from thermodynamics to electronics, and from prices determined by the market to governmental regulations and subsidy schemes [133]. This chapter addresses recent developments in the energy market and their implications for the current electric utility business models in more detail.

The findings of this chapter will be used to provide a partly answer to the second sub research question of this thesis:

What are the major developments in the energy sector and to what extent are current electric utility business models adapted to these developments?

In the next section, 4.1, the major developments in the energy sector will be discussed in more detail. Thereafter in section 4.2, the conceptual framework will be presented with which the utility business models will be analysed. This is followed by an assessment of the current alignment of the different utility business models with the energy sector developments in section 4.3. Finally, a summary of the main findings of this chapter will be provided in section 4.4.

4.1. Major Developments in the Energy Industry

To obtain a good overview of all existing relevant literature on the major developments in the energy sector, both scientific articles and theses were searched, using the five previously named different databases and various combinations of keywords. The specific keywords used for this section were combinations of ”energy sector”, ”energy industry”, ”energy system”, ”power sector”, ”power industry”, ”power system”, ”electricity sector”, ”electricity industry”, or ”electricity system” and ”developments”, ”disruptions”, ”changes”, ”trends”, or ”energy transition”. Hereafter, the quality and usefulness of the results was assessed and cited literature was inspected. After analysing all results, the most relevant sources were used for an analysis of the major developments in the energy sector. Also, expert consultations were conducted during which the literature results were discussed and validated.

4.1.1. Decarbonization

First of all, one of the most important developments that affects the energy industry is the transition from fossil fuels towards Renewable Energy Sources, or *decarbonization* [44], [48], [86], [187]. According to Di Silvestre et al. [44], decarbonization can be defined as ”the declining average carbon intensity of primary energy over time thanks to the exploitation of new and clean energy sources” (p.484). In that respect, the share of RES as wind, solar PV, biomass, hydro, geothermal and marine energy in the global electricity generation mix is constantly increasing [95]. Simultaneously, or partly as a direct result, a growing number of policies (e.g. [40]) focusing on decarbonizing the economy is implemented [44], [95]. As a result, the entire structure of the energy sector is subject to change, affecting the way how energy is produced and distributed to customers [50], [146], [184].

A consequence of this trend is that low or even negative electricity prices are an increasingly common phenomenon (in turn leading to lower overall spot market prices), and many major utilities have faced severe (50 - 80%) losses in their market value [86], [95], [166]. As such, utilities' traditional way of doing business has been disrupted, resulting in the challenge for utilities to develop a suited business model for renewables-based electricity generation [146]. Furthermore, grid operators are increasingly facing the necessity to curtail or re-dispatch renewable energy capacity for grid stability purposes, resulting from large renewable generation overshoots (due to the strong variable nature of RES) [141], [95], [166]. Especially in more rural areas, but also in large productive regions such as windy coasts, these increasing supply peaks are of major concern, and conventional grid expansion is costly and not always an option [166]. For consumers, the decreasing spot market prices have not been reflected in a lower energy bill. In fact, the opposite is true; costs of renewable energy policies aiming at boosting RES diffusion have been passed on to consumers [166], [86].

Besides electricity, this decarbonization trend also applies to other energy vectors as gas and heat [48]. More specifically, there is an increase in the use of green gases, and heat is becoming increasingly generated by heat pumps or heat recovery technologies [48]. Moreover, it must be noted that the strict boundaries between the different energy vectors are becoming increasingly blurred, as for example electricity is now used to produce heat (in case of a heat pump) or hydrogen [48].

Summarizing, the transition towards a renewable energy system heavily affects the entire industry, and utilities are no exception.

4.1.2. Decentralization

Secondly, the energy transition and corresponding implemented policies also imply an increase in the use of Distributed Energy Resources (DERs), or *decentralization* [48], [86], [107], [187]. Distributed Energy Resources can be defined as "any resource capable of providing electricity services that is located in the distribution system" (p.2) [95]. In that sense, DERs not only refers to distributed energy generation, but can also imply energy storage, Demand Response (DR), energy control devices and other energy efficiency services [95]. Taken together, the growing importance of various DERs can be described as a shift towards decentralization, which indicates generating and managing electricity closer to consumption; thus at Low Voltage (LV) and Medium Voltage (MV) levels [44], [166]. In line with the decarbonization trend, most of the large-scale distributed energy generation is contributed by solar PV and wind [44]. As we have seen, this can lead to stability issues for grid operators [166].

Furthermore, besides the more local generation by small solar and wind farms, there is also an increase in prosumers [44], [133], [166]. These prosumers supply a large share of their own demand, and feed residual electricity back into the LV grid. However, they are currently often still dependent on upstream generation for peak demand [133]. This is however changing as well, as deployment of other DERs such as storage systems is rapidly evolving [166]. Moreover, increasing integration of the heat and mobility sectors allows consumers to become not only self-supplying in terms of electricity, but also in terms of other energy, e.g. by Electric Vehicles and Combined Heat and Power (CHP) plants [166].

Finally, within the decentralization trend, a more social trend can be identified. This is the increasing emergence of local, bottom-up energy initiatives [48]. Examples of these are neighborhoods coming up with own plans to become independent of natural gas, or become all electric. Utilities could also play an important role in the facilitation of these initiatives [48].

All in all, this decentralization of the energy system can be interpreted as a downstream shift of value, which implies that a business model centered around offering downstream services will become more promising [86], [133], [166]. Traditional utilities have so far not proven to be effectively responding to this trend [146], [148].

4.1.3. Digitalization

The third major trend that has been disrupting the energy sector is *digitalization* [44], [48], [95], [166], [187]. While sometimes used interchangeably with digitization, the two terms address different subjects. On the one hand, digitization "encompasses the pure technical and technological conversion of analogue into digital signals as well as its storage and transfer" (p.4) [157]. On the other hand, digitalization can be defined as "the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business" (p.485) [44]. As follows from these definitions, digitalization is the correct term to describe this specific trend in the energy sector.

For the energy sector, digitalization implies a shift towards a so-called *smart energy system* in which the use of ICTs in generation, transmission, consumption, and storage leads to increased efficiency; thereby also further enabling decarbonization and decentralization [28], [107], [155]. To be more specific, one can think of ICTs as smart meters, smart home systems, and intelligent integrated solar PV systems, but also Electric Vehicle charging systems [28], [133].

The efficiency gains enabled by these smart products can for example be expressed in terms of active network management possibilities [95], optimization of connected energy flows [43], and demand-side management [133], [166], as well as increased price-responsive demand [95] and profit-generating possibilities for prosumers [166]. In other words, digitalization creates opportunities for grid operators, consumers, as well as utilities [166]. However, new 'smart energy' business models (for example aggregating distributed generation through Virtual Power Plants [43] or creating Peer-to-Peer energy communities [112] are rapidly evolving, and are further challenging the traditional business model of electric utilities [28], [166].

4.1.4. Electrification of end-use sectors

A fourth major trend - mainly disrupting other sectors but indirectly heavily affecting the energy industry - is *electrification* of end-use sectors [44], [48], [168], [183], [187]. A well-known example of such an end-use sector is obviously transportation (Electric Vehicles), but one must also think of electrifying buildings (e.g. with heat pumps) and industry [168]. Together with the decarbonization of the electricity mix, electrification of end-use sectors that are now predominantly running on fossil fuels must lead to achieving ambitious emission reduction targets [183]. As already mentioned in the decarbonization trend, this implies a blurring of the boundaries between different energy vectors [48].

However, this trend comes with another challenge for the power sector. For Europe, after fully recovering from the Covid-19 impact, between 2023 and 2030 electricity demand is expected to increase an astounding 0.8% per year [94]. In advanced economies as Europe, this trend can be largely attributed to increased electrification in mobility and heat (or buildings). Under the widespread electrification scenario, this could even lead to a doubling in electricity demand by 2050 [168]. Firstly, this means that an even larger amount of renewable electricity must be supplied, thereby strengthening the previously identified challenges for grid operators to maintain a stable grid [166]. Secondly, most of this electricity (about 2/3) will be generated at LV and MV levels, and only about one third at High Voltage (HV) levels [44]. Despite ambitious goals for the build-out of more interconnected European transmission lines, this still means that the distribution level will be most affected. This increases the importance of Demand Response measures, supported by deployment of digital technologies and increased use of energy storage [44].

4.1.5. Increased use of energy system flexibility measures

The fifth major trend that can be identified is the *increased use of energy system flexibility measures* [48], [47]. Energy system flexibility can be described as "the ability of the power system (actors, technologies, processes, measures and markets) to respond reliably and rapidly to large fluctuations in supply and demand balance" (p.5) [46]. Power system flexibility has become the key towards energy security [94]. The intermittent nature of RES – both on a daily scale and on a seasonal scale – and this poses two significant challenges to the power system. On the one hand, power production becomes (much) less predictable [44]. On the other hand, power system inertia decreases leading to frequency issues for grid operators. Both challenges call for increased energy system balancing, or flexibility. Where power system flexibility used to be mainly provided by rapidly dispatchable generators, also other balancing measures are increasingly being used [93]. In that respect, power systems are being increasingly interconnected to other power systems nearby (i.e. interconnections between the Dutch and German/UK/Belgian grids) [48], [93].

Furthermore, for both identified challenges, centralized and decentralized electrical energy storage are well-suited solutions [38], [44], [93], [183]. Large-scale, centralized storage options are for example provided by Pumped Hydroelectric plants or large battery storage systems [162]. In line with the trends towards decentralization and digitalization, decentralized storage solutions as home battery storage and thermal energy storage are also increasingly deployed [162], [166].

Besides these (and a few other existing solutions), an alternative solution for both long-term and short-term storage has been emerging: hydrogen storage [38]. In times of excess electricity generation, the excess electricity is used to generate hydrogen through an electrolyzer [38]. The hydrogen can be stored and used again for a time when generation exceeds demand. In this case, the hydrogen is converted back to electricity by means of a fuel cell [38]. Despite its relatively low round-trip efficiency, hydrogen storage enables long term storage at massive scales, and is therefore a highly suitable solution for increasing power system flexibility [38], [115]. This research will not go into further detail on this topic, but it is worth noticing the rapid development of this specific technology and the major role it can play, also in other sectors as mobility and industry [38], [115].

4.1.6. Increased use of energy efficiency technologies

Finally, despite being strongly connected to (and overlapping with) the first three trends, *energy efficiency improvements at demand-side* is another key trend worth mentioning on its own [48], [168], [183], [187]. Where energy generation and distribution are already considerably efficient, efficiency at the demand side has now started to receive attention as well. The ultimate impacts of this trend are increased grid stability and a lower total energy demand through more efficient use, thereby partly counteracting the effect of electrification and decreasing energy system intensity [168], [183]. Energy efficiency measures are present in almost every end-use sector, but has the highest effects in the transport and building sectors [183]. The replacement of internal combustion engines in cars by electric motors is a well-known example, just as replacing light bulbs in buildings with LEDs. As we have already seen in the sections on decentralization and digitalization, energy efficiency measures are also reflected in Demand-Side Management (DSM). Palensky and Dietrich [137] define DSM as ”a portfolio of measures to improve the energy system at the side of consumption. It ranges from improving energy efficiency by using better materials, over smart energy tariffs with incentives for certain consumption patterns, up to sophisticated real-time control of distributed energy resources” (p.381). In that respect, technologies as smart homes, smart meters, smart EV charging systems, and Demand Response can all be considered examples of DSM [28], [133], [137], [166].

In short, the six above-mentioned major trends all lead to fundamental change in the energy sector, affecting both the energy supply chain and society as a whole. As will follow from the case study in Chapter 7, these developments found in literature correspond to the current opinions of utility and CVC managers about this subject.

4.1.7. Side-developments

Besides these six main developments, Di Silvestre et al. [44] identified four side-developments that are noteworthy for a complete picture of the power sector developments (p.483):

- ”Considering the aging of infrastructures, there is a widespread need for investment in end-of-life grid renewal
- Considering all the new energy resources connected to the grid, there is a need to handle grid congestion (with market-oriented policies)
- Market design and regulatory mechanisms are evolving to support the transformation towards equity, access to electricity and lower costs;
- Environmental compliance and sustainability are needed for new and existing infrastructures”

These side-developments mainly indicate that the grid – an essential component in the power system – is subject to some challenges. Despite the fact that this is a highly relevant issue, it mainly affects TSOs and DSOs, who are responsible for grid operation. Therefore, these developments will not be separately included in the analysis of to what extent utilities are currently adapted to the energy sector developments, as that will be limited to the six main developments. However, it must be noted that these grid issues might create new business opportunities for utilities.

The same goes for the latter two side-developments. With respect to evolving market design and regulatory mechanisms, these will be assessed later in this research, when the potential barriers to BMI and better adaptation of utilities to the power sector developments are assessed. For environmental compliance and sustainability of infrastructures holds that this development has too much overlap with the larger decarbonization trend. Therefore, it cannot be seen as separate development.

So, six main developments in the energy sector have been identified. To be able to assess the extent to which the different BM types of utilities are adapted to these developments, in the next section a conceptual framework is presented that will be used for this analysis.

4.2. Conceptual Framework for Analyzing Utility Business Models

In this section, a conceptual framework is presented that will be used to analyze the current alignment of all four utility BMs to each of the six energy sector developments. Eventually, this framework will also be used in the analysis of the potential contribution of Corporate Venture Capital to BMI of traditional electric utilities, as will be presented in Chapter 7.

The conceptual framework is presented in Figure 4.1. First of all, it must be noted that one version of this framework represents one utility type. So, the analysis of all four utility BM types will result in four different frameworks. Within each framework, the organizational environment of a utility is represented by a circle, presented in the middle. The outer part of the framework represents the industry environment of a utility and is represented by a hexagon-shaped 'shell'. This industry environment is divided into six 'domains', each representing one major energy sector development. To analyse the extent to which a utility is currently adapted to each of the six energy sector developments, all of these domains will be (partly) shaded. A score of five means that a utility BM will be fully aligned with a specific energy sector development. In that case, the domain of this development will be fully shaded. On the other hand, a score of one means that a utility BM is not at all aligned with a certain energy sector development; in that case, the domain of this development will not be shaded at all. Every score in between will lead to a partly shaded domain.

A detailed analysis of the current alignment of all four utility BMs with each of the six energy sector developments, as well as the scoring method, is addressed in the next section.

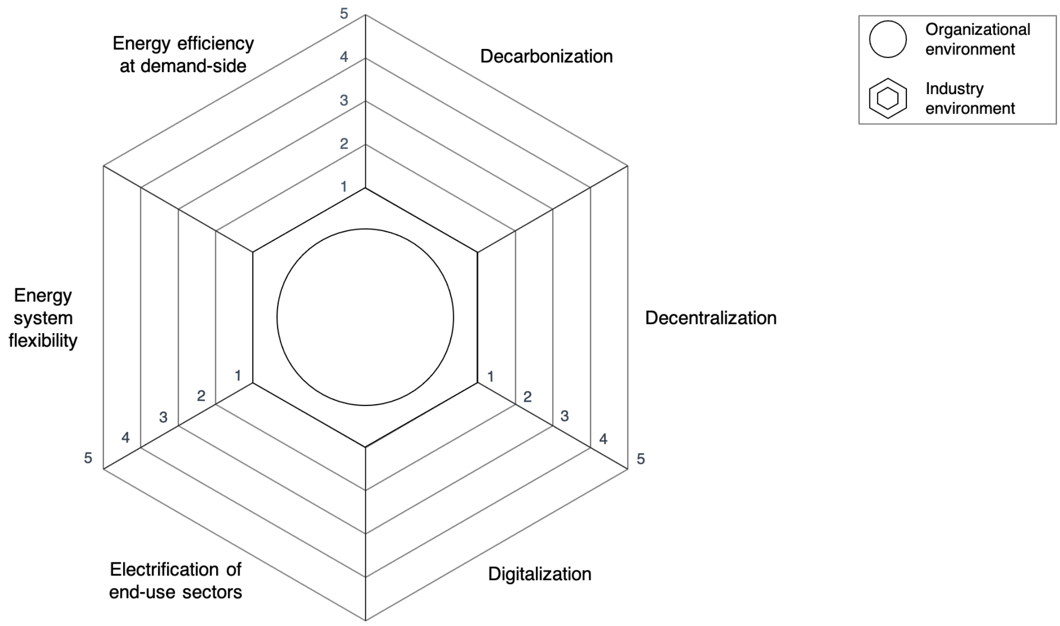


Figure 4.1: Conceptual framework for analysis of the business model of a utility. 1 = poor adaptation of a BM to a specific energy sector development, 5 = excellent adaptation of a BM to a specific energy sector development. Own illustration.

4.3. Current Alignment of Utility Business Models with Energy Sector Developments

In the analysis of the developments in the energy industry, it came forward that the sector faces multiple major changes (e.g. decarbonization, decentralization, digitalization, electrification, increased use of flexibility measures, and energy efficiency improvements) that affect multiple actors in the power industry. For all relevant market actors, the power sector developments have implications for their needs. Specht and Madlener [166] summarized the needs of these different affected parties (i.e. customers, grid operators, society/policy-makers, and energy suppliers), which is presented in Table 4.1 [166].

The findings in this table that concern the needs of energy suppliers already imply that utilities are currently not fully aligned with all developments. However, to obtain a clear picture of where utilities exactly stand, these implications do not suffice. Therefore, two industry experts ([48], [187]) were asked to score the four utility business models on their rate of adaptation to each of the major power sector developments. This was based on the following theorem: "The Traditional / Green / Cooperative / Prosumer Utility Business Model is well adapted to the respective power sector developments."

The score itself was given by using the following 5-point Likert scale:

$$1 = strongly\ disagree,\ 2 = disagree,\ 3 = neutral,\ 4 = agree,\ 5 = strongly\ agree \tag{4.1}$$

The (aggregated) results are presented in Figure 4.2. As can be seen, the figure consists of spider web diagrams that indicate how well each current utility BM is currently adapted to each of the developments. The spider web diagrams are presented as hexagons, in which each side is representing one of the six identified power sector developments. The shaded part in each of the six sides represents how well that specific Business Model is adapted to that respective development. In this score, 1 corresponds to minimal adaptation, and 5 to maximum adaptation.

Table 4.1: Resulting needs of relevant actors with respect to the decarbonization, decentralization, and digitalization of the energy sector. Adapted from Specht & Madlener [166].

Actor	Needs
Customers	• Finding, financing, and operating a suited renewable asset portfolio • Enabling their assets to access and efficiently operate as many additional business cases as possible to max out the economic potential of their assets • Utilizing the potential of smart grid solutions
Grid operators	• New way to reduce load peaks caused by VRE sources by means of local flexibility instead of grid expansion, e.g. by an external provider of peak-shaving services
Society / policy-makers	• Alternatives to conventional grid extension in order to avoid additional long-term surcharges on the electricity bills • Increased diffusion speed of DERs to meet agreed climate targets
Energy suppliers	• Shifting away from the old concept of selling energy volumes towards selling (smart) energy services • Winning and binding customers • Gaining market share in small, distributed renewable assets • Gaining extra value out of DERs, e.g. by aggregation of prosumer supply • Responding flexibly to imbalances between increasingly volatile renewable energy supply and demand in order to avoid imbalance costs

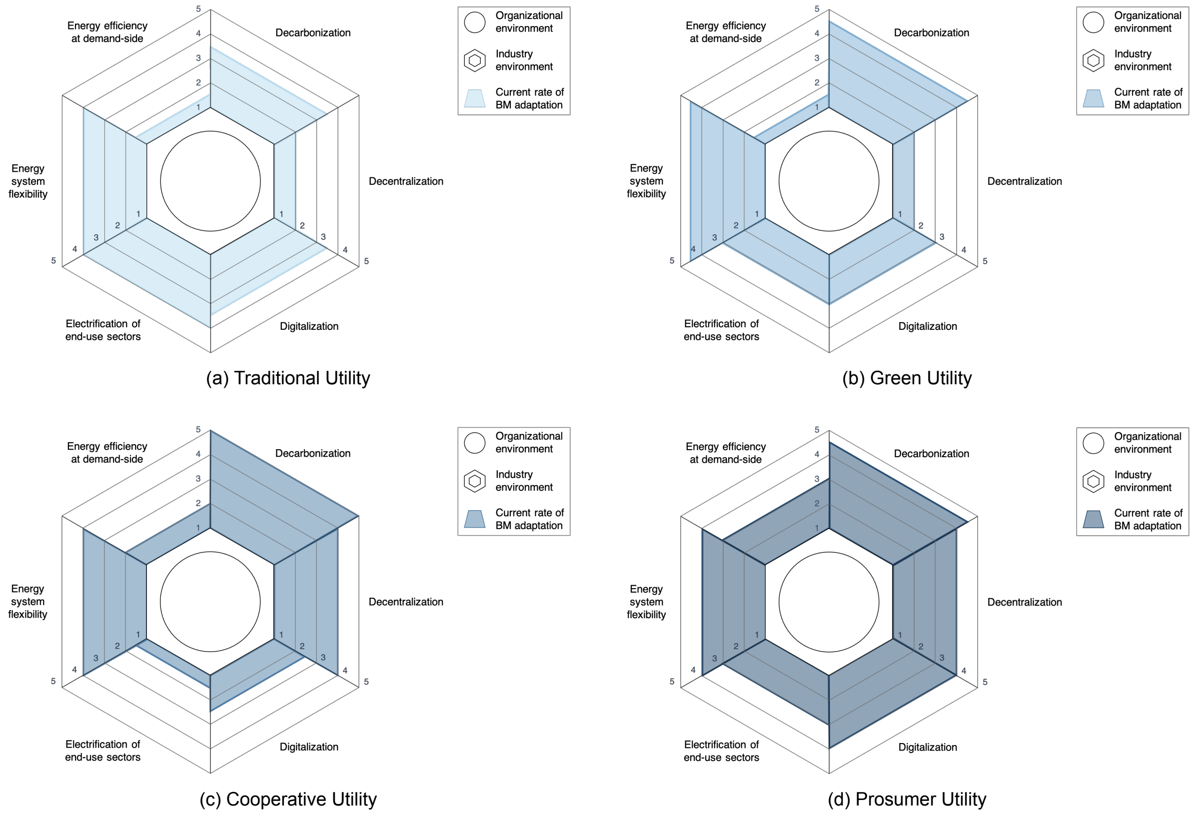


Figure 4.2: Rate of adaptation of current utility business models to major energy sector developments. 1 = poor adaptation of a BM to a specific development, 5 = excellent adaptation of a BM to a specific development. Own illustration, based on aggregated insights from experts [48], [187].

It could be insightful to compare these figures to the findings of the Chapter 3. First of all, regarding the score on decarbonization, it stands out that with a score of 3.5, traditional utilities score considerably lower than the other three BMs, which received a score of at least 4.5. Considering the fact that the three other BM types have been emerging in response to changes in the power sector – mainly the energy transition, this is not a remarkable result. These three models all have a strong focus on renewable energy. Despite traditional utilities are also increasingly focusing on renewable energy, they are also the ones that possess the largest generation assets, which are often still fossil-fuel based.

For full adaptation of utility BMs to the decarbonization trend, they would have to supply all their energy 100% carbon-free. This would not only apply to electricity, but also to gas and to heat. With respect to electricity, for example in Europe (EU-27) the share of renewable energy sources in the gross final electricity consumption in 2019 amounted to 34% [66]. For heating and cooling (which also partly addresses gas), this number equaled 22% [66]. Although these numbers are increasing every year, it implies that there is currently still much terrain to win. Moreover, utilities would have to supply this 100% carbon-free energy to both private and business clients, without buying (often cheap and foreign) RE certificates, and without investing in fossil-fuel based generation infrastructure, which is currently not often the case [130]. While for example green utilities seem to be generally considerably well complying to these requirements with respect to electricity, this is not the case for gas [60]. Only a very small percentage of the supplied gas is green; the remaining part is natural gas of which the carbon emissions are offset [60]. All in all, there is still much to gain for (especially traditional) utilities on this area.

With respect to decentralization, both traditional and green utilities received the score 2, while cooperative utilities and prosumer utilities both scored a four. Again, this result makes sense. In section 3.4, it became clear that the green utility model is quite comparable to that of the traditional utility, despite the fact that the delivered energy is (predominantly) renewable. Besides this, the green utility BM was still centered around the proposition of bulk supply of metered units of energy. On the other hand, cooperative utilities and prosumer utilities have a more decentralized character. In case of cooperatives, we have seen that these are focused on supplying renewable energy to customers in specific local communities, for example generated by a (few) wind turbine(s). In this case, all parts of the energy supply are decentralized. The same goes for prosumer utilities, although in a completely different way. Prosumer utilities focus on offering customers renewable, local, and self-produced electricity by providing them with distributed energy storage equipment and, where possible – self-generation assets. So again, energy supply is decentralized.

Full adaptation of utility BMs to the decentralization trend is somewhat more difficult to describe, as 100% decentralized energy generation is not a goal as such; centralized, renewable generation such as offshore wind or large solar farms will be essential for realizing the energy transition [177]. Nevertheless the focus of power systems will need to shift. Although good European progress on decentralization is being reported, again there is still much terrain to win [106]. The decreasing trend in costs of DERs must continue, prosumers (on a residential, commercial, and industrial level) must be further stimulated by effective legislation, and utilities should offer a wide range of energy services (e.g. efficiency consulting and integration services) and decentralized renewable energy assets to all types of customers – i.e. with respect to distributed solar PV, various storage solutions, smart homes, EVs, power-to-x solutions, but also local (independent) smart grid solutions [14]. Also, a lack of customer demand in several areas will need to be overcome. Moreover, as we have seen, traditional utilities still rely heavily on centralized, often fossil-fuel based generation assets. As long as these are not completely phased out, partly replaced by centralized RE generation and partly replaced by decentralized RE generation in combination with a range of decentralized storage and efficiency assets, utilities are not fully adapted to decentralization.

Thirdly, with respect to digitalization, the results are somewhat more surprising. The cooperative and green utilities score the lowest with 1.5 and 2, respectively. This score falls within the range of expectation, as both models do not incorporate any sophisticated digital technologies. However, when comparing the score of traditional utilities (3.5) and prosumer utilities (4), this small difference is not reflected in the nature of their business models. We have seen that traditional utilities make use of mainly centralized, large-scale, often fossil-fuel based generation assets. On the other hand, the key assets of a prosumer utility are its Virtual Power Plant and Peer-to-Peer software. This includes the digital connectivity of all decentralized generation and storage assets. In other words, one would have expected that the difference in digitalization score between traditional and prosumer utilities would have been larger. This might be due to the fact that there exist a range of other digital solutions as smart homes and smart EV charging systems, which traditional utilities have already (partly) incorporated in their product offerings.

Full adaptation of utility BMs to the digitalization trend would imply full interconnectivity of all energy-related assets, leading to a fully digitally optimized power system. Currently, technologies as Internet of Things solutions, Artificial Intelligence, Big Data, Cloud, 5G, and Blockchain technologies are becoming increasingly important [12]. For example through digital technologies as smart meters, energy management systems, smart EV chargers and a range of other ICT solutions, utilities will be able to obtain detailed insights into customer data, which must lead to tailored offerings of these data insights and many efficiency-improving solutions by utilities to customers [12]. Besides insights and efficiency solutions, also energy aggregation will be important (think of prosumer utilities), as well as grid balancing services to handle grid congestion, enabling P2P energy trading, cybersecurity measures, and privacy and data protection [12]. Although multiple utilities have started customer engagement activities with respect to data analytics, smart behind-the-meter solutions, and energy management solutions, data monetization can still be (much) improved [12]. All in all, it seems that the technology is generally there, but it is not yet generally available to all customers [12].

Fourthly, concerning electrification of end-use sectors, the results fall within the range of expectation. Cooperative utilities score the lowest with a score of only 1.5. This is reflected in their relatively simple business model and their small size. As a result, it can be expected that these utilities do not focus on the provision of for example EV solutions or heat pumps. With a score of 3, green utilities and prosumer utilities already score much better. For prosumer utilities, their innovative character and focus on DERs justify this score, while their relatively small size might limit the score from being higher. For green utilities, their strong focus on renewable energy may pass through to offering a range of products aimed at decarbonization society. However, because of their smaller size compared to traditional utilities, this effect is limited to residential and small commercial customers. For traditional utilities this is not the case. An important part of the electrification trend affects (large) buildings and industry, which are often served by traditional utilities. Moreover, traditional utilities have more generating capacity, so they are better capable of meeting a higher electricity demand. So, in this case the large size of traditional utilities will have a beneficial effect on this area and thus justifies their score of 4.

Full adaptation of utility BMs to the electrification of end-use sectors would obviously not mean that e.g. all heating and mobility would be electrified, as there are also other solutions available (e.g. green gases). On one hand, it means that utilities would have to be ready for increased demand for electricity, which implies increased generation. In line with decarbonization, this generation would obviously have to be renewables-based. Furthermore, it would mean that utilities would have to offer a range of clean, affordable, and efficient products and services with respect to (smart) EV charging, both residential and through public stations. Also, EVs would have to be integrated in the overall energy management system, so they can provide flexibility; utilities would therefore have to build Vehicle-to-Grid capabilities [165]. Also, different heating and cooling solutions will be required for both private and business customers, that will be steered by smart thermostats and integrated with other decentralized assets [12]. Besides this, utilities would have to increase assistance to municipalities and local communities in the facilitation of natural gas independent or all electric neighborhoods. Finally, electrification of industry is also a relevant topic on which many improvements are still to be made. Utilities are to play an important role in this, as they can assist large industry players in decarbonization and electrification of their energy needs, e.g. through heat recovery systems or large heat pumps.

With respect to increased use of energy system flexibility measures, it can be seen that there is little difference across the four BMs and the scores are all high. Traditional utilities, cooperative utilities, and prosumer utilities each score a 4, where green utilities score half a point higher. This high score may partly result from the fact that an important share of the energy flexibility measures (i.e. increased interconnectivity of power grids between countries) can be attributed to the account of TSOs and DSOs. This was also confirmed during the expert consultations, in which the emergence of innovative business models at the network operator part of the supply chain was highlighted [187]. Utilities still have to do their part, but it seems this is already on their radar, ranging from optimizing energy flows in a VPP in case of prosumer utilities to centralized and decentralized energy storage in case of the other utilities.

To fully adapt to this flexibility trend, utilities would have to offer various ways of grid relieving and balancing solutions. Increased interconnectivity of power systems will provide an important part, but mainly affects grid operators. Nevertheless, utilities could increase their activities in provision of these balancing and relieving services to TSOs and DSOs. On the one hand, this would imply providing a sufficient level of (decarbonized) back-up generation assets for times when renewable generation falls short. Currently, this is often provided through gas turbines [12]. On the other hand, a large part of the flexibility will have to be provided by centralized and decentralized, long-term and short-term energy storage. Large-scale storage technologies can for example include Pumped Hydroelectric plants, large-scale battery storage, but also large-scale production and storage of green hydrogen, and other power-to-gas solutions. For the latter, they should also partner with large users of these facilities [14]. Small-scale options would rather refer to residential or local battery storage and thermal energy storage, thereby also including EVs through Vehicle-to-Grid solutions [12]. Other flexibility-enhancing solutions can be provided through aggregation of (smart) DERs or smart grids in general. Currently however, the deployment of energy storage technologies and interconnectivity between power systems is still somewhat limited [36].

Finally, the increased use of energy efficiency technologies is the trend to which all utilities are least adapted. The traditional utility and green utility both score 1.5, where the cooperative utility receives a 2. With a score of 3, the prosumer utility scores somewhat better. This result is not highly surprising, as this is the trend where the focus is on efficiency improvements at the consumer-side. In that respect, utilities will have less power over this trend and must find ways to persuade their customers to welcome efficiency technologies. Therefore, it is expected that utilities can encounter resistance or disinterest among customers. In case of prosumer utilities, the situation is a bit different. This is mainly the result of their VPP and P2P software, which is focused on optimizing energy flows between prosumers and consumers. In this case, higher efficiency is already provided by the assets themselves. However, for each utility type, here is much terrain to win.

The full adaptation of utility BMs to the energy efficiency trend is strongly related to alignment with digitalization. Indeed, many energy efficiency enhancing technologies and energy management services will be digitally-based. In that respect, a highly important aspect of increased adaptation to energy efficiency will be the access to and aggregation of large amounts of customer data. Based on these data, many different, tailored efficiency solutions could be offered, based on dynamic prices or an energy-as-a-service subscriptions [12]. Utilities can play an important role in home energy management, managing consumption, integration of self-generation assets, and other behind-the-meter options [12]. Besides these mainly digital solutions, energy efficiency would also refer to better insulation of houses and buildings, for which utilities could provide consulting and installation services. All in all, the opportunities are abundant. However, currently the full adaptation of utilities to this trend is far from achieved. For example, this is partly due to a lack of customer demand for these solutions, in turn the result of high investment costs, limited perceived benefits, or a lack of interest in efficient consumption [12]. As a result, utilities would have to create more incentives for customer engagement. Also, current incentives to improve energy efficiency have not yet proven to be effective, so utilities would have to partner with governments and regulators [14].

Taking stock – although sometimes together with other utility types – traditional utilities score the lowest on four of the six developments. Moreover, they only score the highest on one development. Therefore, it could be argued that they are least adapted to the power sector developments combined. This corresponds to the finding amongst literature that especially for traditional utilities, both scholars and managers agree on the need for fundamental business model innovation [50], [86], [144], [147].

For a more in-depth analysis, it could be interesting to assess whether this need for fundamental BMI for electric utilities compares to general potential triggers for BMI that are recognized in literature. However, this would not directly contribute to the answering of the sub research question addressed in this chapter. In that respect, an analysis of the triggers for BMI is provided in Appendix D.1.

In such a rapidly developing environment, with decreasing profitability of incumbent business models and the emergence of a large number of innovative startups ready to conquer the energy market, the challenge is clear. Traditional utilities must fundamentally innovate their business model, and they must start doing that now [144]. A few general outlines of what that required BMI for traditional utilities might look like is provided in Appendix D.2.

In addition to the fact that the urgent need for BMI applies especially to traditional utilities, this research focuses on the potential contribution of Corporate Venture Capital activities on business model innovation. Mainly due to their large size and the availability of sufficient financial resources, traditional utilities are the only type of utilities that have these CVC programs in place. Therefore, the remainder of this thesis will solely focus on traditional utilities and will leave the other types of utilities out of the analysis.

So, after Chapter 3 identified four currently existing utility BM types, this chapter has unveiled six main developments in the energy sector. Also, the current alignment of utility BMs with these developments was addressed, resulting in a need for fundamental BMI for traditional utilities – which are therefore the only utility type that will be included in the analysis in the remainder of this research. A graphical representation of the progress made up to and including this chapter is presented in Figure 4.3. It must be underlined that this is a generalized overview, so its contents are not reflecting the exact findings of this chapter and previous chapters (except for the energy sector developments).

In line with the limited alignment of traditional utilities with the power sector developments and the subsequent need for BMI, the next chapter will address the potential barriers that can hinder this BMI.

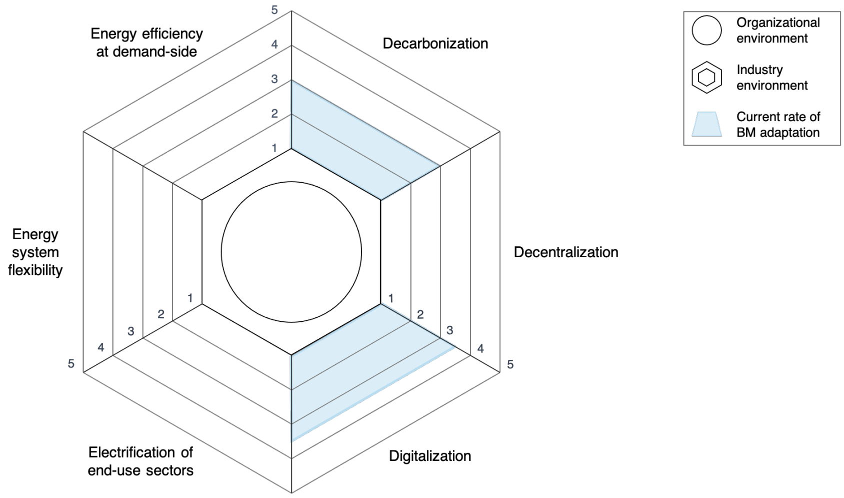


Figure 4.3: Generalized graphical representation of the progress made up to and including Chapter 4. The contents of this figure do not reflect the exact findings, except for the energy sector developments. From now on, only traditional utilities will be further assessed. Own illustration.

4.4. Chapter Summary

The goal of this chapter was to obtain a thorough understanding of the most important developments in the energy sector and the extent to which electric utilities are currently adapted to these developments. An extensive literature review and expert consultations on this subject has delivered sufficient insights for answering the second sub research question of this thesis:

What are the major developments in the energy sector and to what extent are current electric utility business models adapted to these developments?

The energy sector is in the middle of profound change in multiple areas. As such, six major developments have been identified that have a major effect on the electric power industry. The first one is *decarbonization*, also known as the energy transition. In this transition, the world is moving away from fossil fuel sources towards renewable, clean energy sources as wind, solar, biomass, hydro, geothermal, and marine energy. For the power sector, this means that its entire structure has to change, affecting the way in which energy is produced and distributed to customers.Secondly, the energy transition and its related governmental policies also led to shift to *decentralization* of energy generation and management. This does not only mean an increase in the use of decentralized electricity generation assets as solar PV, but also imply increased use of Distributed Energy Resources in general, also including local battery storage, electric vehicles, and other (smart) energy efficiency technologies. The latter already implies the third major trend: *digitalization*. The power sector is shifting towards a smart energy system in which the use of digital technologies must lead to more optimal energy management. Examples of digital technologies include smart meters, smart homes, and smart EV charging systems.

Fourthly, as a result from the global energy transition, *electrification of end-use sectors* is happening, for example in heat and mobility. This also affects the power sector, as this means an increase in electricity demand and electric (digital) technologies as EV charging infrastructure. Furthermore, in response to challenges resulting from the variable nature of RES, we see *increased use of energy system flexibility measures*. These measures mainly include increased interconnection with power grids of neighboring countries and use of centralized and decentralized energy storage options. Besides battery storage, also hydrogen storage technology is rapidly developing. Finally, as was already implicitly covered in digitalization, there is *increased use of energy efficiency technologies*. This is mainly focusing on the consumption side of the power system, leading to a large increase in so-called behind-the-meter options that must lead to more efficient power flow and less energy consumption, also called DSM. Examples include changing light bulbs into LEDs, smart homes, but also DR.

To get a grasp of where utilities currently stand, the current rate of adaptation of all four utility BM types was assessed. It turned out that none of the utilities is sufficiently adapted to all developments, and their rate of adaptation varies heavily across different developments. Especially traditional utilities seem to be insufficiently adapted, as they had the lowest score compared to other utility types on four of the six developments, the lowest of which were on increased use of energy efficiency and decentralization. So, it can be concluded that each of the utility types, but especially traditional utilities, are insufficiently adapted to the identified power sector developments. Furthermore, for better insight into the limited alignment of utilities with all developments, a brief overview of the offerings and activities that would be required for full alignment was provided. This resulted in the conclusion that on each development, for each utility – although to a varying extent – there is still (much) terrain to win.

All in all, the challenge is clear. Incumbent utilities must respond appropriately to these changes, which requires fundamental innovation of their business models. Otherwise, they will face the risk of losing their competitive position to dynamic and innovative new market entrants, or in the worst case, bankruptcy. However, this fundamental innovation of their business models is not as straightforward. In fact, it is a complex process subject to multiple potential barriers. In that respect, the next chapter will address the BMI process in more detail.

5

Barriers to Business Model Innovation

In the previous chapter, various major developments that affect the power sector have been identified and explained. Also, the rate of adaptation of current utility BMs has been addressed. From this adaptation, it was concluded that especially traditional utilities are insufficiently adapted, resulting in a need for fundamental Business Model Innovation. However, this simultaneously exposes a problem: incumbent, established companies generally face significant barriers to business model innovation as they find it difficult to appropriately respond to change [133], [148]. As other incumbent companies, traditional utilities do generally not have a solid reputation of being successful (BM) innovators [147], [148]. Thus, it is insightful to dive deeper into the process of BMI itself, which will address the third sub research question of this thesis:

What are the barriers to Business Model Innovation of traditional electric utilities in order to adapt to the energy sector developments?

In the next section 5.1, first the concept BMI will be briefly explained. Subsequently, in section 5.2 the barriers to Business Model Innovation are addressed. Finally, in section 5.3 the main findings of this chapter are summarized.

5.1. Business Model Innovation: The Concept

Business model innovation has only started receiving attention in academic literature about twenty years ago [67]. Just as in the case of business models themselves (see section 3.1), or maybe as a direct result of it, a generally accepted definition of business model innovation seems to be lacking [67]. This has resulted in a variety of definitions of Business Model Innovation, of which an overview is presented in Table C.2 in Appendix C.

As the focus of this thesis is on business model innovation of traditional electric utilities, it was chosen to adopt a leading definition that corresponds to this subject.Therefore, and also noting that this is the outcome of a thorough evaluation of many years of business model innovation research, the definition of Foss & Saebi [67] will be leading in this thesis:

"[Business model innovation can be defined as] designed, novel, nontrivial changes to the key elements of a firm's business model and/or the architecture linking these elements."

Besides in providing a definition of the concept, there is also considerable difference amongst research on the dimensions of the concept and the ways in which it can occur. However, it is not highly relevant to go into too much detail on this particular subject. The key takeaway here is that BMI not only refers to transformation of an existing business model, but can also address creation or acquisition of an additional model next to an existing model, or creation of a new model if there is no current model [75]. Also, companies can shape BMI in different ways, for example by adding new business activities, by linking activities in another way, or change the party that performs the activities [7].

A more extensive description of the typologies of BMI is left for Appendix D.3.

While the definition and typology of Business Model Innovation are subject to some disagreement amongst researchers, it has been increasingly acknowledged that business model innovation is positively related to firm performance [202], [67], [10]. To be more specific, BMI can potentially deliver transformative growth and exponential returns [120], and represents an often overlooked future value source which has the potential to translate into sustainable competitive advantage [7], [91]. This has the additional benefit that an entirely novel activity system is more difficult to imitate than a product or process [7]. Furthermore, business model innovation has the potential to enable renewed value propositions, enhanced uniqueness, and acquisition of new markets and customers [91]. As a result, it can be explained as a strategic organizational renewal mechanism [164]. Finally, it seems that firms with a focus on business model innovation tend to outperform their peers on profitability [76].

To conclude, the relevance of business model innovation for the electric power sector is again underlined by the conclusion of Massa & Tucci [120]: "in the course of most industrial sectors and humanitarian undertakings, there will come a time when the traditional way of creating, delivering, and capturing value is no longer valid, efficient, useful, or profitable. In such moments (or perhaps just before!), organizations that embrace BMI will embrace the possibility to reshape industries and possibly change the world." (p.437/438).

Now the context and relevance of Business Model Innovation for traditional utilities has been clarified, the remainder of this chapter will focus on the barriers to BMI of electric utilities.

5.2. Barriers to Business Model Innovation of Electric Utilities

With the increase of the amount of literature on business model innovation in general, many researchers have also addressed the barriers to achieving it. This comprises generally applicable barriers, as well as specific ones for electric utilities. To obtain a full overview of the existing literature on this subject, the standard five scientific databases were searched with varying combinations keywords, including "business model innovation", "BMI", "business model transformation", or "business models" with "barriers", "inhibiting factors", "inhibitors", "challenges", "moderators", "moderating variables", both with and without "electric utilities", "energy utilities", "utilities", "utility of the future", "energy", or "renewable energy". The results are presented in this section.

As a result of the diverging research on business model innovation in general, many different classifications exist to describe the barriers to BMI. In fact, even the used classification terms differ considerably. These divergent terms and definitions found in literature can be rather confusing. Therefore, this research will capture all divergent descriptions in the following term: A *barrier* is a "factor that hampers, delays or blocks things to be achieved or prevents people to communicate or progress" (p.30) [131].

Also, a certain classification framework is adopted to ensure that a clear overview can be maintained. Although different frameworks have been used for classifying all barriers, according to author the most clear and complete framework was provided by Horváth & Szabó [91]. Moreover, this framework has already been applied to companies operating in the distributed energy market before, which indicates its relevance for BMI for utilities, as they are one of the company types operating in this market. Horváth & Szabó [91] distinguished five main types of barriers to BMI: 1) organizational and company resource barriers (the term organizational here was added by author), 2) financial and profitability barriers, 3) awareness and behavioural barriers, 4) regulatory and institutional barriers, and 5) technological barriers.

It must be noted that Horváth & Szabó [91] only addressed specific barriers in business model development for distributed solar PV. So, the barriers they identified must obviously be extended by barriers found in literature about BMI in general, as well as other specific barriers for BM development in other more specific areas that are relevant for electric utilities. Therefore, the barriers described in this section address both generic barriers to BMI – which are relevant for business model innovations in general, despite sector or activity differences – and specific barriers to BMI for utilities which will be more in line with the identified energy sector developments of Chapter 4. Nevertheless, the classification framework of Horváth & Szabó [91] was adopted, as according to author this is more widely applicable than just for barriers in BM development in distributed PV.

5.2.1. Organizational and Company Resource Barriers

Within a changing context, organizations need to both exploit their current business model and at the same time develop new capabilities by experimenting with new business models [33], [148]. According to Tushman and O'Reilly [181], this organizational ambidexterity "requires organizational and management skills to compete in a mature market (where cost, efficiency, and incremental innovation are key) and to develop new products and services (where radical innovation, speed, and flexibility are critical)" (p.11). Focusing on only one of those elements will lead to long-term failure [181]. However, it seems that successful incumbent companies are often failing in developing the required capabilities to manage disruptive technologies [148]. For the energy sector, this means that utilities will have to maintain operating their current (traditional) business model, as well as developing new business capabilities to adapt to the identified major ongoing trends [147].

As this already implies, there exist many potential organizational and company resource barriers, which represents the most extensive set of all potential barriers to BMI. Chesbrough [33] was one of the first to study barriers to business model innovation. His findings show that barriers can occur in a cognitive form, e.g. managers failing in identifying the right business opportunities and new business models because of the mental inability to use information objectively [33]. Since then, the existence of cognitive barriers has been widely acknowledged [17], [67], [148], [190]. On the other hand, when managers do have identified the right business model, barriers can occur in the form of conflicts with existing business models or assets [33], [37], [167], [202]. For example, if for a traditional utility the model of selling as much electricity as possible is their cash-cow, why would they be interested in energy efficiency technologies for customers [48]? This goes hand in hand with incumbent companies sometimes having active interest in slowing down innovation because they fear losing their competitive position to new market entrants with innovative BMs [62], [156].

Moreover, Helms [86] argued that next to conflicts with existing assets and BMs, also difficulties in asset transformation are a separate barrier. On the one hand, the traditional utility business model is characterized by a high level of capital-intensity and thus high levels of depreciation [86]. On the other hand, a business model (or range of different business models) merely focusing on providing various energy solutions and services is characterized by high level of expense-intensity and intangible assets [86]. These differences can hinder the transformation of assets of utilities.

Besides these, barriers can occur as the result of a lack of competencies to build and manage new capabilities [67], [91], [148], gaps in the product portfolio [91], [148], insufficient allocation of resources to new technologies [127], [148], [159], and shortcomings in management and business skills [67], [91], [167]. Furthermore, barriers exist that are related to the search process of BMI: the where, how, and what [190]. In other words, this refers to the high complexity of BMI, which can be traced back to the fact that a BM consists of multiple interconnected components [127]. Simultaneously, this leads to lengthy innovation processes [127]. Regarding the BM innovations themselves, they are often said to be missing a customer-focused orientation, leading to a lack of knowledge of customers and a missing logic of how to reach them [62], [91], [127], [190]. This corresponds with another, more general barrier, namely the existence of incorrect or misaligned corporate structures [127], [167]. Furthermore, barriers follow from the fact that companies often have a short-term focus, for example driven by an orientation on maximizing shareholder value [17], [127].

Also, widely recognized barriers exist at an organizational and personal level. Conflicts with organizational values, culture, or design are seen as important barriers [17], [67]. Especially cultural aspects, for example the resistance to change a business model, are said to play a large role as they can lead to considerable friction [127], [190]. This can for example be related to the fact that employees are in fear of losing their jobs, fear increased work load, but also to too high expectations of the new business model [167]. At a micro level, more personal barriers consist of employee characteristics in terms of human capital, skills, and psychology (i.e. motivation, engagement, etc.) [62], [67].

5.2.2. Financial and Profitability Related Barriers

The second category of potential barriers to BMI of electric utilities addresses financial and profitability related barriers. This category mainly affects specific barriers for BMI and increased adaptation of traditional utilities to the identified power sector developments. First of all, factors as high initial investment costs and a lack of financial resources of customers can significantly increase the payback period for investments in distributed energy equipment [62], [91]. As a result, it may be not affordable for a too large group of customers, leading to a lower demand and profitability issues for utilities [154], [159]. Therefore, these barriers can pose significant challenges to the development of new business models by utilities, for example in the areas of distributed solar PV and energy efficiency. Indeed, it seems that many utility managers do not perceive the distributed solar PV market as an attractive market, which hinders innovation of utility business models in this area [148]. This has mainly two causes: the higher costs of generation compared to conventional generation or large-scale renewable generation, and the small project size [148]. These barriers also became eminent in the turn-key model that some utilities have applied for distributed PV [154]. However, it must be noted that these examples were found in references that were respectively published in 2013 and 2015. Since then obviously a lot has changed, which could challenge its current relevance. Nevertheless, this barrier could still apply to other areas as energy efficiency or electric mobility, as these trends are more recent and less progress on these areas has been made than in distributed solar PV.

Another financial barrier specifically addressing business model innovation with respect to renewable energies was found to be high additional costs, for example high battery costs, high O&M costs, and transaction costs for grid interconnection) [62], [91], [154]. These high additional costs can hinder electric utilities in the development of adequate business models in the fields of EVs and residential solar PV, among others [62]. In addition, referring back to the prosumer utility business model which aims at providing as many customers as possible with (battery) storage assets, high battery costs could negatively affect further development of this BM.

Horváth & Szabó [91] mentioned one additional specific financial barrier: a lack of access to loans for customers with respect to residential solar PV, which would hinder utilities in the roll-out of business models in this area. However, after closer inspection it seems that this was only the case before 2013 [170]. Therefore, this barrier will not be included,

Finally, expert consultations led to one additional barrier: utilities could have a lack of debt or equity finance to invest in innovation or new technologies (CAPEX) [48], [187]. However, after closer inspection it seems that this mainly applies to smaller utilities [147]. Moreover, managers of larger utilities have explicitly stated that their financial position is more than sufficient [86]. In line with the sole focus of this thesis on traditional utilities, it was decided to discard this barrier.

5.2.3. Awareness and Behavioural Barriers

Awareness and behavioural barriers are the third category of potential barriers to BMI of traditional utilities. Customer awareness and acceptance can strongly affect the demand for (distributed) renewable energy technologies [91]. In that sense, a lack of knowledge or information on these technologies and misinformation about their benefits can lead to lower customer awareness and demand [62], [91], [159]. Moreover, achieving customer acceptance is reported to be more challenging for service-oriented firms than for product-oriented firms [160]. As we have seen before, an important part of future utility activities is expected to include energy services in various fields.

The existence of a low customer demand as a barrier seems to correspond to an existing perception amongst some utility managers that a sufficient customer demand for utility activity in for example distributed RE is lacking, and therefore development of utility BMs in this field cannot be justified [148]. Moreover, evidence of this perception can also be found in the example of the lack of customer demand for smart thermostats in the Netherlands, which became clear during consultation with an industry expert [48]. Being excluded from incentive packages, as opposed to smart meters the smart thermostat has experienced a highly limited roll-out in the Netherlands, which points at a lack of customer demand [48]. The existence of lack of customer demand for energy efficiency products in general has been confirmed in other work [27], among others caused by a lack of information about benefits of these technologies. For both factors holds that they can present a significant barrier to the development and expansion of utility BMs and activities in certain fields, not only related to energy efficiency. Therefore, it could limit the increased adaptation of utility BMs to these trends; thereby hindering BMI.

Besides this, behavioural barriers and concerns have found to play a negative role. Firstly, electricity (at least in European or Western countries due to the high reliability of the power system) is generally considered to be a low-interest product [89]. Basically seen, it is intangible, cheap, and almost always available, so therefore it lacks customer interest. Moreover, in general customers tend to be risk-averse or can be not responsive to novelty in general [91], [167]. As a result, there exists a general lack of customer interest on RE technologies or other energy-related BM innovations. This barrier does not only specifically apply to utilities or RE, but can be found in other sectors with low-interest products as well, i.e. in the telecommunications sector.

Finally, a barrier was identified that addresses awareness on the company-side, as utilities could have an insufficient amount of knowledge about the potential markets for different RE technologies or potential customers, resulting from a lack of information [62]. This could hinder utility managers in identifying new BM opportunities, thereby hindering BMI in multiple areas of RE.

5.2.4. Regulatory and Institutional Barriers

The fourth important category is regulatory and institutional barriers to BMI of traditional utilities. Many barriers in this category can be related to shortcomings of the legal framework, as most introduced regulations are either inconsistent, incomplete, or immature [91], [166], [167]. While this is recognized as a more generally applicable barrier to BMI, a clear and more specific example can be found in the area of energy efficiency related BMI of traditional utilities. More specifically, with respect to the lack of smart thermostat deployment in the Netherlands [48]. Where in other countries as Germany smart thermostats were deployed together with smart meters to increase customer consciousness and decrease their energy usage, in the Netherlands it was decided to leave this to the open market. This has turned out to be subject to a lack of customer demand leading to a lack of smart thermostat deployment [48].

Besides this, more specifically concerning regulations and legislation on RE, despite the introduction of many regulations and legislation favoring renewable energy supply, these regulations often change or have an unclear long-term focus, leading to unpredictability and thus a lack of long-term planning reliability for utilities [62], [166]. As a result, building and operating the required complex logistics networks will become a challenge [62]. A clear example are the issues with decreasing feed-in tariffs, taxation, and a low electricity price, which are also constantly changing [91], [154]. These issues lead to insufficient incentives for customers in various fields of energy (e.g. EVs, energy efficiency), affecting customer interest and demand, which in turn hinders utilities in the development and expansion of appropriate BMs in these fields.

In addition, incentives are often misplaced, as they are not tailored to the varying local situations [62]. This combination of a missing long-term planning reliability and misplaced incentives results in long and uncertain development cycles for utilities, which will negatively affect BMI [62].

Furthermore, in general the introduction of digital technologies introduces large amounts of customer data, which can rise concerns about privacy and internet security, thereby presenting another potential barrier to BMI [67]. For utilities, following from the digitalization of the energy system and introduction of many smart DERs, this will be a highly relevant barrier as well. As a result, on the one side laws on these topics will have to guarantee customer protection, while on the other side they must avoid introducing irrational barriers [166]. Besides this, as some BMI involve acquisitions or relying more on external partners, competition law and generalized trust can be barriers as well [67]. With respect to competition law, as energy is a commodity product this includes strict regulations for consumer protection as well. All in all, a stable regulatory framework is one of the essential elements of successful BMI of electric utilities [91].

Finally, two more specific institutional barriers can be identified. In that respect, resistance from informal social institutions is recognized to an important potential barrier [67]. More specifically for utilities one could think of various examples, including the well-known resistance to nuclear energy, biomass, and 'not-in-my-backyard' issues of wind turbines or solar farms on land. The other one addresses a barrier of BMI for utilities in the specific areas of RE development. This is a lack of skilled people with specific training in RE, i.e. for installation and O&M, to ensure successful projects [159]. Practical evidence of the existence of this barrier is highly eminent. For example, in the Netherlands there are serious shortages of skilled personnel in the installation sector, which is reported to pose a significant threat to the energy transition and the Dutch ability to achieve its climate targets [134]. One could for example think of delays in the deployment of EV charging stations, distributed solar PV, and the increased energy efficiency of residential property.

5.2.5. Technological Barriers

Finally, also technological barriers can hinder BMI of traditional utilities. Especially reliability, stability, and efficiency of the power grid have already turned out to be critical barriers [91], [154]. Although the infrastructure is generally strong and reliable, it only allows for a certain share of renewable energy sources due to their strong variable nature [62]. Therefore, capacity constraints have become a significant barrier, as it will require (significant) expansion of the grid capacity to maintain meeting reliability requirements [91]. Industry experts have concerns that these problems may eventually lead to large power losses [154]. As we have seen in Chapter 4, this has led to a need for power system flexibility solutions.

This flexibility does not only apply to generation overshoots: in times of little wind or sunshine and high demand, there is need for system flexibility – for example through energy storage – to avoid system performance risks and be able to meet demand. This also holds for utilities, as in order to avoid imbalance costs they will have to come up with innovative flexibility solutions [166]. Moreover, the flexibility potential at the household level introduced by distributed energy sources typically allows for managing consumption or production for several hours, but not for i.e. seasonal fluctuations [166]. So, utilities will have to develop appropriate BMs and capabilities to tackle these challenges.

These factors also lead to increased competition of RE technologies with existing technologies, and thus demands higher levels of performance and cost effectiveness of renewables [62]. Another reason for increasing levels of competition with existing technologies is due to the low energy density of renewables compared to that of fossil fuels [62]. This poses considerable limitations for some applications, and thus introduces challenges to new BMs (for example with respect to excess electricity storage or large-scale application of biomass) [62]. Finally, with respect to customer orientation, it is important that customers will not experience serious comfort reduction, which poses another important challenge to distributed technologies and their management [166].

Finally, other technological barriers include the lack of standard procedures for grid connection and metering issues [154]. Where the former has mainly relevance for decentralized energy generation, the latter may negatively affect decentralized generation, but also EV charging, and energy efficiency technologies. Both factors challenge the effectiveness of activities of utilities in these fields.

5.2.6. Mutual Exclusivity of Barriers to BMI

So, a wide range of barriers exists, which all have the potential to hinder BMI of traditional utilities. However, after further inspection it turns out that a few barriers show significant overlap. To ensure mutual exclusivity of the set barriers, it was decided to merge some of the identified barriers, based on own insights and consultation with one industry expert [187].

First of all, five mergers were made in the organizational and company resource category. 'Conflicts with existing assets and business models' and 'interest of incumbents in slowing down innovation because they fear losing their competitive position' are not mutually exclusive, as the latter already implies a conflict of innovation with existing assets or business models. Therefore, these two were merged into the former. Besides this, 'shortcomings in management and business skills' and 'lack of competencies to build and manage new capabilities' are basically referring to the same thing, so these are merged into the latter. Furthermore, despite the fact that Helms [86] argued for including 'difficulties in asset transformation' as a separate barrier, according to author this shows too much overlap with the more generally described 'conflicts with existing assets and business models'. Therefore, only the latter will be included in the final list. Also, 'misaligned or wrong corporate structures' is already reflected in the more general organizational design part of 'non-supportive organizational values, culture, and design', so only the latter is included in the final list of barriers. Finally, 'a lack of competencies to build and manage new capabilities' consists of 'cognitive barriers' and 'inability to allocate sufficient resources to new technologies' [148]. Therefore, these are combined into one extensive barrier.

Furthermore, with respect to financial barriers, a 'lack of financial resources of customers' and 'high initial investment costs for customers' are highly interrelated, so it was decided to combine these two in high initial investment costs. Secondly, 'high additional costs' can be one of the direct causes for 'profitability problems for utilities', and will therefore not be included. separately. Regarding regulatory and institutional barriers, the emergence of 'long and uncertain development cycles' can be seen as the result of 'unpredictable regulations leading to a lack of long-term planning reliability' and 'misplaced incentives'. Therefore, it is not relevant to include the barrier 'long and uncertain development cycles' on its own. Considering the technological barriers, 'low energy density of renewables' has strong overlap with 'competition of RE technologies with existing technologies' as it can be seen as one of the causes for this competition. Therefore, the former was discarded. Finally, 'security of supply' is already reflected in 'system performance risks' and therefore not mentioned on its own.

5.2.7. Attaching Labels to all Barriers

Now the list of barriers can be considered mutually exclusive, the specific purpose of this research requires additional step: labeling all barriers – where possible – to specific power sector developments, based on the identified developments of section 4.1. This is based on the following classification: [1] = decarbonization, [2] = decentralization, [3] = digitalization, [4] = electrification of end-use sectors, [5] = increased use of flexibility measures, [6] = increased use of efficiency technologies, [7] = generic barriers for BMI. As this implies, there exist both barriers that are specific for certain power sector developments and generic barriers that affect the process BMI in general and can therefore hinder all business model innovations; no matter what this specifically includes.

Two methods were used to label the barriers. On the one hand, the assessed literature was further inspected to obtain any information on specific relevance of certain barriers to certain developments. For example, a few papers were found to be completely devoted to barriers for further decentralization of the energy sector, specifically concerning residential solar PV. In that case, most barriers could be labeled to both decarbonization and decentralization. On the other hand, as the energy sector is changing at a rapid pace, research that was conducted a few years ago might not be (fully) relevant anymore today. Therefore two industry experts [48], [187] were consulted, which led to additional recent insights on the labels. For example, barriers that used to be relevant for decarbonization a few years ago, might nowadays be mainly relevant for energy efficiency, as this trend has only started to receive attention a few years ago.

5.2.8. Overview of Potential Barriers to BMI of Traditional Utilities

An overview of all potential barriers, including their classification, related power sector developments, and related papers, is presented in Table 5.1. In this table, the barriers that were confirmed by expert consultations are highlighted.

What this extensive set of barriers already implies, is that the approach here has been to translate all potential causes for the limited adaptation of traditional utilities to the various identified power sector developments into barriers to business model innovation. Obviously, other approaches could have been taken, but according to author this specific approach is a clear, complete, and structured way of assessing the causes for this limited adaptation.

It is important to stretch that the substantive component of Business Model Innovation is also translated into barriers. As Richter [148] discovered, this substantive component is reflected in the potential BMI barriers *Gaps in the product and service portfolio* and *Lack of competencies to build and manage new capabilities due to cognitive barriers (managers failing to recognize business opportunities) and the inability to allocate sufficient resources to new technologies*, which are both relevant for all identified power sector developments.

Indeed, it is important that utilities focus on the right BM innovations and come up with new propositions that will enable them to better align with all energy sector developments. Examples of what these 'right' BM innovations might include are provided in the BMI opportunities for utilities that Bryant et al. [23] identified (p.1034/1035):

- Become a **comprehensive energy solution provider**, i.e. consulting, installation, financing, O&M, and warranties of electricity generation and heating/cooling systems for a fee
- Shift to **energy-as-a-service**, offering a monthly flat-fee service contract to customers
- Build a **platform/virtual utility model**, connecting distributed generators with customers
- Reduce cost of energy by **technology experience effects** that reduce costs of distributed VRE
- Develop **alternative customer engagement routes**, i.e. media and entertainment, home automation, building security, energy saving, and data aggregation

- Generate additional revenue with **demand response and balancing**; which will provide extra services to grid operators
- Provide grid operators with assurance of large generating capacity, leading to **capacity payments**

With respect to the interrelationships between BMI and CVC as will be addressed in the next two chapters, it will also be assessed to what extent CVC can help avoiding the two barriers related to this substantive component of BMI. Therefore, in the case study in Chapter 7 also an analysis of the substantive component of CVC activities will be performed, through an analysis of the venture portfolios of the two CVC units of the studied utilities. Indeed, it does matter in which types of ventures the CVC units invest, in order to be able to assess whether this will help utilities with identifying the right BM innovations and avoiding a lack in the product or service portfolio.

Finally, it must be noted that not all of these potential barriers will be relevant in the eyes of electric utilities themselves, as will follow from the case study results in Chapter 7.

Table 5.1: Potential barriers to business model innovation of electric utilities. Adapted from Horváth & Szabó [91] and extended by literature study findings. Highlighted are barriers that were confirmed by at least one of two industry experts [48], [187]. Power sector developments: [1] = decarbonization, [2] = decentralization, [3] = digitalization, [4] = electrification of end-use sectors, [5] = increased use of flexibility measures, [6] = increased use of efficiency technologies, [7] = generic barriers for BMI.

Classification	BMI Barriers (B) – [related power sector developments]	Related papers
Organizational and company resource barriers	1. **Lack of competencies to build and manage new capabilities due to cognitive barriers (managers failing to recognize business opportunities) and the inability to allocate sufficient resources to new technologies – [1], [2], [3], [4], [5], [6]** 2. **Gaps in the product and service portfolio – [1], [2], [3], [4], [5], [6]** 3. **Conflicts with existing assets and business models – [7]** 4. Search-related barriers (where, what, how to innovate) due to complexity of BMI – [7] 5. Lack of customer-focused orientation, leading to a missing logic of how to reach them in the BMIs themselves – [7] 6. Lengthy innovation processes – [7] 7. Non-supportive organizational values, culture, and design – [7] 8. Non-supportive human capital, skills, and psychology – [7] 9. **Short-term focus, i.e. mainly focusing on maximizing shareholder value – [7]**	[17], [33], [37], [62], [67], [91], [127], [147], [148], [154], [156], [167], [190], [202]
Financial and profitability barriers	10. **Profitability problems for utilities in certain markets due to high costs, small project sizes, and high additional costs (i.e. O&M, transaction costs for grid interconnection, and high cost of batteries) – [1], [2], [4], [5], [6]** 11. **High initial investment costs for customers, lowering demand and thus lowering market attractiveness for utilities – [1], [2], [6]**	[62], [91], [127], [148], [154], [159]
Awareness and behavioural barriers	12. **Misinformation or lack of knowledge about benefits of RE technologies by customers leading to lower customer awareness and acceptance, hindering utility BMI in certain areas – [2], [3], [4], [6]** 13. **Lack of customer demand in certain areas, blocking the justification of utility BM development in these fields – [2], [4], [5], [6]** 14. **Behavioural barriers and concerns (risk-aversion, customers unresponsive to novelty, etc.) limiting market potential for new utility activities – [2], [5], [6]** 15. Lack of knowledge and information by utilities about markets for RE and potential customers – [1], [2]	[62], [91], [148], [159], [167]

Regulatory and institutional barriers	16. **Shortcomings of legal framework (inconsistency, incompleteness, immaturity) hindering utility activity in certain areas – [2], [4], [5], [6]** 17. **Issues about feed-in tariffs and taxation, limiting customer interest for novel utility BMs – [1], [2], [5]** 18. **Low electricity price, limiting customer interest and demand for new utility BMs – [2], [6]** 19. **Unpredictable regulations leading to lack of long-term planning reliability for utilities – [1], [2], [4], [5], [6]** 20. **Misplaced incentives (insufficient adaptation to local situation and conditions) leading to uncertain development cycles for utilities – [1], [2], [5]** 21. **Privacy and internet security law, restricting customer data usage and thus limiting digital BMIs – [2], [3], [6]** 22. **Competition law and consumer protection, limiting BM acquisition opportunities or profitability of certain BMIs – [2], [4], [6]** 23. **Resistance from informal social institutions (e.g. nuclear, biomass), blocking certain BMIs – [1]** 24. Generalized trust, which if lacking can limit partnering opportunities – [7] 25. **Lack of skilled people for installation, O&M, etc. limiting diffusion of new BM activities – [1], [2], [3], [5], [6]**	[62], [67], [91], [146], [154], [156], [159], [166], [167]
Technological barriers	26. **Limited grid capacity, constraining new RE integration and thus limiting utility BMI activity in this area – [1], [2], [4]** 27. **System performance risks, constraining new RE integration and requiring innovative flexibility enhancing BMIs – [1], [2], [4], [5]** 28. **Strong competition of RE technologies with existing technologies, posing limitations to some applications of RE and thus BMIs in these areas – [1], [2], [4], [5], [6]** 29. **Risk of customer comfort reduction, limiting the market potential for certain BMIs – [2], [4], [6]** 30. **Lack of standard procedures for grid connection, hindering BMIs in decentralization – [2]** 31. **Metering issues, limiting the effectiveness and potential of certain propositions that rely on this factor – [2], [4], [6]**	[62], [91], [147], [154], [166]

So, Chapter 3 identified four currently existing utility BM types. Subsequently, Chapter 4 identified the major power sector developments, the current alignment of utility BMs with these developments, and the resulting need for fundamental BMI for traditional utilities. Now, this chapter has addressed the potential barriers (generic and development-specific) that can hinder BMI and better adaptation of traditional utilities to the identified power sector developments. A graphical representation of the progress made up to and including this chapter is presented in Figure 5.1. It must be underlined that this is a generalized overview, so its contents are not reflecting the exact findings of this chapter and previous chapters (except for the energy sector developments).

On the one hand, the identified barriers address the generic barriers to BMI, presented in the center of the figure. We have seen that these are relevant for all business model innovations in general, despite sector or activity differences, and were represented by the label [7]. The generic barriers mainly include organizational and company resource barriers. On the other hand, specific barriers to BMI for utilities are the ones that hinder better alignment of utilities with the identified energy sector developments, and were represented by the labels [1] to [6]. Therefore, they are presented in one or multiple of the six domains that each represent a major development. Furthermore, the red outlined areas represent the hindering impact of the BMI barriers on better alignment with each energy sector development. Finally, the arrows represent the fact that barriers to BMI hinder better alignment of utilities with the energy sector developments; they cannot lead to worse alignment than the current situation.

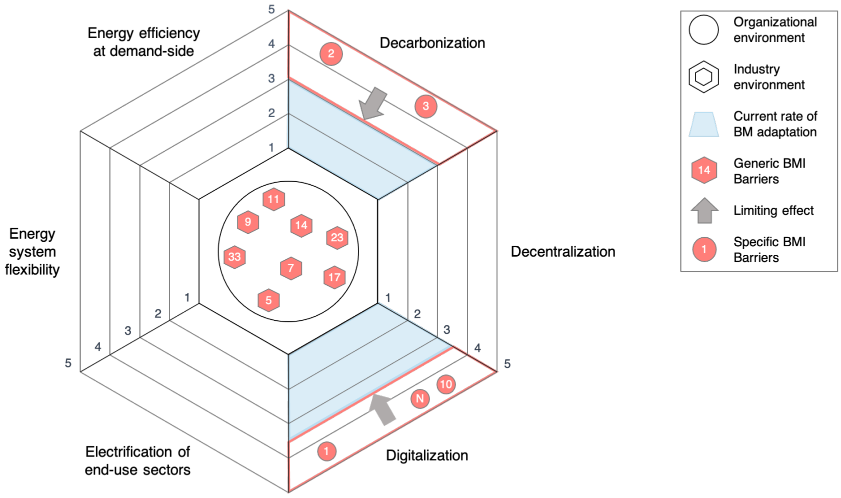


Figure 5.1: Generalized graphical representation of the progress made up to and including Chapter 5. The contents of this figure do not reflect the exact findings, except for the energy sector developments. Own illustration.

5.3. Chapter Summary

The goal of this chapter was to obtain a thorough understanding of business model innovation for electric utilities. An extensive literature review and expert consultations on this subject have delivered sufficient insights for answering the third sub research question of this thesis:

What are the barriers to Business Model Innovation of traditional electric utilities in order to adapt to the energy sector developments?

After a brief explanation of the concept itself, the barriers to BMI were assessed. It was found that barriers to Business Model Innovation can be divided into five categories, and can be either described as generic barriers to BMI – independent from sector or company activities – or can be directly linked to one or multiple of the identified power sector developments. First of all, of the organizational and company resource barriers, the most widely acknowledged is the lack of competencies to build and manage new capabilities, due to cognitive barriers or insufficient resource allocation to new technologies. Together with gaps in the product and service portfolio, this barrier forms the highly important substantive component of BMI. Besides these two, other barriers can include conflicts with existing assets and business models, a non-supportive organizational culture, design, and human capital, and a short-term focus (i.e. on maximizing shareholder value). Secondly, financial and profitability barriers can for example refer to high initial investment costs for customers or profitability problems for utilities. Also, awareness and behavioural barriers can mainly include misinformation and poor knowledge about benefits of renewable energy technologies by customers, a general lack of customer demand, or behavioural barriers and concerns (customers unresponsive to novelty in general). Furthermore, regulatory and institutional barriers can range from general shortcomings of the legal framework and unpredictable regulations that lead to a lack of long-term planning reliability, to misplaced incentives, issues about feed-in tariffs and taxation, and privacy and internet security law. Also, a lack of skilled people for installation and O&M seems to limit the development and diffusion of new BM activities of utilities. Finally, technological barriers can refer to the limited grid capacity and system performance risks due to the variable nature of RES, but also strong competition of new technologies with existing technologies, among others.

So, on the road to business model innovation and better adaptation to the energy sector developments, traditional utilities will have to tackle many potential barriers. On the other hand, various instruments exist that can help them to address these challenges. It seems that traditional utilities have specifically set their sights on Corporate Venture Capital activities to help them innovate their business models and secure sustainable competitive advantage.

6

Corporate Venture Capital and its Link to Business Model Innovation

In the analyses of major energy sector developments and business model innovation in the electric power industry, it stood out that traditional utilities stand at the beginning of what is a journey of fundamental transformation towards becoming the decarbonized, decentralized, and digitalized utility of the future. However, this journey is subject to many potential barriers, which must be removed or circumvented to be able to fully adapt to all major developments. To support traditional utilities in this challenge, an open innovation approach was found to be favourable over innovation solely from within the company. More specifically, it seems that many utilities aim to harness the entrepreneurial knowledge and power of start-ups through such open innovation, and more specifically, through Corporate Venture Capital programs [118]. That this specific approach has been fastly gaining ground is reflected in the fact that nine of the ten largest European electric utilities have established such programs [111]. In this way, they aim to support the required innovation of their business models, which must lead to a maintained, sustainable competitive advantage [91].

In this chapter, CVC programs of electric utilities will be addressed in more detail, including their potential effect on business model innovation. By doing so, this chapter will address the fourth sub research question of this thesis:

What is the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments?

In the next section 6.1, the concept of CVC will be explained, useful background information will be provided, and the potential benefits will be discussed, as well as potential barriers and stimulating factors to CVC. Hereafter, section 6.2 will address the potential effect of CVC on the barriers to BMI. Finally, a summary of the findings of this chapter will be provided in section 6.3.

6.1. Corporate Venture Capital Programs of Electric Utilities

6.1.1. Corporate Venturing and Corporate Venture Capital

As was previously discussed in Chapter 1, *Corporate Venturing* is one of the three domains of Corporate Entrepreneurship. During the past years, especially this CV domain has been recognized as a highly valuable way for corporations to revitalize operations, build new capabilities, and achieve strategic renewal [129]. This is especially the case when combining CV with an open innovation approach. As Narayanan et al. [129] put it: "companies frequently use internal and external sources to gain access to ideas, discoveries, technologies, innovations, business practices, and even businesses that can fuel growth and enhance profitability", and "CV is the set of organizational systems, processes and practices that focus on creating businesses in existing or new fields, markets or industries – using internal and external means" (p.59). In other words, the importance of an integrated open innovation approach that combines internal and external ideas and capabilities is highlighted.

This simultaneously reveals the subdivision of Corporate Venturing into internal venturing and external venturing [122]. *Internal venturing* refers to ”new innovations developed at various levels of the firm but within the boundaries of the firm” (p.372) [122]. In other words, internal venturing activities happen within an organizational domain. On the other hand, *external venturing* can be seen as venturing activities that ”result in the creation of semi-autonomous or autonomous organizational entities that reside outside the existing organizational domain” (p.372) [122]. Differently put, external venturing activities cross organizational borders. In literature, external Corporate Venturing is recognized as one of the most important organizational instruments to shape an open innovation approach [188].

Further descending the tree in Figure 1.6, it can be seen that in turn, Corporate Venture Capital is one of the three different modes of external Corporate Venturing. Without diminishing the importance of venturing alliances and transformational arrangements, these two modes of external venturing are outside the scope of this thesis and will therefore not be further discussed. As such, this research exclusively focuses on Corporate Venture Capital. Nevertheless, the importance of applying an integrated combination of instruments to stimulate innovation is again underlined [48].

For CVC, again three different specific structures exist. In case of *third party funds*, corporations make investments into traditional VC funds, that in turn invest that money into ventures [186]. As the incumbent firm has no direct link with the ventures in this configuration, the objective here is mainly financial. Secondly, *dedicated funds* represent a situation in which a firm has its CVC fund managed by an independent VC firm, but acts as the only limited partner [186]. In that sense, it will now be possible to exert more direct control over the investments and harvest some strategic benefits as well. Thirdly, *self-managed funds* are the configuration in which firms directly invest into ventures, without any intermediary [186]. As a result, the firm will have the most control over its investments and will thus be able to achieve the most strategic objectives.

In the literature review of CVC activities of electric utilities, no distinction was made in the different forms of CVC. However, for the case study this thesis will exclusive concern self-managed funds, being direct investments of corporations into ventures – not via an externally managed fund as is the case with third party or dedicated funds. This is due to the fact that the only two utilities active in the Netherlands that are pursuing CVC activities have established self-managed funds.

A clear and comprehensive definition of Corporate Venture Capital that still appears in highly recent work on CVC (e.g. [124]) was provided by Dushnitsky [53] (p.3):

”[Corporate Venture Capital is] a minority equity investment by an established firm in an entrepreneurial venture that seeks capital for growing its operations.”

Furthermore, two dimensions of Corporate Venture Capital can be distinguished: its objective (financial/strategic) and the degree to which the operations of the investing company and the venture are linked (tightly/loosely) [32]. This results in four types of CVC investments, of which an overview is presented in Figure 6.1.

As can be seen in the figure, *driving* CVC investments can be described by a tight link between the operations of the corporation and the venture, as well as a strategic investment objective [8], [32]. *Enabling* investments have the same strategic objective, but are also characterized by a loose operational link. In turn, *emergent* investments have a mainly financial investment objective, combined with a tight link between the operations of the corporation and the venture [8], [32]. Finally, *passive* investments are characterized by a mainly financial investment objective, as well as a loose operational link. This last type is the most similar to independent VC investment as they are primarily committed for financial reasons [8], [32].

CVC investing follows wave patterns, in which the activities increase and decrease accordingly over time [52]. Since 2003, the fourth large wave has begun. This implies that there are many challenges to CVC that heavily affect its popularity. However, Dushnitsky [52] also presented evidence that this fourth wave is already being different than the previous ones. This is for example reflected in a much larger average lifespan of CVC programs, its spreading towards unconventional sectors (e.g. the energy sector), and the evolving view that it is a key innovation strategy component; not to mention the fact that some companies even remained committed to CVC during the Great Recession [52].

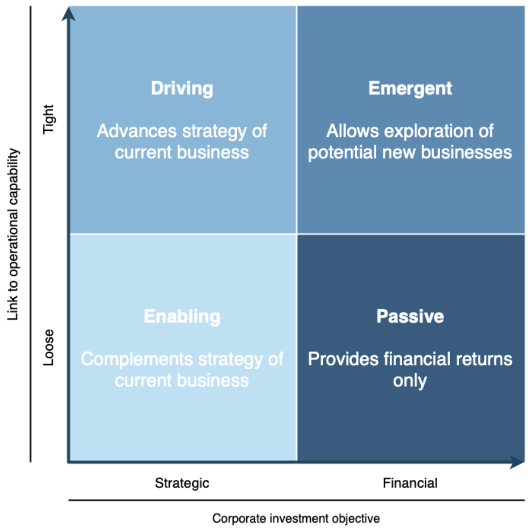


Figure 6.1: Types of CVC investments. Own illustration, adapted from Chesbrough [32].

In that respect, in the past the potential financial return of CVC investments was the main, so not the only objective [21] – just as still is the case for independent VC investments [51]. However, for corporate VC the focus has become predominantly strategic [31], with the goal of driving business development [171]. As a result of the increasingly strategic focus, Chesbrough and Tucci [31] argued that CVC should be examined in the larger context of corporate innovation activities, so its performance should be evaluated by how investments have advanced the investing companies. So, it seems that CVC programs are increasingly recognized as a means to deliver significant strategic benefits for Business Model Innovation of (incumbent) corporations.

Generally, CVC activities include three involved parties: corporation, CVC unit, and startup [128]. They interact with each other in various ways, as depicted in Figure 6.2 [128]. The specific organizational structure can vary significantly, even between different self-managed funds [49]. On the one hand, CVC units can have a looser structure, more similar to independent VC funds, operating as a wholly owned subsidiary (separate entity) of the parent corporation with full investment discretion [49], [57], [128]. On the other hand, CVC units can have a tighter structure, being embedded within a business unit and requiring approval and funding for each separate deal [128].

As this already reveals, the former is more associated to financial objectives, while the latter is more strategy-focused [49], [57]. However, seen from the venture perspective, the latter creates a higher

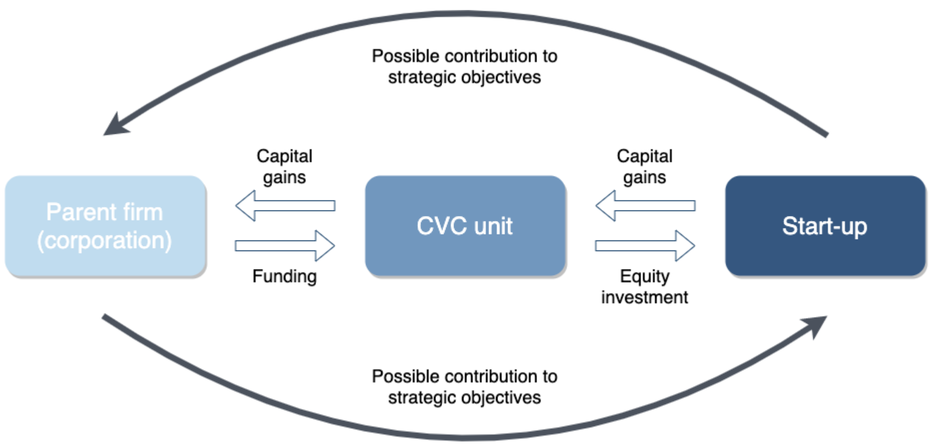


Figure 6.2: General roles of the corporation, CVC unit, and startup involved in CVC investments. Own illustration, adapted from Napp & Marshall [128].

risk of imitation of the entrepreneurial product, technology, or service [57]. Generally, the majority of CVC units are integrated in the corporation [35].

Now the concept of Corporate Venture Capital has been explained, the next section will address its relevance for the energy sector.

6.1.2. Corporate Venture Capital in the Energy Sector

Traditionally, CVC activities were mainly being pursued by the information technology, telecommunications and pharmaceutical industries [180]. The energy sector used to be a relatively 'stable' industry, and thus not one with many CVC activities going on. However, the recent major disruptions in this sector have challenged the competitive position of electric utilities. This has resulted in a sharp increase in their innovation investments, with a simultaneous change from closed to open innovation [111]. To shape this open innovation model, in the past decade many utilities have established CVC programs.

The novelty of CVC in the energy sector goes hand in hand with the amount of literature on the subject in this specific context. To give a grasp of the numbers, an initial search in Scopus and Web of Science with keywords "corporate venture capital", "corporate vc", "corporate venturing", or "cvc" and "energy" or "utilities" led to only nine unique results, of which six were discarded after inspection either due to a lack of sector relevance, or inadequate assessment of corporate VC. A subsequent search in Google Scholar delivered a few more useful articles. Finally, after inspection of cited work, a few other articles and theses were found. However, the total amount of relevant literature on this subject is still limited.

Before the Great Recession, CVC in the energy sector was subject to much internal resistance, as both management and employees did not understand the added value of these activities [179], [180]. Many electric utilities perceived competitive advantage to be obtained through a low price or classical services, and not through innovation [180]. As a result, they seemed to be more focused on maintaining current competencies instead of investing in new ones [178]. As we have seen in section 5.2, this conflict of interest between new and existing business models was also identified as an important potential barrier to business model innovation.

Therefore, it does not come as a surprise that during the financial crisis many CVC funds of energy companies were shut down [111]. After recovering from the crisis, many corporations relaunched their CVC programs around the mid 2010s. Livieratos & Lepeniotis [111] were the first to devote renewed attention to CVC programs of electric utilities, and highlighted the potential of CVC programs to be an important means for utilities to successfully transform their business model and to maintain their leading competitive position in the changing industry [111]. Moreover, being strongly related to open innovation, CVC activities are now also linked to and complemented by other open innovation related activities, further underlining their strategic relevance and increasing popularity [111].

With respect to the identified dimensions of CVC investments, it seems that in the case of electric utilities the operations of the parent company and the ventures are generally tightly linked [111]. This would imply either a 'driving' investment type, or an 'emergent' one, depending on the dominant investment objective. It turns out that both types exist within the utility industry, but 'emergent' investors are rather an exception as most investments are predominantly strategy-driven [111]. However, according to author this will in all probability not be a matter of black and white, and thus the boundaries between these investment types will be blurred. Nevertheless, it is still insightful to have a general idea of the dominant CVC investment strategy in the electric power sector.

After having obtained a general idea about CVC and its relevance for electric utilities, the specific potential benefits of CVC activities will be assessed in the next section.

6.1.3. Potential Benefits of CVC Activities

As already became eminent, CVC activities are being increasingly related to drive strategic renewal and new business creation [129]. However, how this translates into specific benefits with which CVC activities can contribute to BMI of electric utilities has not been addressed yet. Due to the lack of integrated research on BMI and CVC as was explained in section 1.3, and the limited amount of research on CVC activities of electric utilities as was explained in the previous section, an assessment of all potential benefits of CVC activities in general was demanded. So, this section will identify all potential benefits corporations can reap with CVC activities. Then, in section 6.2, the possibilities for how these potential benefits can help to remove or circumvent the barriers to BMI for electric utilities will be addressed. Also, in the case study in Chapter 7, the practical relevance of these potential benefits of CVC and their link to the barriers of BMI is further assessed.

To obtain a full overview of the literature on this subject, the standard five scientific databases were searched with varying combinations keywords, including ”corporate venture capital”, ”cvc”, ”corporate vc”, or ”corporate venturing” with ”benefits”, ”objectives”, ”advantages”, or ”goals”, both with and without ”electric utilities”, ”energy utilities”, ”utilities”, or ”energy”. The results are presented in this section.

First, a classification framework will be adopted for clarity purposes. In that respect, different classifications exist in literature. For example, Pinkow and Iversen [140] embedded the objectives of CVC in the theory of organizational ambidexterity and proposed a classification framework that distinguishes between strengthening, complementing, and expanding objectives, based on either a more exploitational or a more explorational orientation of a firm’s CVC activities. However, according to author the framework of Maula [122] provides a more complete and useful classification. Therefore, this framework will be adopted as a starting point for identification of all potential benefits of CVC activities.

The benefits that incumbent firms can reap from CVC are abundant and divergent [122]. Firstly, as already became clear, a distinction can be made between financial and strategic objectives. With respect to **financial objectives**, the only specific element is the financial gains that CVC activities can bring [122]. However, this is widely acknowledged in research, e.g. in [21], [31], [52], [180].

With respect to strategic objectives, a further distinction is made into *learning*, *option building*, and *leveraging* [122]. First of all, learning-related benefits can refer to **market-level learning**, specifically through identification of, monitoring of, and exposure to new technologies, markets, and business models [122], [128], [140]. In other words, through CVC activities corporations can identify innovative ideas, products, services, or technologies that are developed externally and have the potential to substitute the corporation’s current ones [52]. Through exposure to new disruptive technologies and business models, CVC might be an important strategic renewal mechanism for firms [73].

The second subcategory of learning related benefits is **venture-level learning** [122]. CVC is often tied to *interorganizational learning* [129]. Harvesting the external knowledge of competent entrepreneurial ventures might be critical for incumbent corporations to remain competitive [54]. More specifically, CVC activities can be used as an external way of R&D, as complementary to or substitution of regular R&D activities [73]. Also, it could improve a firm’s own manufacturing processes through learning from venture manufacturing processes [122]. Finally, companies will be able to learn about specific pitfalls in markets or technologies as a result of the experiences of ventures [32], [54].

Thirdly, CVC can enable **indirect learning** [122]. More specifically, corporations can benefit from the entrepreneurial, dynamic nature of ventures to promote entrepreneurship in their own corporate culture that is often static and not innovative [111], [108], [122]. Also, other benefits can be obtained through the training of junior management, improve a corporation’s internal venturing processes through more experience in working with ventures, learn about VC in general, or through expansion of a firm’s network by access to new contacts [122], [171].

With respect to option building, firms can benefit from CVC activities by creating **options to acquire companies** through the identification and assessment of potential acquisition targets [105], [122], [125]. Secondly, for corporations CVC activities can create **options to enter new markets** [122]. This can either refer to accelerated entry of a firm in a new market, or the creation of the option for a firm to expand its business in a new market when that market turns out to be relevant and valuable [26], [122], [180]. Thirdly, another sub-category of option building benefits was added as the classification of Maula [122] insufficiently addresses this option, and according to author it is too important not to mention on its own. This is the creation of **options to access and exploit external BMs, technologies, and services**, either new or complementary [54], [55], [111], [128]. In that respect, through CVC corporations would not have to develop every new technology itself in order to still be able to offer it to customers.

The third category of CVC benefits identified by Maula [122] addresses leveraging. This can refer to a firm **leveraging own technologies and platforms**, for example by increasing demand for its own technology and products and the possibility to shape markets. Shaping markets can be important for corporations who want to mitigate potential competitive risks with the possibility to nurture new market entrants enabled [48]. Furthermore, leveraging own technologies and platforms can also refer to the possibility to steer standard development of technologies, or to supporting the development of new applications for its own products [8], [105], [111], [128], [122].

On the other hand, leveraging can also refer to a firm being able to **leveraging own complementary resources** [122]. This can for example be shaped by the addition of new products to existing distribution channels, or the utilization of excess plant space, time, and people [122], [171]. For both holds that more efficient use of distribution channels, plants, or people could be achieved.

Finally, another category of potential CVC benefits was added to the framework, as according to author this could not be classified into one of the other categories. This category is **Branding**, which is achieved through promotion of an innovative corporate image [100]. While this benefit did not abundantly appear in literature, its relevance was confirmed by an industry expert [48]. A more innovative corporate image can for example increase attractiveness of corporations to other startups, which could therefore be increasingly willing to collaborate. Also, an innovative image could be beneficial for increased attractiveness to investors or other potential partners.

An overview of all potential benefits of CVC activities for electric utilities is provided in Table 6.1.

In any event, it is clear that investing companies can highly benefit from CVC activities. It should be noted that the large majority of investing companies has a combination of strategic and financial objectives, but strategic objectives have the overhand [35], [105], [122], [178]. The potential of CVC was again underlined by Casey et al. [26] in a Deloitte report on the future of CVC: "CVC is no longer an instrument to only explore new technologies and business models. Together with business transformation and Disruptive M&A, CVC is becoming a growth instrument to fuel new business opportunities in both the core business and adjacent sectors and drive transformation" (p.10). In other words, CVC enables incumbent firms to address and effectively respond to various technological shifts that can transform their industries, for example digitalization [21], [129].

In that respect, it was found that European utilities acknowledge the need for BMI in response to the severe industry changes ahead. They seem to see collaboration with startups as pivotal to be able to innovate and maintain their competitive position in the changing energy industry [111].

When aggregating the potential benefits of CVC activities at firm level, a few general advantages of CVC at an industry level can be extracted. First of all, practical evidence suggests that firms pursuing CVC activities produce higher innovation rates than their peers that do not [54]. This positive impact can for example been extracted from the fact that products of parent companies often incorporate innovations from their portfolio ventures [49]. Also, CVC leads to higher patenting activity [49].

Furthermore, CVC investments lead to strategic alliance formation (in an inverted U-relation) and acquisition activity, and can affect financial performance [49]. Interestingly, when firms are pursuing CVC activities with a strategic aim, this has a more positive effect on the overall financial performance of the parent company than when firms are pursuing CVC activities with a financial aim [49]. In fact, it was found that firms pursuing CVC for financial objectives are at a considerable risk of negatively affecting financial performance of the parent.

Obviously, reaping the potential benefits of CVC activities is not as easy as it may seem. In that respect, a range of potential barriers and stimulating factors exit that can hinder or boost the positive impact of CVC activities. However, this research focuses on the potential contribution of CVC to BMI of utilities, so not on the required conditions for this contribution to become reality. In that respect, a general description of the barriers and stimulating factors that can hinder or boost the effect of CVC activities is provided in Appendix E.1.

Finally, taking the venture perspective, besides funding CVC does also have strategic relevance. More specifically, CVC is found to be more efficient than independent VC in boosting development [54], [105], and enhances the venture's reputation [11], [128]. Also, corporate VCs' technical, network, and market knowledge can foster internationalization of ventures, and provides them with access to new customers, suppliers and partners [139]. So, CVC is an attractive opportunity for ventures to secure

Table 6.1: Potential benefits of CVC programs for electric utilities. Adapted from Maula [122] and extended by literature study findings.

Classification	CVC Benefits (C)	Related papers
Financial objectives	1. Financial gains	[21], [31], [32], [35], [52], [54], [55], [73], [100], [108], [111], [122], [128], [180]
Market-level learning	2. Identification of, monitoring of, and exposure to new technologies, markets, and business models	[8], [21], [26], [31], [35], [52], [54], [55], [73], [100], [105], [108], [111], [122], [128], [140], [171], [180], [191]
Venture-specific learning	3. External R&D 4. Improve manufacturing processes 5. Learn about specific market or technology pitfalls	[21], [31], [35], [52], [54], [73], [105], [122], [140], [180], [191]
Indirect learning	6. Change corporate culture: promote entrepreneurship 7. Train junior management 8. Learn about VC in general 9. Improve internal venturing 10. Complementary contacts / expand network	[100], [108], [111], [122], [140], [171], [180]
Options to acquire companies	11. Identify and assess potential acquisition targets	[13], [21], [35], [55], [105], [122], [140], [171], [191]
Options to enter new markets	12. Accelerated market entry 13. Option to expand business	[8], [26], [100], [105], [108], [111], [122], [128], [140], [180], [191]
Options to exploit external BM innovations	14. Access and exploit new or complementary BMs, technologies, and services	[21], [35], [54], [55], [111], [128], [140]
Leveraging own technologies and platforms	15. Increase demand for technology and products 16. Shape markets, i.e. by nurturing potential competitive risks 17. Steer standard development 18. Support development of new applications for products	[8], [35], [55], [100], [105], [108], [111], [122], [128], [140]
Leveraging own complementary resources	19. Add new products to existing distribution channels 20. Utilize excess plant space, time, and people	[122], [171]
Branding	21. Promoting an innovative corporate image	[48], [100]

funding, while at the same time boosting their growth. A concrete example of the positive impact of CVC on growth and development of ventures at an aggregated level can be extracted from their valuation at Initial Public Offering (IPO), e.g. the venture going public [186]. It is found that ventures backed by CVC receive a higher valuation at IPO than ventures backed by independent VC funds [55], [180].

As this research focuses solely on the incumbent utility perspective, an overview of potential benefits of CVC for ventures is left for Appendix E.2. In addition, in that appendix also an overview of the potential barriers to the impact of CVC activities for ventures will be provided.

Now all potential benefits of CVC activities to corporations have been identified, the next section will link these to the barriers to BMI of electric utilities.

6.2. Potential Effect of CVC Benefits on the Barriers to BMI

In Chapter 4, it became clear that traditional utilities are currently insufficiently aligned with all six identified major developments in the energy sector and that Business Model Innovation is required in order for them to maintain their competitive position. Also, it was assessed what would be specifically required for traditional utilities to become fully adapted to each trend.

However, this is not as straightforward as it may seem. In Chapter 5 it became clear that incumbent organizations as traditional utilities generally experience difficulties with BMI, due to a range of generic barriers that hold for many large corporations despite differences in sector or company activities. Furthermore, the limited current alignment of traditional utilities with the identified power sector developments can be due to a large variety of causes, which have all been translated into potential specific barriers to Business Model Innovation of traditional utilities that actively hinder better adaptation to one or multiple of the identified developments.

Due to the fundamental nature of the power sector changes and the speed with which it is changing, incumbent utilities will not be able to achieve the demanded BMI on their own. In fact, external collaboration with startups is seen as pivotal to increase the speed and impact of BMI. In the previous section 6.1 it became clear that CVC is one of the instruments that incumbent corporations as traditional utilities can apply to fuel new business opportunities and boost BMI. Moreover, the promising potential of this instrument has been translated into a range of potential benefits that CVC activities can bring. Due to a lack in literature on this subject however, the relevance of these benefits for electric utilities, as well as their specific potential effect on the barriers to BMI, has not yet been sufficiently addressed.

In that respect, the next step in the analysis is to assess the potential contribution of the identified CVC activities to remove or circumvent the barriers to BMI. Due to the described lack in literature on this subject, this section will assess this potential contribution based on previously obtained insights from literature and industry experts.

First of all, it has become clear that CVC activities can lead to financial gains for corporations. Although the rationale behind CVC investing of traditional utilities seems to be mainly strategic, the financial aspect may not be forgotten and can therefore still be an important potential benefit of CVC. Looking at the potential barriers to BMI, one of the financial and profitability related barriers was found to be lack in profitability of certain business model innovations, for example due to high costs and small project sizes in the residential solar PV energy domain. So, if CVC investing would lead to financial gains, that implies that these high costs and small project sizes would be less of a problem, as the financial gains will reduce the impact of this barrier. Utilities would then be able to increase BM activities in this domain, which would lead to achieving economies of scale, again reinforcing the diffusion of their propositions. Without the financial gains of CVC, the high costs could be a much more severe barrier which could ultimately hinder all utility activity in this domain.

With respect to market-level learning, the identification of, monitoring of, and exposure to new technologies, markets, and business models was one of the most widely acknowledged potential benefits of CVC activities. In such rapidly changing environments as the energy sector, it is essential for incumbent organizations to have a clear picture of what is exactly going on. In fact, we have already seen that as a result of the energy sector changes, three new types of business models for utilities have been emerging (green, cooperative, and prosumer utility) with which a wide range of new, dynamic market entrants are trying to conquer the power market. Moreover, besides models for utilities themselves, also many different types of new BMs and propositions have been emerging that relate to one or multiple of the (future) activities of utilities. One could think of the development of energy efficiency technologies, EV chargers, but also to a wide range of digital technologies enabling customer data insights. So for utilities, in order to effectively respond to all trends and innovate their BM on different areas, it will be essential to have a complete and clear overview of what is going on in the market.

When assessing the barriers to BMI, it turns out that multiple are related to a lack of market overview. First of all, an important potential barrier to BMI was found to be a lack of competencies to build and manage new capabilities, due to cognitive barriers (managers failing to recognize business opportunities) and the inability to allocate sufficient resources to new technologies. Increased exposure to new technologies, markets and business models by utility managers could thus be beneficial for them in terms of recognizing new business opportunities or better prioritization in resource allocation. This will decrease the chances that utilities will miss the boat on some pivotal new business opportunities, or could even enable valuable first-mover opportunities if a utility would have a better market overview than its competitors. The same goes for search-related barriers (where, what, how to innovate) due to the complexity of BMI. Specifically the exposure to other, new and innovative business models and propositions could be a guidance to the search for appropriate BMI of utilities themselves.

Potentially less directly apparent, but still relevant, is the often short-term focus of incumbent companies, for example a main focus on maximizing shareholder value. Increased exposure to the market could be beneficial for a more long-term oriented focus, for example because utility management would scrutinize the need for BM innovation and new business creation in certain areas. Because they would have a better overview of potential future competitive threats, and obviously an important factor for utility managers is to maintain or expand the utility's competitive position, they would be more inclined to shift their focus more towards the longer term. Finally, obviously a better market overview will also help to remove the lack of knowledge and information about markets for RE and potential customers by utilities, as they gain valuable market insights which could help them to develop more comprehensive and tailored propositions.

Considering venture-specific learning, there is the potential benefit of external R&D as a result of the CVC activities. As for each organization, but especially for organizations active in a market that is undergoing rapid change (as is the case with traditional utilities), R&D activities are important to be able to develop new propositions. However, internal R&D requires much time and is highly expensive. Through CVC, utilities would have the access to external R&D by ventures. As a result, there would be no or less need for internal R&D in specific areas. This would avoid high internal R&D costs, which could decrease profitability problems of certain BM innovations. Also, it could also significantly decrease the length of internal BM innovation processes. Furthermore, the CVC benefit of learning about specific market or technology pitfalls could help to remove search-related barriers to BMI, as again this would lead to a better and more thorough market and technology overview. This could help utilities in developing adequate BMs and propositions, which avoid the pitfalls that have already been discovered by others. Moreover, perhaps in a more indirect way, learning about market and technology pitfalls could help remove technological barriers, as well as profitability problems that are sometimes associated with certain business model innovations. Obviously, learning from the experience of ventures with certain market or technology pitfalls would avoid the risk that a utility would experience the same pitfall, thereby avoiding potential profitability problems with new BM innovations as a result of those pitfalls.

Indirect learning benefits of CVC can be related to barriers to BMI as well. More specifically, CVC could lead to promotion of entrepreneurship in the corporate culture, which could help to remove a non-supportive organizational values, culture, and design. Indeed, traditional utilities are incumbent companies that are characterized by a static and slow nature. Collaborating with dynamic, fast-moving ventures with all types of innovative thinking can lead to an increased entrepreneurial culture within utilities, which is beneficial for all BMI in general. Besides this, it might also be beneficial for more supportive human capital, who are often reported to have a risk-averse attitude or are afraid of change in general. Through directly collaborating with dynamic startups with innovative ideas, human capital may gain energy and an increased positive attitude towards change and innovation in general, thereby removing a potential generic barrier to BMI of utilities.

Furthermore, the training of junior management through CVC activities may lead to a positive effect on the lack of competencies by utility managers to build and manage new capabilities. Effective training of junior management through collaboration with all types of ventures might avoid future cognitive barriers or insufficient resource allocation to new technologies, barriers that are currently often tied to senior management, leading to wrong choices and a hindrance for all BMIs in general.

With respect to the option building related benefits of CVC activities, it was found that CVC can create options for corporations to acquire other companies, specifically through the identification and assessment of potential acquisition targets. In other words, utilities could then be simply able to buy BM innovation externally, which could be the best option in some cases. The assessment efforts for identifying ventures for CVC activities could support other corporate M&A activities, in which acquisition target assessment is also one of the key activities. Moreover, this could be a way to help filling potential gaps in the product portfolio, as well as helping to remove the barrier of a lack of skilled people for installation and O&M - in the case corporations would for example specifically target an installation company. Also, in this way the lengthiness of internal BM innovation processes could be circumvented. Finally, acquisition of other companies could potentially help to decrease conflicts with existing assets and business models. This would however be dependent on the applied organizational structure, as a certain level of autonomous operation (i.e. being an independently operating subsidiary) would be required for this barrier to be removed.

Concerning options to enter new markets, the possibility of accelerated market entry through CVC activities could be beneficial for decreasing the lengthiness of BM innovation processes of utilities. Also, the creation of options for utilities to expand their business (when a new market turns out to be relevant and valuable) could help to circumvent (future) gaps in the product and service portfolio, and help to remove search-related barriers to BMI. Indeed, early investment in and subsequent active partnerships with a range of ventures active in various sub-markets in the energy sector creates a range of future options for utilities to expand their business in those areas with new, innovative BMs. As it is uncertain beforehand which markets will exactly turn out to be profitable, this is a highly efficient way of creating future options and increase the chances for successful BMI. Also, this could help to circumvent the negative effects of a short-term focus, as in this case the options to enter new valuable markets would still be on the table, despite the fact these markets might first have been overlooked as a result of the short-term focus.

The final category of option building related benefits of CVC, specifically the option to access and exploit new or complementary BMs and technologies, might help to remove some barriers to BMI as well. Obviously, it could help to fill gaps in the product and service portfolio of utilities without requiring them to develop these solutions themselves. This simultaneously contributes to removing the barrier addressing lengthy BM innovation processes, as the BM innovations have been developed by entrepreneurial ventures who are much more dynamic than incumbent utilities and will therefore increase the speed of these BMIs. Besides this, being able to access and exploit external propositions could help to remove the lack of skilled people for installation (which could be complementary to certain products or technologies), if utilities would target ventures with installation solutions. For example, in response to the lack of skilled installation personnel in the Netherlands [134], new ventures with innovative propositions have been emerging (e.g. [149]). Access to these BMs and solutions by utilities could help them in diffusion of new BM innovations that heavily rely on skilled personnel.

Furthermore, conflicts with existing assets and business models could be reduced or removed, because they would not experience tensions between (maybe competing) internal solutions. In fact, they can exploit the external technology where needed. Also, in case accessing and exploiting complementary solutions by utilities, it might help to remove a lack of customer demand for certain products or services, as well as help to solve some financial and profitability issues and technological barriers. However, this would all be strongly dependent on the technology or service that is accessed, underlining the importance of the substantive component of both BMI and CVC.

Regarding leveraging of own technologies and platforms, through CVC corporations could be able to increase the demand for their own technologies and products, or to support the development of new applications for their products. Obviously, this could both help to remove a lack of customer demand which, as we have seen, hinders some BM innovations, for example in the field of energy efficiency. If a new solution or BM would be wider applicable, this might increase customer demand in this area and thus increase the effectiveness of this specific BMI. Also, the development of new applications for products or services could help to fill gaps in the product and service portfolio. Despite the possibility enabled by CVC to shape markets or steer standard development could be highly beneficial, this rather affects the competitive environment of a firm than it directly stimulates innovation of a firm's business model. Therefore, it seems that these two potential benefits of CVC cannot be easily related to barriers to BMI.

Finally, the possibility created by CVC for a firm to leverage its own complementary resources, specifically by adding new products to existing distribution channels, could help to remove or reduce conflicts with existing assets and business models, as this would lead to increased synergy, cost efficiency benefits, and thus less competition with existing assets or BMs.

With respect to branding related benefits of CVC, although the promotion of an innovative corporate image might be important for several purposes (i.e. increased investor, venture, or customer attractiveness), it seems that this cannot be easily related to one of the barriers to BMI. Nevertheless, increased attractiveness to other ventures because a utility is already (fruitfully) collaborating with ventures might open up more investment and partnership opportunities, thereby positively affecting the CVC activities as a whole.

An overview of how the different CVC benefits can help to remove or circumvent barriers to BMI is presented in Table 6.2.

Table 6.2: Potential contribution by CVC benefits to remove or circumvent barriers to BMI of electric utilities.

CVC Benefits (C)	**Potential effect on BMI Barriers (B)**
1. Financial gains	10. Profitability problems of certain BMIs could be decreased as high costs and small project sizes would be less of a problem
2. Identification of, monitoring of, and exposure to new technologies, markets, and business models	1. Lack of competencies to build and manage new capabilities could be reduced as increased exposure might clarify new business opportunities and positively affect sufficient resource allocation 4. Search-related barriers could be reduced as increased exposure could provide guidance to the search 9. Short-term focus could be reduced as utility management could scrutinize the need for BMI as a result of a better market overview and identification of potential future competitive threats 15. Lack of knowledge about markets for RE and potential customers by utilities could be reduced as a result of increased market insights
3. External R&D	6. Lengthy BM innovation processes could be circumvented as they would be developed externally 10. Profitability problems could be decreased as high internal R&D costs would be avoided, reducing the cost of BM innovations
5. Learn about specific market or technology pitfalls	4. Search-related barriers could be reduced as a result of a more thorough market and technology overview 10. Profitability problems could be circumvented as these pitfalls would be clear and could therefore be avoided
6. Change corporate culture: promote entrepreneurship	7. Non-supportive organizational design, culture, and structure effects could be reduced as a result of a more entrepreneurial culture 8. Non-supportive human capital effects might be reduced as a result of direct collaboration of employees with dynamic startups, increasing their attitude towards change and innovation

7. Train junior management	1. Lack of competencies to build and manage new capabilities could be circumvented in the future by early training of junior management through intensive collaboration with ventures
11. Identify and assess potential acquisition targets	2. Gaps in the product and service portfolio could be reduced by simply acquiring ventures that offer the needed products or services 3. Conflicts with existing assets and BMs could be decreased when an acquired company would operate with a certain degree of autonomy 6. Lengthy innovation processes could be circumvented as a result of acquisitions 25. Lack of skilled people for installation, O&M, etc. could be reduced if an installation company would be acquired
12. Accelerated market entry	6. Lengthy BM innovation processes could be reduced as a result of more rapid market entry
13. Option to expand business	2. Gaps in the product and service portfolio (in the future) could be circumvented as a result of different options that would be on the table 4. Search-related barriers could be reduced as a result of different available options to expand the business with different innovative BMs 9. Short-term focus effect could be circumvented as the options for business expansion would be still available, although a certain market might first have been overlooked
14. Access and exploit new or complementary BMs, technologies, and services	2. Gaps in the product and service portfolio could be circumvented as the possibility would be available to exploit external products and services 3. Conflicts with existing assets and BMs could be reduced as these external BMs and technologies would not experience the tensions that emerge between two internal (competing) BMs or solutions; they can exploit the external solutions where needed 6. Lengthy BM innovation processes could be reduced as the BM innovations would have been developed by entrepreneurial ventures which are more dynamic and therefore increase the speed of these BMIs 13. Lack of customer demand in certain areas could be reduced if complementary solutions would be accessed and exploited; that combined with internal solutions lead to a better and more complete proposition, thus increasing attractiveness for customers 25. Lack of skilled people for installation, O&M, etc. could be reduced if ventures would be targeted that offer i.e. installation-related solutions
15. Increase demand for technology and products	13. Lack of customer demand could be reduced if demand for own technology and products would be increased
18. Support development of new applications for products	2. Gaps in the product and service portfolio could be reduced as new applications for products or services could help to fill these gaps 13. Lack of customer demand could be reduced if solutions would be wider applicable, thereby increasing customer attractiveness
19. Add new products to existing distribution channels	3. Conflicts with existing assets and BMs could be reduced as cost benefits and increased synergies would be achieved as a result of more efficient use of existing distribution channels

All in all, as can be seen in the table, it seems that many potential benefits of Corporate Venture Capital activities could help to remove or circumvent barriers to Business Model Innovation of traditional utilities. However, it is still unclear whether this is also the case in practice. In that respect, the next chapter will provide the findings of a case study on this subject, which must lead to a complete and clear overview of how CVC activities can contribute to BMI of traditional, incumbent utilities.

So, Chapter 3 identified four currently existing utility BM types. Thereafter, Chapter 4 identified the major power sector developments, the current alignment of utility BMs with these developments, and the resulting need for fundamental BMI for traditional utilities. Subsequently, Chapter 5 addressed the potential barriers (generic and development-specific) that can hinder BMI and better adaptation of traditional utilities to the identified power sector developments. In addition, this Chapter identified the potential benefits of CVC activities of traditional utilities and assessed the potential contribution of CVC activities to remove or circumvent the barriers to BMI. A graphical representation of the progress made up to and including this chapter is presented in Figure 6.3. It must be underlined that this is a generalized overview, so its contents are not representing the exact findings of this chapter and the previous chapters (except for the energy sector developments).

So, the new elements in this graphical summary compared to the previous chapter, are the different potential benefits of CVC activities, represented by green squares. On the one hand, the identified potential benefits of CVC activities can help to remove or circumvent address the generic barriers to BMI, presented in the center of the figure. We have previously seen that these are highly relevant barriers, important for all business model innovations in general, despite sector or activity differences. On the other hand, the identified potential benefits of CVC activities can help to remove or circumvent specific barriers to BMI for utilities, affecting alignment of utilities with the identified energy sector developments. Therefore, these are presented in one or multiple of the six domains that each represent a major development. The green outlined areas represent the maximum potential improvement in alignment that can be achieved by CVC benefits overcoming barriers to BMI. Here, the relative importance of both BMI barriers and CVC benefits is excluded. The red outlined areas represent the minimally hindering impact of the BMI barriers.

Finally, the grey arrows represent the fact that barriers to BMI hinder better alignment of utilities with the energy sector developments (limiting effect), and that benefits of CVC activities can stimulate better alignment of utilities with the energy sector developments (stimulating effect).

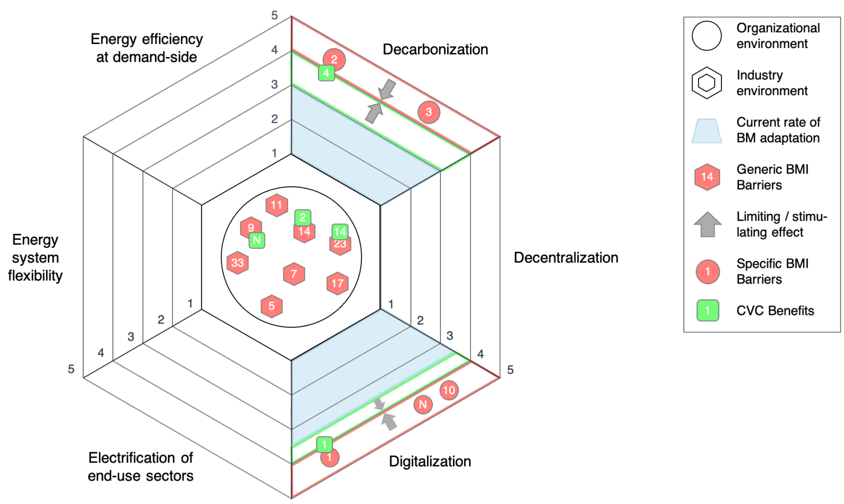


Figure 6.3: Generalized graphical representation of the progress made up to and including Chapter 6. The contents of this figure do not reflect the exact findings, except for the energy sector developments. Own illustration.

6.3. Chapter Summary

The goal of this chapter was to obtain a thorough understanding of Corporate Venture Capital activities of electric utilities. An extensive literature review and expert consultations on this subject have delivered sufficient insights for answering the fourth sub research question of this thesis:

What is the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments?

Corporate Venture Capital is one of the instruments which is increasingly seen as an important means for stimulating business model innovation of traditional, incumbent utilities. Therefore, glscvc often has a mainly strategic rationale and can deliver many different potential benefits. Besides the fact that CVC can lead to financial gains, as expected the strategic benefits are dominant.

First of all, there are learning-related benefits. This can occur at market level – through corporations being exposed to new technologies, markets, and business models, at venture-level – corporations harvesting external R&D knowledge of ventures, improving own manufacturing processes, or learning about specific market or technology pitfalls, and at an indirect level — for example through promoting entrepreneurship in the corporate culture, train junior management, or network expansion. Secondly, there are option building benefits. These include options to acquire companies by identifying and assessing potential targets, options to enter new markets by accelerate market entry or create options to expand business, and options to access and exploit external BMs, technologies, and services. Thirdly, different leveraging benefits exist. CVC can enable corporations in leveraging own technologies and platforms, i.e. by increasing demand for its products or support developments of new applications for products. Leveraging can also refer to complementary resources, for example by enabling firms to add new products to existing distribution channels. Finally, CVC can deliver branding-related benefits, as it promotes an innovative corporate image to the outer world, thereby increasing attractiveness.

It seems that many of these potential benefits of CVC could help to remove or circumvent barriers to BMI which prevent better adaptation of traditional utilities to the energy sector developments. These include both generic barriers and specific barriers for increased adaptation to certain power sector developments. One of the most eminent examples is that the exposure to new technologies, markets, and business models could help utilities to remove the lack of competencies to build and manage new capabilities due to cognitive barriers and insufficient resource allocation, as well as search-related barriers, a short-term focus, and a lack of knowledge or information about new markets and potential customers. Furthermore, through financial gains, learning from ventures and indirect learning, corporations could diminish potential profitability problems, decrease the length of BM innovation processes through external R&D, promote entrepreneurship in their corporate culture, and identify certain market or technology pitfalls, among others. Other relationships can be found in the options building benefits of CVC, as options to enter new markets and access to external BMs and technologies could potentially remove gaps in the product portfolio, a lack of skilled people, a lack of customer demand, and conflicts with existing assets and business models, among others. Finally, leveraging related benefits could for example lead to increased customer demand and reduced conflicts with existing assets and business models.

So, in the journey of incumbent utilities to remove or circumvent the barriers to business model innovation and better adapt to the energy sector developments, CVC seems to have the potential to deliver value in several ways. Its diverging range of benefits has the potential to remove or circumvent many identified barriers to BMI. In that respect, the potential contribution of CVC is estimated to be significant.

7 Case Study

In the four former chapters, the results of an extensive literature study on the main subjects of this thesis have been described. Combined with insights from industry experts, this has already led to a vast amount of knowledge. In addition to these first chapters, a case study has been conducted. As explained in Chapter 2, the aim of the case study is to illustrate and concretize the previous findings. In this way, the thoroughness of the research will be increased. Moreover, as the speed of change in the power sector is immense, it could turn out that (part of) previous research findings are either not completely relevant anymore or have shifted in focus. In that respect, the case study will provide additional insight on the current situation.

The outcomes of this chapter will be used to answer the fifth sub research question of this thesis:

To what extent can the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments be seen in practice?

In the next section, 7.1, the setup and outline of the case study will be outlined. Here after, the interview results will be discussed in section 7.2. Then, the results of an analysis of the venture portfolios are presented in section 7.3. This is followed by a comparison of the literature results and case study insights in section 7.4. Furthermore, in section 7.5 a conceptual framework will be proposed that integrates all findings of this research. Finally, section 7.6 will provide a summary of the main findings of this chapter.

7.1. Case Study Setup and Outline

As mentioned in the introduction of this chapter, the case study is used to obtain more in-depth, practical insights on multiple subjects, with the goal of illustrating and concretizing the previously obtained insights from literature and expert consultations. The case study consists of two cases, Eneco / Eneco Ventures and ENGIE / ENGIE New Ventures, which will be briefly described below. The four assessed main subjects in the case study include 1) the power sector developments and their impact on the traditional utility Business Model, 2) current alignment of utility BMs with the power sector developments, 3) the need for Business Model Innovation of traditional utilities, and the potential barriers hindering BMI and better alignment with the power sector development, 4) the potential benefits of CVC activities and its effect on the barriers to BMI, and 5) the substantive component of CVC activities of traditional utilities and its relation to the substantive barriers to BMI.

The first four of these subjects were assessed through six semi-structured interviews. Semi-structured interviews are particularly useful when in-depth information needs to be collected from multiple interviewees [58], which is the case here. Furthermore, interviewees were selected from two perspectives. Part of the interviewees were selected from the incumbent utility strategy and innovation perspective, and the other part from the CVC unit perspective. In this way, a holistic approach must be secured. It was deliberately chosen not to include the entrepreneurial / venture perspective as well. As explained before, this is due to the fact that this research focuses solely on the incumbent utility perspective, and thus assesses the potential contribution of CVC only to incumbent utilities – and not to ventures. A description of the job titles of the interviewees is presented in Table 7.1. With respect to the anonymity, the job titles are more generally described.

For each type of interviewees, a different list of interview questions was prepared, which can be found in Appendix A. Obviously, there was a considerable amount of overlap between the question sets, but for each type slightly more emphasis was placed on the expertise of that specific interviewee. So, the question set for the CVC managers addressed the CVC part more extensively, and vice versa.

Besides this, in advance of these interviews, also a short survey was sent to all interviewees. This had a few different purposes. First of all, this was used to increase the validity of the interviews, by having all interviewees answering a few exactly similar questions. Secondly, for example in assessing the relevant barriers for business model innovation, it can be expected that when asked in an open question no interviewee would mention more than five barriers – despite the fact that more might have been relevant. By adding a survey, these problems could be avoided. Also, by sending the survey in advance, answers could be further discussed during the interviews. The downside of this choice is that a bias might appear, which will be further addressed in Chapter 9. However, it must be noted that not all interviewees completed the survey beforehand, and one interviewee did not complete it at all. Finally, in line with the exploratory nature of this research, it must be noted that the aim of the survey is in no way to provide statistically significant results, but only to lead to a more clear and complete picture of the researched subjects.

To assess the substantive component of CVC and its relation to the substantive component of BMI barriers, an analysis of the venture portfolios of both CVC units was conducted. Indeed, when researching the potential contribution of CVC on BMI (especially in response to the major power sector disruptions), it does matter in which types of ventures utilities invest.

7.1.1. Case 1: Eneco and Eneco Ventures

Eneco Group, of which the roots are dating back to the mid nineteenth century, is a Dutch energy utility which is also active in Belgium, Germany, and the UK [61]. With millions of customers, Eneco is one of the largest utilities in the Netherlands and Belgium. The company also owns multiple subsidiaries. Where Eneco used to be owned by many Dutch municipalities, in 2020 the company was acquired by a Japanese consortium consisting of Mitsubishi and Chubu [61]. According to the Eneco Group, with this acquisition the company can continue to further implement its sustainable energy strategy, which was already introduced back in 2008. As many other traditional energy utilities, Eneco not only used to be active in the generation, supply, and marketing of energy, but also in grid administration activities [61]. Due to the Independent Grid Administration Act, in 2017 the grid administration activities were divested to the new network company Stedin Group.

Eneco Ventures, founded in 2015, is the corporate venture arm of Eneco Group. The fund invests in startups and scale-ups active in Northwestern Europe that focus on accelerating the energy transition [77]. It specifically targets ventures that are active in the (integrated) clean and smart energy sectors, for example with respect to energy-as-a-service, e-mobility, heat, and energy management [61]. The fund has made eleven investments in total, of which six are still in the portfolio [77].

Table 7.1: Overview of interviewees.

Company	**Interviewee**
ENGIE	Strategic Innovation and Disruptions Manager (FR)
ENGIE	Innovation & New Business Manager (NL)
ENGIE New Ventures	Investment Director & Business Analyst (FR; together)
Eneco	Strategy Manager (NL)
Eneco	Innovation Manager (NL)
Eneco Ventures	Investment Director (NL)

7.1.2. Case 2: ENGIE and ENGIE New Ventures

ENGIE Group is the name with which the GDF SUEZ Group (a merger of Gaz de France and SUEZ) decided to continue in 2015 [63]. Before that, the roots of the company go back to the mid nineteenth century. Nowadays, ENGIE Group is one of the largest energy companies in the world, active all around the world with a total of more than 170,000 employees and more than €60 billion of annual revenues [63]. The Group also owns multiple subsidiaries and is listed on the Euronext stock exchanges in Paris and Brussels [63]. The company is not only providing electricity, gas, and heat, but also manages the largest natural gas distribution network in Europe and is active in electricity distribution network management (both through independent subsidiaries) [63].

ENGIE New Ventures, founded in 2014, is the corporate venture arm of ENGIE Group. The fund has a total size of €180 million and has six different offices across the world [189]. It is focusing on creating a range of new opportunities for ENGIE Group in all fields of the energy transition, and provide ENGIE with an instrument to re-envision its current business models [189]. The fund has made 25 investments in total, of which sixteen are still in the portfolio [189].

7.2. Case Study Results: Interviews

The first part of the case study consisted of a range of interviews, with interviewees representing both the incumbent utility (strategy or innovation) perspective and the CVC perspective. A more detailed description of the methodology was already provided in Chapter 2. In this section, the results of the interviews are extensively described. In line with the anonymity of the interviewees, as addressed in Chapter 2, the results are completely anonymized. The distinction between the two utilities and individual interviewees is made in random order, so it is not possible to relate findings to individual companies or interviewees. The differences between utilities and individual interviewees are indicated by abbreviations. The two utilities are indicated by 'Utility A' and 'Utility B'. The interviewees representing the incumbent utility (strategy/innovation) perspective are indicated by U1 and U2 (Utility A), and U3 and U4 (Utility B). The interviewees representing the CVC unit perspective are indicated by C1 (Utility A), and C2 (Utility B). Finally, sometimes aggregated results for both utilities are presented as well. This is indicated by AG-A (Utility A), AG-B (Utility B), or AG-T (total).

7.2.1. Major Developments in the Energy Sector

The first major subject that was assessed in all interviews concerned the major developments that are currently disrupting the energy sector, of which six were identified in Chapter 4. An overview of the answers is provided in Table 7.2.

As can be seen in the table, most developments were explicitly mentioned in all of the interviews. However, four cases exist in which a specific development was not explicitly discussed during an interview, but was only acknowledged in the survey that was sent to each interviewee. Hereby, it must be noted that all interviewees acknowledged all six developments in the survey that was sent to them. Moreover, none of the interviewees provided an affirmative answer to the question if any developments were missing. This section will address all developments in more detail, also discussing differences in emphasis that was put on certain developments.

Table 7.2: Interview results on the major developments in the energy sector. ✓ = explicitly and directly mentioned when asked, O = mentioned as "three D's", X = mentioned in examples, S = only acknowledged in survey. Interviewees representing the incumbent utility perspective are indicated by U1 and U2 (Utility A), and U3 and U4 (Utility B). Interviewees representing the CVC unit perspective are indicated by C1 (Utility A), and C2 (Utility B).

Energy Sector Developments	**Utility A**			**Utility B**		
	U1	U2	C1	U3	U4	C2
Decarbonization	✓	✓	O	✓	✓	✓
Decentralization	X	✓	✓	✓	✓	✓
Digitalization	✓	✓	O	X	X	O
Electrification of end-use sectors	✓	✓	✓	S	S	✓
Energy system flexibility	✓	✓	S	✓	✓	✓
Energy efficiency at demand-side	X	✓	✓	✓	✓	S

Decarbonization

The Decarbonization trend was recognized by all interviewees as being one of the most important trends. However, where some of the interviewees mentioned the transition towards renewable energy sources and a decarbonized energy system as a still central theme, others seemed to rather see it as a base condition, being the origin for the other five trends that are now dominating. A clear example of the latter vision:

"So, the fact that you are 'green', fun. It is a hygiene factor, of course you are green. [...] Where it is going, is a situation in which the energy system is democratized, driven by decarbonization and CO2 policies."

When asked about the main developments, only two interviewees mentioned decarbonization as the very first trend. However, this does not diminish its importance, as by others it was described either as one of the well-known "Three D's" (decarbonization, decentralization, digitalization), in a more broad sense as the energy transition, or at a somewhat later moment. Also, no apparent differences between the cases, nor between the CVC and incumbent utility perspectives could be identified. To illustrate this: one utility manager and one CVC manager mentioned decarbonization as the very first trend. All in all, it seems that the decarbonization trend is already largely embedded in the thinking and doing of utilities, as well as their venturing arms. So, the importance of decarbonization is in all means clear.

Decentralization

Secondly, the Decentralization trend seems to be clearly on the radar of incumbent utilities. Moreover, by multiple interviewees it was recognized as the most important trend – or one of the most important trends – that is currently affecting the power sector. However, while all interviewees acknowledged the importance of this trend, not all of them mentioned it separately. Again, decentralization was also more generally described as one of the three D's – which were all considered important – or it was sometimes integrally described together with decarbonization. These two perspectives can be clearly illustrated by the following two quotes.

"According to me, the most important one, and a very obvious one, is that an enormous shift is visible from centralized energy production to decentralized energy production."

"A few things can be recognized. The whole energy landscape as such is changing, and that means that at the generation side, there will be much more local, decentralized, and sustainable generation."

Only one interviewee was less specific, and described decentralization (combined with other trends) more generally as 'development of new propositions'. However, later in the interview a specific example was mentioned in which residential solar PV was identified as a relevant theme, thus also implying decentralization. Besides this interviewee, all other interviewees provided similar answers, so no differences between cases or perspectives emerged. All in all, it can be concluded that for all interviewees, decentralization is seen as an important trend.

Digitalization

With respect to digitalization, the answers were much less explicit than in case of decarbonization and decentralization. In fact, it was not mentioned as one of the first trends by any of the interviewees. However, again by some interviewees it was generally included in the three D's or mentioned later on. Also, others covered it implicitly in 'development of new propositions' (when directly asked digitalization was confirmed to be concerned by this description), or even more implicitly in the observation that "energy management will become a highly important service". As we have seen in Chapter 4, energy management will be largely based on a range of digital technologies. On the other hand, one interviewee elaborated on the importance of customer data analysis as a key element for development of new BMs. Obviously, this reflects a digitalization trend.

While no differences between the utility and CVC perspectives could be observed, it is interesting to note that Utility A seemed to be somewhat more explicit about this trend than Utility B. However, this difference could not be easily explained.

Finally, one interviewee specifically mentioned the fact that digitalization is a trend in which the energy sector is lagging behind. As digitalization forms the basis for effective energy management, affecting both flexibility and energy efficiency, this is something to keep in mind.

Electrification of end-use sectors
While electrification of end-use sectors as mobility and heat was not the first trend which interviewees came up with, but in all but two interviews it was mentioned as an important trend. One interviewee described EVs and heat pumps in the context of larger energy management activities, another pointed at electrification being partly driven by the development of neighborhoods independent of natural gas. The importance of electrification in the mobility sector was explicitly recognized by two interviewees. As one of them mentioned:

"The majority of cars on the road is still fossil-fuel based, but it is not surprising that Tesla is currently worth more than Chrysler, Ford, etc. combined. That is just an enormous shift."

However, one of the interviewees also pointed out the fact that electrification in mobility and heat is an important trend, but not the only way to address decarbonization of those sectors. Also the importance of green gases was underlined, especially for application in heavy-duty vehicles, but also for general application in the energy mix.

Finally, it is interesting to note that the two interviewees who did not mention electrification – nor EVs, heat pumps, or other products that relate to this trend – were both from the incumbent utility perspective, and both from the same utility. On the other hand, in the CVC perspective of that utility, the importance of electrification was highlighted. This might indicate that this respective incumbent utility is not (specifically) focusing on electrification in end-use sectors as mobility and heat itself, but leaves this domain to be addressed by its venturing arm, for example by accessing and exploiting external technologies through partnerships with portfolio ventures.

Increased use of energy system flexibility measures
Energy system flexibility is seen as a key issue by many interviewees. Many identify this trend as being driven by the large variability of renewable energy sources as wind and solar, which have to be integrated in the energy system. Furthermore, especially energy storage (including green gases as hydrogen) and increased interconnection between energy systems have been highlighted, as well as back-up energy generation. As two interviewees pointed out:

"Flexibility is a central topic for the coming ten years. Maybe not right now, or maybe now at a small, local scale, but in the coming ten years that is going to be the major issue for energy systems. Because of the intermittency of renewables, because of the synergies and connections across systems that didn't exist so far, or green gases and gases that keep to provide some electricity, and especially flexible electricity."

"So, storage will be an incredibly important element for security of supply, but will also be an incredibly price-determining activity on the energy market."

Only one interviewee did not explicitly mention energy system flexibility or associated subjects. Except this, all answers were highly similar, so no differences between both cases or the utility and CVC perspectives emerged. So, it seems that energy system flexibility is recognized as a highly important trend that will remain relevant for a considerable amount of time.

Increased use of energy efficiency technologies (at demand-side)
Finally, also energy efficiency has been identified as an important theme. For example, one of the interviewees mentioned energy efficiency as one of the key issues:

"And that means that the consumption side should be much more based on and aimed at energy saving."

However, by most other interviewees energy efficiency has been mainly recognized somewhat more implicitly, i.e. as an important part of the more general 'energy management' or 'energy as a service' trends. In that respect, an example was provided that specifically included Demand Response, which we have seen that is one of the forms of energy efficiency:

"And that will mean that energy management will become an incredibly important service. Because, again, nobody is interested in energy. [...] So, you want to provide a service to customers in which you will take over a part of his control. I would call that energy as a service. [...] Managing your solar PV installation, managing your battery – in your car or as a separate unit, your heat pump, Demand Response programs, flexibility, the whole story combined."

All in all, it can be concluded that also energy efficiency is recognized as a key theme in the energy sector, as only one of the interviewees did not address more specifics than 'energy services'. However, no differences between both utilities or the utility and CVC perspectives could be observed.

So, having addressed all developments, it can be concluded that the importance of all six developments that emerged from Chapter 4 is recognized in practice, although with a varying amount of importance. Also, besides the observation with respect to electrification of end-use sectors, no significant differences between the two cases or between incumbent utility/CVC perspectives were found.

7.2.2. Current Alignment of Utility BMs with Developments

After the different energy sector developments have been assessed, the second subject concerns the current alignment of the four different utility BM types with each development, and the alignment of traditional utilities in more detail. In that respect, all interviewees were asked to score the different business on each development, based on the exact same methodology as with the scores of industry experts, as were provided in Chapter 4. In that respect, the score was given based on a 5-point Likert scale, in which 1 corresponds to a poor score and 5 to an excellent score. All but one interviewees provided scores. The results are presented in Table 7.3 to 7.6.

Table 7.3: Interview results on the current alignment of the Traditional Utility Business Model with each of the six energy sector developments. The scores are based on a 5-point Likert scale, in which 1 refers to 'poor' and 5 to 'excellent'. U1 & U2 (Utility A) and U3 & U4 (Utility B) represent interviewees from the incumbent utility perspective. C1 (Utility A) and C2 (Utility B) represent interviewees from the CVC unit perspective. Interviewee U4 did not provide scores. AG-A, AG-B, and AG-T indicate aggregated results for Utility A, Utility B, and in total, respectively. In case of blank cells, no score was provided.

Traditional Utility BM	**Utility A**				**Utility B**			**Total**
	U1	U2	C1	**AG-A**	U3	C2	**AG-B**	**AG-T**
Decarbonization	4	2	3	**3**	3	4	**3.5**	**3.2**
Decentralization	3	1	1	**1.67**	3	2	**2.5**	**2**
Digitalization	4	1	3	**2.67**	4	3	**3.5**	**3**
Electrification of end-use sectors	4	1	4	**3**	5	3	**4**	**3.4**
Energy system flexibility	3	1	4	**2.67**	5	4	**4.5**	**3.4**
Energy efficiency at demand-side	3	2	2	**2.33**	3	4	**3.5**	**2.8**

Table 7.4: Interview results on the current alignment of the Green Utility Business Model with each of the six energy sector developments. The scores are based on a 5-point Likert scale, in which 1 refers to 'poor' and 5 to 'excellent'. U1 & U2 (Utility A) and U3 & U4 (Utility B) represent interviewees from the incumbent utility perspective. C1 (Utility A) and C2 (Utility B) represent interviewees from the CVC unit perspective. Interviewee U4 did not provide scores. AG-A, AG-B, and AG-T indicate aggregated results for Utility A, Utility B, and in total, respectively. In case of blank cells, no score was provided.

Green Utility BM	**Utility A**				**Utility B**			**Total**
	U1	U2	C1	**AG-A**	U3	C2	**AG-B**	**AG-T**
Decarbonization	3	2	3	**2.67**	5	4	**4.5**	**3.4**
Decentralization	4	2	2	**2.67**	3	3	**3**	**2.8**
Digitalization	4	4	3	**3.67**	3	3	**3**	**3.4**
Electrification of end-use sectors	4	2	4	**3.33**	2	3	**2.5**	**3**
Energy system flexibility	3	2		**2.5**	3	3	**3**	**2.75**
Energy efficiency at demand-side	3	2	3	**2.67**	4	3	**3.5**	**3**

Table 7.5: Interview results on the current alignment of the Cooperative Utility Business Model with each of the six energy sector developments. The scores are based on a 5-point Likert scale, in which 1 refers to 'poor' and 5 to 'excellent'. U1 & U2 (Utility A) and U3 & U4 (Utility B) represent interviewees from the incumbent utility perspective. C1 (Utility A) and C2 (Utility B) represent interviewees from the CVC unit perspective. Interviewee U4 did not provide scores. AG-A, AG-B, and AG-T indicate aggregated results for Utility A, Utility B, and in total, respectively. In case of blank cells, no score was provided.

Cooperative Utility BM	**Utility A**				**Utility B**			**Total**
	U1	U2	C1	**AG-A**	U3	C2	**AG-B**	**AG-T**
Decarbonization	3	1		**2**	4	2	**3**	**2.5**
Decentralization	4	4		**4**	4	4	**4**	**4**
Digitalization	3	1		**2**	4	3	**3.5**	**2.75**
Electrification of end-use sectors	3	1		**2**	3	1	**2**	**2**
Energy system flexibility	3	1		**2**	3	1	**2**	**2**
Energy efficiency at demand-side	3	1		**2**	4	1	**2.5**	**2.25**

Table 7.6: Interview results on the current alignment of the Prosumer Utility Business Model with each of the six energy sector developments. The scores are based on a 5-point Likert scale, in which 1 refers to 'poor' and 5 to 'excellent'. U1 & U2 (Utility A) and U3 & U4 (Utility B) represent interviewees from the incumbent utility perspective. C1 (Utility A) and C2 (Utility B) represent interviewees from the CVC unit perspective. Interviewee U4 did not provide scores. AG-A, AG-B, and AG-T indicate aggregated results for Utility A, Utility B, and in total, respectively. In case of blank cells, no score was provided.

Prosumer Utility BM	**Utility A**				**Utility B**			**Total**
	U1	U2	C1	**AG-A**	U3	C2	**AG-B**	**AG-T**
Decarbonization	3	4	4	**3.67**	4	4	**4**	**3.8**
Decentralization	4	4	5	**4.33**	5	5	**5**	**4.6**
Digitalization	4	4	4	**4**	5	3	**4**	**4**
Electrification of end-use sectors	4	4	5	**4.33**	3	4	**3.5**	**4**
Energy system flexibility	4	5	4	**4.33**	4	4	**4**	**4.2**
Energy efficiency at demand-side	4	4	3	**3.67**	4	4	**4**	**3.8**

When assessing the results, immediately one thing stands out. Especially for the traditional utility, but to a lesser extent also for the green utility and cooperative utility, the aggregated scores of Utility A are for almost all developments (significantly) lower than the aggregated scores of Utility B. In fact, for the traditional utility, this is the case for all six developments, while for the green utility and cooperative utility this can be seen in four and three developments, respectively. Moreover, with respect to the cooperative utility, not for any development the aggregated scores by Utility A exceed the scores by Utility B.

Interestingly, this seems to be the direct result of the U2-perspective in Utility A, which has resulted in significantly lower scores than both its counterpart in the U1-perspective of Utility A, and the U3-perspective of Utility B. It can be seen that in all but one of the eighteen scores for these three utility BM types, interviewee U2 provided the lowest score among all interviewees. The cause for this may be found in the perception of this interviewee towards the degree of innovativeness of the different BMs. To illustrate this, the less positive perception of this interviewee became clear in the following statement when asked about what will be happening in the energy sector:

> *"I think that we will be watching the same as in the internet world around 2000, the millennium, with the arise of a few new, large companies that will take over."*

It seems that for interviewee U2, one of the candidates for those companies that will be taking over might be the prosumer utility, as the score for the prosumer utility BM is significantly higher than for the other models, and comparable to the scores of the other interviewees. As we have seen in Chapter 3, the prosumer utility is (by far) the most innovative model, with a completely different way of supplying energy to customers than the other three BMs.

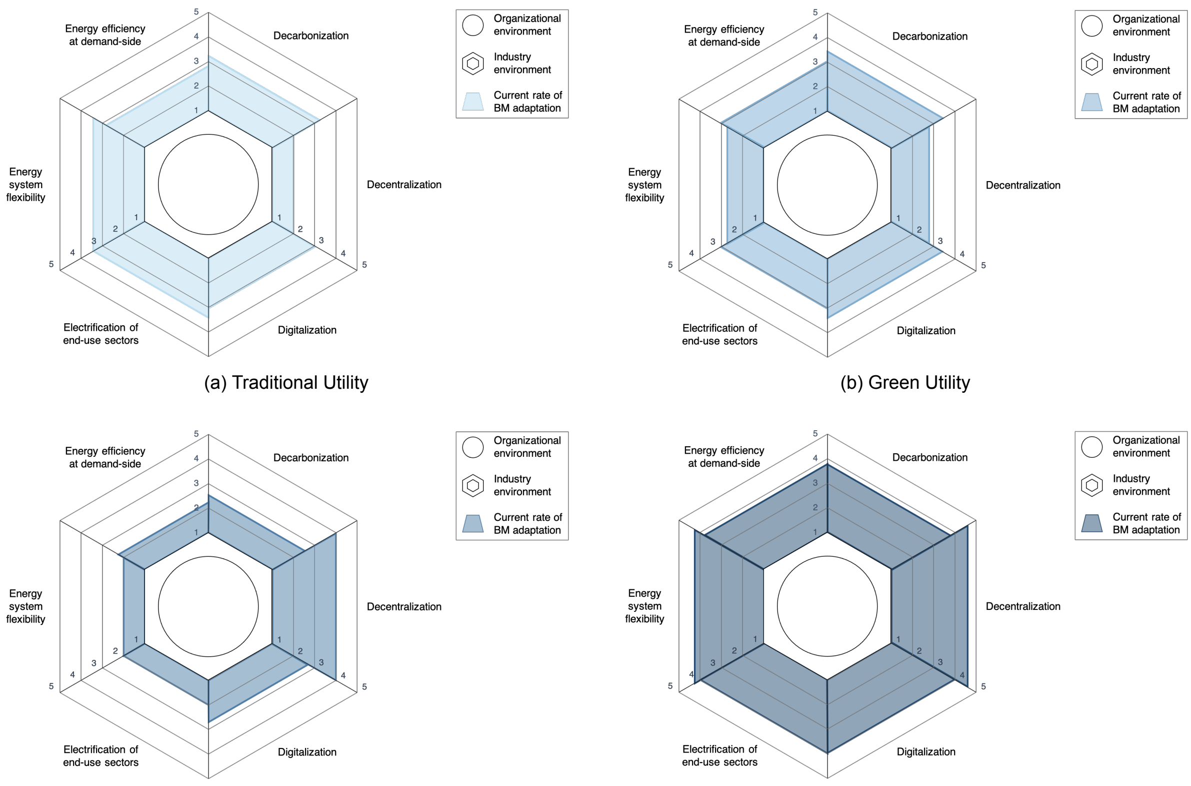
Besides this specific interviewee, no other major differences can be seen, both between utility and CVC perspectives and between the two utilities in general. The only other score that stands out is the score of the C2-perspective of Utility B for the cooperative utility model on the last three developments.

Here, three times the lowest score was provided, thereby acknowledging the score of U2 (Utility A) and being significantly lower than the score by the U1 and U3 perspectives who seem to have a more neutral perception. The latter is also interesting, as both interviewee U1 and U3 seem to be more neutral in general and do not recognize much differences between the four BMs. This is especially true for interviewee U1 (Utility A), in which hardly any differences between the four models can be retrieved, maybe except for the fact that the score for the prosumer utility BM is slightly higher than for the others. All in all, although to a varying extent, it can be concluded that all interviewees recognize possibilities for better alignment for all four BM types.

When aggregating the results of individual interviewees, the alignment of the four different models with the developments can be directly compared with each other. To enhance clarity, a visual representation of the aggregated alignment of all BMs with the developments is provided in Figure 7.1.

As can be easily retrieved from the figure, the cooperative BM was awarded the lowest scores, except with respect to decentralization. The traditional utility is ranked third with a highly modest score on all developments, the lowest being awarded to its rate of adaptation on decentralization. The green utility follows shortly after, scoring slightly higher on four developments than the traditional utility. Only with respect to electrification and energy system flexibility, the traditional utility scores higher. Finally, it is obvious that the prosumer utility is perceived to be most aligned with all developments, receiving the highest score on each of the developments.

While the latter result may not be that surprising, especially the low scores of the cooperative utility stand out. In the scores provided by the two industry experts, as was presented in Chapter 4, the cooperative utility BM scored low on digitalization, electrification, and energy efficiency, but it received the full score on decarbonization, and a four on both decentralization and flexibility. So, with respect to decarbonization and flexibility, there is significant difference in the scores. Especially the low score on decarbonization is interesting, as cooperative utilities can be recognized by providing a local group



(a) Traditional Utility (b) Green Utility

(c) Cooperative Utility (d) Prosumer Utility

Figure 7.1: Rate of adaptation of current utility business models to major energy sector developments. 1 = poor adaptation of a BM to a specific development, 5 = excellent adaptation of a BM to a specific development. Own illustration, based on aggregated insights from interviewees.

of customers with predominantly renewable energy, often generated by a few wind turbines or a small solar farm (as we have seen in Chapter 3). The cause for this low score indicates that according to traditional utility and CVC managers, cooperative utilities do not succeed in this mission. As one of the interviewees mentioned about cooperative utilities:

> *"At some point, we have seen the emergence of a major trend of cooperatives, energy cooperatives of municipalities. And each of those had the illusion of being able to take over the role of energy companies. [...] Eventually, only a few have survived, and only because they had a few people at their disposal with knowledge about energy, about the market, and whom have had patience. However, a very large number did not make it."*

For the traditional utility, also some interesting results stand out. As followed from the results in Chapter 4, the two industry experts awarded the traditional utility with the relatively lowest score on energy efficiency and decentralization (both together with the green utility), on decarbonization, and on flexibility (together with the cooperative utility and prosumer utility). In contrast, the interviewees awarded the traditional utility with the relatively lowest score only on decentralization. So, overall the traditional utility was relatively (significantly) better evaluated by the interviewees than by the external industry experts. This might indicate a bias, as all interviewees are working at traditional utilities and therefore have a too positive attitude towards their own (type of) utility.

Finally, it stands out that with respect to decarbonization, the interviewees seem to agree on the perception that none of the utilities is fully aligned with this trend, as the highest score was a 3.8, awarded to the prosumer utility. In comparison, in the scores provided by the industry experts, the cooperative utility received the full score, and the green utility and prosumer utility both a 4.5. In that respect, the interviewees seem to recognize that the current share of RE in the energy mix is still considerably low, and that thus all utility types are still highly dependent on (back-up) energy generation based on fossil fuels. It is expected that the industry experts did not sufficiently concern this fact in their scores.

All in all, as the scores imply, for all four utility BM types – although to a varying extent – it is clear that there is still much work to be done. In line with the scope of this research, from now on the focus will be solely on traditional utilities. As such, the limited current alignment of traditional utilities with the energy sector developments and the subsequent need for fundamental BMI for traditional utilities were assessed in more detail.

The observation that traditional utilities are only partly adapted to the power sector developments was shared by all interviewees. However, it seems that both utilities are recognizing the need to better adapt to these developments, and have already made some good progress. As interviewees from Utility A and B mentioned, respectively:

> *"We're trying. Two steps forward, one step back. Those developments are major. People are now beginning to understand and are becoming more aware of those new business models, were this definitely was not the case five years ago."*

> *"The transition we have been watching in the market has been, and still is, flowing into our company. Originally we were not well adapted, being a slow mover. [...] So, you can now see those types of innovations and new business developments being very clearly organized within companies, to be able to respond effectively to this transition."*

Besides the current efforts, the perception that fundamental business model innovation will be required for traditional utilities was again shared by all interviewees. First of all, traditional utilities seem to be too large to focus on better alignment with only a few of the identified developments. In other words, they will have to innovate their business model on each of the six domains. Besides that, the enormous scale of the changes in the energy sector were highlighted, which will lead to fundamental changes in the traditional BM. Many illustrations of this perception can be given, but the most striking was the following:

> *"Our current model and the one towards we are heading have nothing in common, except for the fact that we deliver energy to customers. But the operating model at the backside is almost 180 degrees different. It is a switch from push to pull; all possible areas of marketing will become diametrically opposed to the current model."*

The differences for traditional utilities seem to be the direct result from the changing energy value chain. As one interviewee mentioned, it used to be simply a matter of ’moving boxes’, producing electrons, transporting them, selling them, delivering them, and settling the bill. The focus on energy production and system optimization is shifting to optimization at the customer-side. As a result of this shift, traditional utilities will have to develop a new range of business models that sufficiently address these changes. Simultaneously however, the traditional model is still the most profitable one, with which the new models will have to be financed. In other words, this implies evidence of the need to become ambidextrous (i.e. being able to successfully operate and manage multiple business models at the same time), as was also identified in the literature study in Chapter 5.

Without diminishing the enormous scope of the demanded changes, some fields were identified in which the ’old’ model will still be partly relevant, for example in the development of large-scale offshore wind farms. It was believed that this will require a quite similar approach as the development of coal plants used to require. However, the importance of a *portfolio approach* was stretched, in which all aspects need to be integrated. More specifically, besides developing a wind farm, one will simultaneously have to be innovative in the way energy is sold, flexibility is taken into account, and so on.

All in all, it seems that the power sector is shifting towards a highly complex system, in which it will be essential for traditional utilities to take an integrated approach and manage a variety of business models at the same time. If they will succeed in this challenge seems to be ambiguous. Where most interviewees pointed out the current efforts and the progress being made, one of them was slightly more sceptic:

> *”The question is if we will succeed. I don’t think so. [...] Obviously, there will be some incumbents that will continue to exist. Definitely the ones that are still integrated. But wow, we will feel the pain.”*

What this already indicates, is that this required Business Model Innovation for traditional utilities is a highly complex process, subject to many hurdles that can ultimately turn out to become too big a challenge. In that respect, the next section will assess the barriers to BMI for traditional utilities.

7.2.3. Barriers to Business Model Innovation of Traditional Utilities

The approach to analyse the barriers that traditional utilities experience in their journey of BMI was two-folded. Firstly, all potential barriers to BMI that emerged from the literature study, as presented in Chapter 5, were included in the survey that was sent to all interviewees in advance, and were to be marked if found relevant. Additionally, this subject was discussed during the interviews, to allow for more detailed insights and potentially additional relevant barriers. By also including the barriers in the survey, the possibility was avoided that an interviewee would only mention a few barriers while potentially more could have been relevant. Indeed, seeing the large number of potential barriers, it was not expected that an interviewee would come up with more than five barriers.

In analysis of the results, first a distinction was made between the barriers that were marked as relevant in the survey, the barriers that were discussed during the interviews, or both marked in the survey and discussed during the interviews. In that way, it will become visible that some barriers are more ’concretized’, while others resulted more implicitly from interviews. An overview of these results is provided in Table 7.7. It must be noted that interviewee U2 from Utility B did not complete the survey.

The results will be analysed based on the extent to which they are recognized, divided into recognition by both utilities, recognition by one utility, recognition by a single interviewee, or no recognition at all, respectively.

Table 7.7: Interview results on the relevance of barriers to Business Model Innovation of traditional utilities. X = confirmed in survey, O = confirmed in interview, ✓ = confirmed in both. U1 & U2 (Utility A) and U3 & U4 (Utility B) represent interviewees from the incumbent utility perspective. C1 (Utility A) and C2 (Utility B) represent interviewees from the CVC unit perspective.

Barriers to BMI for Traditional Utilities	Utility A			Utility B		
	U1	U2	C1	U3	U4	C2
1. Lack of competencies to build and manage new capabilities due to cognitive barriers (managers failing to recognize business opportunities) and the inability to allocate sufficient resources to new technologies	O	✓	✓	O		O
2. Gaps in the product and service portfolio	X	O	O			
3. Conflicts with existing assets and business models				✓		X
4. Search-related barriers (where, what, how to innovate) due to complexity of BMI		O	O	O		O
5. Lack of customer-focused orientation, leading to a missing logic of how to reach them in the BMIs themselves				✓		
6. Lengthy innovation processes	✓		O		O	O
7. Non-supportive organizational values, culture, and design	O	✓			O	✓
8. Non-supportive human capital, skills, and psychology		✓		✓		
9. Short-term focus, i.e. mainly focusing on maximizing shareholder value	✓		X			✓
10. Profitability problems for utilities in certain markets due to high costs, small project sizes, and high additional costs (i.e. O&M, transaction costs for grid interconnection, and high cost of batteries)	✓		X	X	O	X
11. High initial investment costs for customers, lowering demand and thus lowering market attractiveness for utilities	X	X				
12. Misinformation or lack of knowledge about benefits of RE technologies by customers leading to lower customer awareness and acceptance		X				
13. Lack of customer demand in certain areas, blocking the justification of utility BM development in these fields	✓	✓		X		X
14. Behavioural barriers and concerns (risk-aversion, customers unresponsive to novelty, etc.) limiting market potential for new utility activities	✓	O	X		O	X
15. Lack of knowledge and information by utilities about markets for RE and potential customers						
16. Shortcomings of legal framework (inconsistency, incompleteness, immaturity) hindering utility activity in certain areas	✓			X	O	
17. Issues about feed-in tariffs and taxation, limiting interest for novel utility BMs	O	✓				
18. Low electricity price, limiting customer interest and demand for new utility BMs	✓	✓				
19. Unpredictable regulations leading to lack of long-term planning reliability		X			O	X
20. Misplaced incentives leading to uncertain development cycles for utilities		✓	X	X		
21. Privacy and internet security law limiting digital BMIs			X			X
22. Competition law and consumer protection, limiting BM acquisition opportunities or profitability of certain BMIs					O	X
23. Resistance from informal social institutions (e.g. on nuclear, biomass), blocking certain BMIs	X					
24. Generalized trust, which if lacking can limit partnering opportunities	X					
25. Lack of skilled people for installation, O&M, etc. limiting new BM activities		✓				
26. Limited grid capacity, constraining new RE integration and thus limiting utility BMI activity in this area		X			O	
27. System performance risks, constraining new RE integration and requiring innovative flexibility enhancing BMIs		X		X	O	
28. Strong competition of RE technologies with existing technologies, posing limitations to some applications of RE and thus BMIs in these areas	X					X
29. Risk of customer comfort reduction, limiting the market potential for certain BMIs	X					
30. Lack of standard procedures for grid connection, hindering BMIs in decentralization						
31. Metering issues, limiting the effectiveness and potential of certain propositions						

Barriers recognized by multiple interviewees from both utilities
First of all, multiple barriers stand out that are widely recognized as being relevant, by interviewees from both utilities. As can be seen in the table, a lack of competencies to build and manage new capabilities was recognized by five of the six interviewees. However, it must be noted that in case of Utility B, the existence of this barrier was not concretized but rather followed more implicitly from the interviewees. Evidence of the relevance of this barrier for Utility B follows for example from the following statement:

> *"It would be the mindset, I would say – which is also the habit if you have been accustomed to look at the world in a certain way as an individual, but more importantly as an organization – that it is very difficult to challenge yourself. When you see an evolution, as an individual you may even think that it is a danger, you may be challenged at some point by what you see emerging, but as an organization it is very difficult to believe that."*

What this quote already implies, is that incumbent organizations as traditional utilities find it generally hard to identify new business models that have the potential to pose a threat to their current model. They are captured in a certain, incumbent way of thinking and evaluation of their environment, which leads to cognitive barriers, or a certain way of subjectivity, in identification of potential new BMs. Besides this, it also seemed that sometimes, insufficient resource allocation is also actively an issue for development of new capabilities.

This first observation is also closely related to search-related barriers, which are directly emerging as a result of the high complexity of BMI as a process. Despite the fact that none of the interviewees marked this in the survey, during interviews with both utilities the relevance of this barrier did become (though sometimes implicitly) apparent, for example through statements as "Corporates are champions in not exactly knowing what they want", and "[...] you can start experimenting with what the customer likes, and in which type of model, and how far you can go". Also, one of the interviewees mentioned the following, further acknowledging existence of this barrier:

> *"That is because you see them on a day-to-day basis, you see opportunities, you see your counterparts looking at those disruptive business models or technologies. And then you have the opportunity to give that message to so many people in the company [...]. You really enlighten them with these new opportunities that they probably will not be aware of without you.*

Other organizational barriers that are recognized by both utilities are the lengthiness of (BM) innovation processes, non-supportive organizational values, culture, and design, non-supportive human capital, skills, and psychology, and a short-term focus. All seem to be directly related to the nature of incumbent, traditional organizations in general. Indeed, lengthiness issues are often the direct result of the bureaucratic design and processes within such corporations. Again, for Utility B, the relevance of this barrier only followed from the interviews, but became definitely apparent through statements as "if you look at how incredibly fast the landscape is changing, and how incredibly slow a corporate is, then you can feel the tension".

Obviously, these 'standard' characteristics of an incumbent player are reflected in a non-supportive organizational design and culture, as well as a non-supportive human capital, skills, and psychology. With respect to the first, the large distance between executive management and the daily workplace was highlighted as a large barrier, also directly resulting in a lack of knowledge and insights by executive management of potential new BMs, which again refers to a lack of competencies to build and manage new capabilities. With respect to non-supportive human capital, as was quoted by one of the interviewees: "everybody supports renewal, as long as everything remains as it is". Non-supportive human capital is often reflected in employees resisting to change, for example because they fear losing their jobs as a result of that change. Interestingly, this barrier was not confirmed by the CVC perspective of both utilities. However, this might be explained by the fact that CVC managers work in a dynamic environment and collaborate most with the innovation-related departments of the utility. As a result, they might not be fully exposed to the more change-averse employees. Evidence of a short term focus can for example be found in the following:

"Innovation follows waves. It is one of the first domains where cuts are made in case of setbacks, that is always difficult. What I miss in the whole corporate land, is a long-term vision in that domain."

Furthermore, profitability problems for utilities in certain markets are a widely recognized barrier, as well as a lack of customer demand in certain areas and behavioural barriers and concerns. The profitability issues may be the result of a variety of causes, to which a limited market readiness was specifically added by one of the interviewees. With respect to a lack of customer demand and behavioural barriers, a highly important issue became visible: "consumers are not interested in energy, except for when they do not have it". It is a commodity product which is – for example especially in the Netherlands – always available. This lack of general interest in energy flows over into a lack of customer demand in certain areas. Customers who actually are interested in energy seem to be only interested in the hardware (i.e. solar PV panels), and not so much in efficiency optimization processes.

Interestingly, the lack of customer interest is not only a negative thing for incumbent utilities. In fact, this seems to be one of the only reasons that they are still in a quite comfortable position. This paradox is strikingly captured in two different statements that were provided by the same interviewee: "Because our culture is still prompted by the fact that 60 to 70 percent of our customers is 'sleeping' and pays a high tariff, we do not feel enough pain – that startups do feel." and "but we live in a relative wealth due to that sleeping customer base. So, you need urgency to come to these types of decisions." In other words, on the one hand this large sleeping customer base leads to a lack in urgency and therefore hinders BMI, but on the other hand it decreases the urgency for BMI.

The lack of customer interest and demand unveils yet another barrier: the low electricity price. As a result of this low price, customers are not interested in for example energy efficiency measures, which will only save them a few cents. Interestingly, this was not mentioned by Utility B, and an explanation for this observation cannot be easily provided. It could be that because of its strong link to customer interest and demand, it was already captured under those barriers. The existence of other regulatory and institutional barriers was more widely confirmed, for example with respect to shortcomings of the legal framework, unpredictable regulations leading to lack of long-term planning reliability, and misplaced incentives. As can be seen in the table, all interviewees have recognized at least one of those barriers. Furthermore, what stands out is that the existence of barriers with respect to privacy and internet security law was only recognized by CVC managers from both utilities. This could potentially indicate that this is currently (still) predominantly an issue for startups and scale-ups working on innovative digital solutions with respect to customer data, solutions which utilities currently have not sufficiently addressed – as followed from their modest rate of adaptation to the digitalization trend in Figure 7.1.

Finally, three other barriers emerged that were recognized by both utilities. These were a limited grid capacity, system performance risks (especially with respect to security of supply), and strong competition of RE technologies with existing technologies, posing limitations to some applications of RE and thus BMIs in these areas. In the first two cases, it were only interviewees from the incumbent utility perspective who acknowledged the relevance of these barriers. A potential cause for the lack of recognition by CVC managers could be that these issues mainly affect the development of larger scale RE projects, such as solar or wind farms or company-scale projects, of which variability issues can lead to grid problems (either to too limited grid capacity in case of high energy output or security of supply in times of low energy output). Often, these are not the type of projects where many startups or scale-ups are involved. With respect to strong competition of RE with existing technologies, no additional insights emerged except for the fact that this may result from the low energy density of renewables.

Barriers recognized by multiple interviewees from one utility

Besides the barriers that were acknowledged by both utilities, a range of barriers became eminent that seem to be relevant to only one of the assessed utilities, but to multiple interviewees. In that respect, Utility A recognized gaps in the product and service portfolio, while Utility B acknowledged conflicts with existing assets and business models. This different perception might be due to a difference in size. In fact, it can be expected that a larger organization with more business activities will have less gaps in product and service portfolio, but will have to manage a larger variety of business models, which can be in conflict with each other. For a smaller utility, it is the other way around.

Besides these two, a high initial investment cost for customers was also only found to be relevant to a single utility. No watertight explanation can be provided for this observation, however it must be noted that two interviewees of Utility B acknowledged the existence of a lack of customer demand, which could be the result of a too high initial investment cost. In that respect, a specific example of a too high initial investment cost for customers was provided by Utility A, which can hinder the scaling-up of certain solutions by utilities. This example seems to be more generally applicable than just for a specific utility:

> *"Another aspect is that some products and services are not completely financially viable yet. So, these require a subsidy or incentive scheme. [...] A heat pump is obviously still highly expensive, that is not an option for everyone."*

Three other barriers only recognized by one utility (but at least two interviewees) are issues about feed-in tariffs (FITs) and taxation, a low electricity price, and competition law and consumer protection. However, for FITs the explanation may be quite simple, as this is strongly dependent on geography, as the stringency and outline of regulations on these topics vary highly between different countries. As such, it can be expected that utilities with a (slightly) different geographic focus can have a different perspective on this subject. For the low electricity price the same could be said, however it was already discussed that this barrier also has a strong link to a lack of customer demand, and it could therefore be that interviewees from Utility B already implicitly captured this barrier as one of the causes for a low demand. The same goes for competition law and consumer protection, however it could also be that this is seen as a logical, more 'given' fact and therefore not recognized as a real barrier by most interviewees. Another interesting observation is that both the FIT and electricity price issues were not acknowledged in the CVC perspective. Again, this might be the result of startups and scale-ups are working on highly innovative, specific solutions and might not feel the result of these issues (yet).

Barriers recognized by a single interviewee
Thirdly, we have the barriers that were only recognized by one interviewee, which are six in total. These are somewhat more difficult to explain. For example, a lack of customer-focused orientation was marked and mentioned by one interviewee as a relevant barrier:

> *"If we want to stay an energy producer and energy seller at the same time – and I believe that's what we want to do – we need to look at how we deal with the end-customers."*

Although being not explicitly mentioned as a barrier, the relevance of this subject also emerged during other interviews, thereby underlining its importance:

> *"And we are shifting towards a situation in which we will directly control 50% of customer costs. [...] That is a small step for a man, a huge step for companies like ours."*

Secondly, misinformation or a lack of knowledge about benefits of technologies by customers was marked as a relevant barrier by one interviewee. However, this was not further discussed during the interview and as such, no additional insights can be retrieved. The same goes for resistance from informal social institutions and generalized trust, which were both marked but not further discussed as well. More interesting is the result with respect to a lack of skilled people for installation and O&M, among others. Indeed, in Chapter 5 we have seen recent news coverage of this being a relevant problem, however there is only one interviewee who acknowledged this. However, this could be due to the fact that utilities have already made good progress on this issue. The interviewee who marked this barrier mentioned the following:

> *"What you now see across the world, also at other large companies, is that the first step is installation. If you watch the advertisements on TV, you see that everybody brings a happy technician to your home. That is the first step we are taking towards that new model."*

This might indicate that already sufficient progress on this issue has been made, and it was therefore not deemed to be relevant by most interviewees. Nevertheless, in line with recent news coverage [134], this still might be a limiting factor. Furthermore, a risk of customer comfort reduction was marked once, although this seems to be rather a point of attention that has to be kept in mind than being an active barrier.

Barriers not recognized at all
Finally, three barriers were not marked at all. First of all, a lack of knowledge and information by utilities about markets for RE and potential customers was also not confirmed to be a barrier. This is obviously related to search-related barriers, so the same argument applies. And again, existence of this barrier was also not indicated by the industry experts, so this seems to be an irrelevant barrier for at least European traditional utilities. For less-developed countries and markets (which still largely or solely depend on fossil fuels), this could be still a relevant issue.

Furthermore, two technological barriers were not acknowledged: a lack of standard procedures for grid connection, and metering issues. It seems that technology issues are not such of a barrier (any-more), as was also confirmed by an interviewee through ”in technological terms, everything is already possible, technological issues no longer present a barrier”. Moreover, both issues are expected to occur in a relatively new, undeveloped market. As the energy transition and its corresponding six major developments are already going on for some years, it may be expected that these teething troubles are now over. However, one of the industry experts highlighted these barriers as relevant. On the other hand, this expert highlighted all technological barriers, which might indicate that he is somewhat more sceptical about the current state of technology in general. On basis of the interview results, it could be concluded that these issues are not presenting a real barrier to BMI of traditional utilities.

So, having addressed all barriers from Table 7.7, one final note has to be taken. One of the interviewees proposed a few additional barriers in the survey. For example, market readiness was proposed as another financial and profitability barrier. Secondly, the relevance of a lack of incentives for customers was highlighted, who consequently miss the general belief that they would benefit from investing in certain products or services. Finally, resistance from incumbent players, especially DSOs, was identified as additional barrier.

Now all relevant barriers to BMI have been identified, the final part of the analysis assesses the potential contribution that CVC activities can deliver to remove or circumvent these barriers. This is addressed in the next section.

7.2.4. Potential Contribution of Corporate Venture Capital to Business Model Innovation of Traditional Utilities

As was also the case with assessment of the relevant barriers to BMI of traditional utilities, the approach to analyse the contribution of CVC to remove or circumvent those barriers was two-folded. Firstly, all potential benefits of CVC activities, as presented in Chapter 5, were included in the survey that was sent to all interviewees in advance, and were to be marked if found relevant. Additionally, this subject was extensively discussed during the interviews, and in several ways. In that respect, the *raison d'être* of the CVC unit was discussed, as well as its goals, structure, types of ventures that are targeted, collaboration with the incumbent utility, and how it compares to CVC in other industries. Also, the relevance of individual CVC benefits was discussed, as well as common exit strategies. Finally, the contribution of CVC to help remove or circumvent the barriers to BMI was specifically assessed, as well as the necessity for traditional utilities to engage in CVC activities.

First of all, before assessing individual benefits of CVC and corresponding relations to BMI barriers, it is insightful to elaborate upon the general raison d'être of both CVC funds, and their role within the larger BM innovation strategy of both utilities. In that respect, it was found that the general purpose of the CVC fund can in both cases be captured by *bringing external knowledge, technologies, and innovative BMs inside the company*. In other words, all interviewees acknowledge the fact that not all the smart people in the world work for them, and that they should reap the benefits of the massive amount of knowledge, ideas and innovations that are developed outside of the company. In this way, new or additional value must be created for the incumbent utility, for example in terms of know-how and new business capabilities that would be not feasible, too expensive, or would take too long to develop internally. Through CVC, new innovative BMs can be brought on-board that can help traditional utilities in realizing the required changes. As such, it is seen as one of the key tools to support BMI of big incumbents in general, and specifically in the energy sector in response to the rapid changes. As one of the interviewees mentioned:

> *"We see these changes happening in the market, and we have to go along with that, because in twenty years from now the whole landscape will be different. [...] So, we have to and we do go along with that, but obviously that is a considerably big challenge. That is exactly a domain in which Venturing and M&A can play an important role, to help speed up that process."*

Regarding the role of CVC within the BM innovation strategy of traditional utilities, it stood out that – as could be expected – CVC is not the only instrument for utilities. In fact, the importance of an integrated approach combining internal and external tools (open innovation) was highlighted by all interviewees. With respect to the external tools, CVC is not the only way traditional utilities collaborate with external startups. It was found that – depending on size – they make use of a variety of tools, ranging from partnerships without investment, collaboration with startup incubators, and collaboration with startup accelerators, among others. Internal tools for example include R&D and internal venturing. Nevertheless, this does not diminish the importance of CVC as an instrument.

In that respect, in both cases the positive effects of CVC activities were recognized. Moreover, in one case even all interviewees agreed upon the fact that CVC is an essential component of the BM innovation strategy of traditional, incumbent utilities. This became clear through statements as:

> *"It is almost a license to operate to have it. There are different ways, [...] and we do not have to do everything through external venturing. [...] But I think everybody should have it."*

Interestingly, interviewees from the other utility were less determined about this subject, despite the fact that they acknowledged that in their own case it has been and still is highly beneficial for BMI. They were however especially less certain of the necessity of CVC for other traditional utilities. This seems to has to do with company size and the extent to which a company has strong internal R&D capabilities. The larger a utility is and the stronger its internal R&D capabilities are, the less essential CVC was found to be. However, there might have been a small bias as well, as one of the interviewees mentioned the fact that CVC funds of other utilities are expected to have a stronger focus on financial returns instead of strategic benefits, while this is not proven to be true.

All in all, it became clear that all interviewees were determined about the contribution of CVC to at least their own utility, which obviously suffices. Each of them acknowledged the contribution of CVC to BM innovation processes. To address this contribution in more detail, the relevance of all potential CVC objectives from Chapter 6 was assessed, as well as their specific ability to help remove or circumvent barriers to BMI.

In analysis of the results on this subject, first a distinction was made between the CVC benefits that were marked as relevant in the survey, the benefits that were discussed during the interviews, or both. In that way, it will become visible that some benefits are more 'concretized', while others resulted more implicitly from interviews. An overview of these results is provided in Table 7.8. It must be noted that interviewee U4 (Utility B) did not complete the survey.

As immediately stands out from the table, the results are much more uniform than in the case of barriers to BMI. In that respect, ten CVC benefits were found to be relevant to both utilities, one benefit only to a single interviewee, and the remaining benefits were not acknowledged at all. So, there are no benefits which are relevant to only one utility, which seems to point at a considerably similar strategy of both utilities for their CVC funds.

Financial objectives

First of all, it is important to stretch that although not the main objective, *financial gains* are still important for both utilities. In both cases, some general financial objectives were mainly seen as a prerequisite for CVC, but not a goal as such, as was illustrated by one of the interviewees:

> *"We are not looking for profitable companies, we are looking for companies that can give us a gain when we exit. That is quite different. [...] So, in the baseline we don't invest in startups that we think are going to create losses for the fund. But of course, it happens, because Venture Capital is a risky business."*

Table 7.8: Interview results on the relevance of benefits of Corporate Venture Capital activities of traditional utilities. X = confirmed in survey, O = confirmed in interview, ✓ = confirmed in both. U1 & U2 (Utility A) and U3 & U4 (Utility B) represent interviewees from the incumbent utility perspective. C1 (Utility A) and C2 (Utility B) represent interviewees from the CVC unit perspective.

Benefits of CVC for Traditional Utilities	**Utility A**			**Utility B**		
	U1	U2	C1	U3	U4	C2
1. Financial gains		✓	O			O
2. Identification of, monitoring of, and exposure to new technologies, markets, and business models	✓	✓	✓	✓	O	✓
3. External R&D	O		✓			✓
4. Improve manufacturing processes						
5. Learn about specific market or technology pitfalls		X	X	✓		X
6. Change corporate culture: promote entrepreneurship	✓	✓	O	O	O	O
7. Train junior management						
8. Learn about VC in general						
9. Improve internal venturing						
10. Complementary contacts / expand network		X				
11. Identify and assess potential acquisition targets						
12. Accelerated market entry	O	O	X		O	✓
13. Option to expand business	O	O	O	O	O	✓
14. Access and exploit new or complementary BMs, technologies, and services	O	✓	O	✓	O	✓
15. Increase demand for technology and products						
16. Shape markets, i.e. by nurturing potential competitive risks						
17. Steer standard development						
18. Support development of new applications for products						
19. Add new products to existing distribution channels		X		X		
20. Utilize excess plant space, time, and people						
21. Promoting an innovative corporate image	✓	X	O	O		X

This is also where the portfolio effect comes into play: "a portfolio where we do invest with a minority share in a startup allows us to equilibrate the risk between the ones which are making a lot of money and the ones which are less profitable and sometimes which lose money". This portfolio effect seems to be key for both utilities, as some financial returns are expected by the utility on the portfolio as a whole. Besides these objectives, also practical evidence of financial benefits of CVC activities has been found. As was mentioned:

"The first observation is that it didn't cost us any money. [...] So, all gains it provided are very cheap. For us, it has been really cheap innovation."

So, despite the fact that only one interviewee actually acknowledged the importance of financial gains in the survey, the interviews gave sufficient evidence of the relevance of this benefit, and as such it cannot be ignored. However, there is insufficient evidence for this benefit contributing to overcome specific barriers to BMI.

Market-level learning

The first strategic benefit of CVC activities is simultaneously the most widely acknowledged one. In that sense, the importance of *exposure to new technologies, markets, and business models* was not only acknowledged by all interviewees who filled out the survey, but also became eminent in each of the interviews. Because of the CVC activities, knowledge and active discussions are brought into the company that both employees and management would otherwise not be aware of. So, even if the decision is made not to invest in a particular venture, the fact that everybody in the company is now aware of the startup and the discussion whether to invest has taken place, additional value has been created. New knowledge and awareness that might influence future decisions. This was for example illustrated by quotes as "because of those investment decisions, you brought discussions to C-level which they normally wouldn't have" and "But on top of that, you give some ideas to people and you basically make them more open to what's going on". However, the most striking description was the following:

> *"Particularly because you gain a lot of insight in these types of other companies, scale-ups and startups, because you are monitoring them and the activities they develop. If you don't have that, you are missing out on what is happening in the market. Then you only read about it, you are on your supertanker out on sea, sailing a predefined course, but you don't see what all those little boats are doing. [..] But because you are putting people on those little boats, also the captain on that supertanker obtains a very clear overview of what is happening around him."*

As this already implies, this benefit of CVC activities can help to remove or circumvent different barriers to BMI. First of all, it was acknowledged that it can contribute to provide employees and managers with a better overview of potential new business opportunities and active discussions about these subjects, thereby reducing the cognitive barriers that result in a **lack of competencies to build and manage new capabilities**. For example:

> *"You really enlighten them with these new opportunities that they probably will not be aware of without you. [...] Then you are presenting some company that is promising to bring you a lot of money with a new business model, a new technology that nobody in the company was aware of, or it was only to some colleagues. [...] Sometimes they [a certain department] don't see the full picture and they lack the business opportunities that we should have in mind."*

Also, it was confirmed that because of the exposure to new markets and business models, **search-related barriers due to the complexity of BMI** could be decreased. Finally, it was also widely confirmed that a **short-term focus** at management level will be positively affected. As one of the interviewees further explained this effect: "By putting emerging technologies or business models at the agenda of the CVC investment committees, it somehow forces top management to decide on some long-term orientations". As we have seen, part of the CVC investments indeed include options that seem interesting for the long term, which the utility wants to monitor through a CVC investment. As all individual investment decisions are made at top management level, they will have to concern these options, which can help to positively affect their short-term focus.

Venture-level learning

With respect to venture-specific learning benefits of CVC, first of all the relevance of CVC as an *external R&D* tool was confirmed. The importance of R&D related benefits was further underlined during several interviews, ranging from an almost substitution of internal R&D activities to a more complementary role. Moreover, one interviewee argued that internal R&D is a highly expensive process, and the question could be raised if the gains justify these high costs, especially when it could also be outsourced to ventures through CVC activities. It seems that to some extent this argument also holds for other utilities. Indeed, the following statement was provided:

> *"In particular CVCs, together with all the departments focusing on innovation, have the crucial role to bring the know-how and competencies within the company which would be too expensive or too long do develop internally."*

So, this implies that CVC in the form of an external R&D tool, can help to overcome the **lengthy innovation processes** that can be a barrier to BMI, as well as help to reduce **profitability problems** in certain areas as a result of high development costs.

Secondly, the relevance of another venture-specific CVC benefit was acknowledged: *learn about specific market or technology pitfalls*. More specifically, one interviewee recognized its potential contribution to circumvent **profitability problems** in certain areas. Through CVC activities, a range of options for further opportunities can be explored, while knowing that they can fail. For utilities, this can be an efficient way of learning what will work out well and what will not, thereby contributing to circumvent potential profitability problems.

Indirect learning
With respect to the indirect benefits of CVC activities, the *promotion of entrepreneurship in the corporate culture* was widely acknowledged as being relevant. While only two interviewees concretized this observation in the survey, it became eminent in each of the interviews. For example:

> *"Bringing the external environment to the company has triggered and moved people to think differently, it has brought entrepreneurship to the company. Yes, that has definitely helped, culture-wise."*

Another confirmation of this fact became for example clear through statements as "I wouldn't say because of the CVC, this is a full ecosystem that you have to take in mind. We are contributing to that [a more entrepreneurial culture]". Obviously, this positive effect in organizational culture can be directly related to the BMI barrier **non-supportive organizational values, culture, and design**.

In addition to this rather aggregated cultural effect at firm level, the promotion of entrepreneurship in the corporate culture can be beneficial to the mindset of human capital as well. While pointing at the difficulties of changing the mindset of all employees of such large firms by only the CVC activities, it was stated that "there are some successful cases where they did [change their mindset]". As such, this can be directly linked to another barrier of BMI: **non-supportive human capital, skills, and psychology**.

As can be seen in the table, there is also another indirect benefit of CVC activities that was only recognized by one interviewee: *complementary contacts and network expansion*. However, this was not further discussed during the interview, so the specific effects of this benefit and the extent to which it can help to remove or circumvent barriers to BMI remains unclear. Moreover, when looking at the barriers to BMI, there seems to be no barrier which can be directly related to this benefit. As such, it is assumed that this network expansion benefit does not directly contribute to overcome barriers to BMI. Nevertheless, the relevance of this benefit in other areas is not diminished.

Options building
Moving further, with respect to the option building benefits of CVC, it stands out that three benefits are widely acknowledged to be important. First of all, CVC can create options for traditional utilities to *accelerate entry in certain markets*. Although only being marked in the survey by two interviewees, during four interviews the relevance of this subject explicitly emerged. Statements on this subject ranged from "it could help to speed up the development of a market", to "it was also specifically aimed at speeding up towards a much larger market reach", or:

> *"Agility. The one that will be able to adapt to the market developments is the one that will last and become the winner. [...] Size is not important, it is agility that matters."*

This accelerating effect can obviously help to overcome the BMI barrier of **lengthy innovation processes**. However, it would be too short-sighted to stop there. This accelerating effect emerged as a rather highly important benefit for the process BMI as a whole, more in terms of being a catalyst to all BMI processes, and not only to speed up entry in certain markets. In that respect, interviewees identified the creation of internal friction because of CVC and the limited time frame of CVC, respectively, both as having an accelerating effect to BMI in general:

> *"[...] Because of that Venturing, we have been able to show all those external innovations to the company, to demonstrate how it could work, and thereby creating awareness and acceleration. Because the resistance against those investments means that we have to prove to the people who are resistant that alternative approaches are also possible. And that friction is likely to create the most value for the company."*

> *"But the fact that we have the options to invest in companies, in startups going that direction, and the fact that the opportunity of investment is limited in time, help everybody to understand and accelerate the thinking of the company. Because the*

Strategy people, they take their time to develop a strategy, [...] but when a startup is raising money, this is right now, this is not in six months. And I think this time pressure that we feel as an investor and that we then convey to the user teams pushing in the same direction – but at their pace – is also an acceleration for the company itself."

Besides these acceleration effects of CVC, it also creates *options for (future) business expansion*, as was recognized by all interviewees (although mostly only during the interviews themselves). In that respect, a few specific examples were mentioned in which certain investments directly led to lots of new business in certain domains, capabilities which could not have been easily developed internally. Also, it was mentioned that two categories of ventures are targeted: ventures which bring short-term collaboration opportunities and ventures active in domains which can be interesting for the long term, depending on market development. The latter implies that these types of investments are specifically aimed at creating future options for business expansion.

Also, another interviewee mentioned to be currently working on a file that is a very good example of "successfully helping to adapt the strategy of the company by pushing through the CVC activity in a new business where there are new activities". Finally, the relevance of this CVC benefit was also illustrated by the typical exit strategies of the CVC funds. In both cases, it was mentioned that full integration of ventures in the utility (that means, the utility purchasing all shares of the venture) is a common exit strategy, obviously depending on the specific strategic rationale behind each investment.

When looking at the related barriers to BMI, it was acknowledged that these options for business expansion can fill (future) potential **gaps in the product and service portfolio**. It was however noted that a strong vision of a utility will be required for this effect to become practice. Additionally, the creation of future business expansion options could circumvent a **lack of competencies to build and manage new capabilities**, as with the CVC activities these business models are developed externally and the utility will have the (future) opportunity to expand its business with these activities. To further illustrate this, one interviewee mentioned that an increasing emphasis is put on including provisions about exits already in the investment contract. In this way, utilities want to draft air tight contracts with respect to their option to acquire the venture in the future.

Furthermore, the creation of a range of options for future business expansion can provide a guidance to the complex search process and provide inspiration for BM innovations, thereby helping utilities to reduce **search-related barriers** to BMI. However, despite this potential contribution, it was underlined that the search for the right BM innovations remains a highly complex process. In addition, it was mentioned that the size of the CVC funds will be relevant as well, as their relatively small size does not allow for the creation of multiple future options on a single specific topic; thereby limiting this potential effect. Nevertheless, it could still make a contribution. Finally, another potential effect could be the circumvention of **short-term focus** effects. If a variety of future, potentially valuable options is on the table, new BMs and capabilities are thus built externally. In this way, the impact of a short-term focus would be circumvented as potentially essential options for the longer term are still on the table as well. However, it must be noted that no unambiguous answer on this effect could be retrieved from the interviews. So, it remains unclear whether this is indeed a relevant effect.

Furthermore, the CVC benefit of being able to *access and exploit new or complementary BMs, technologies, and services* was widely recognized as well. While this seems to be overlapping with the creation of options for business expansion, this benefit rather focuses on benefits on a shorter term, more in terms of reinforced commercial partnerships with ventures through CVC investments. As was recognized by one of the interviewees:

"The focus that we have for CVC is to look at companies which are developing solutions that we would not develop ourselves, that is the first point. So, there is a complementarity with what we do in other parts of the company"

In other words, where the creation of options for business expansion rather addresses investing new, innovative BMs that could open up new (future) markets, accessing and exploiting new or complementary BMs, technologies and services focuses rather on the creation of synergies in domains which are already visibly relevant. Through CVC, either new partnerships with ventures could be established, or already existing partnerships could be reinforced. As one of the interviewees described this, ”the best relationship is being a joint shareholder of something that you want to develop together”. Finally, the shorter term nature of this CVC benefit compared to the creation of options for future business expansion was also reflected in the exit strategies. In that respect, it was found that in some cases successful partnerships had been created in which it was not meaningful anymore to be a shareholder as well, so it was decided to exit with continuation of the partnership.

When looking at the barriers to BMI, the ability to access and exploit external BMs, technologies, and services can remove several barriers. First of all, it could help to circumvent **gaps in the product and services portfolio**, as these gaps are filled by the exploitation of external products and services. Secondly, it was acknowledged that **lengthy innovation processes** could be circumvented, as this CVC benefit removes the need for internal development of some BMs or technologies. Hereby, it was however noted that a corporate often has a strong distinct way of doing things, resulting in potential scepticism towards external solutions. Thirdly, an example was provided in which a specific investment could help to remove the **lack of skilled people for installation** of certain products. However, as this already implies, this is strongly related to the specific proposition of the venture.

Furthermore, another, more indirect relationship can be identified, as one of the interviewees provided a specific example of an investment which has led to the utility being able to access and exploit sophisticated customer data aggregation and analysis technologies. This can help to reduce a **lack of customer demand**, which was illustrated in another part of the interview:

> *”[...] Because you can identify customer needs without asking it themselves – because they have no idea. Everything that you ask, you will not get any response. But as a result of being able to apply data analytics, [...] you can create a clearer view of how we can solve this for customers. And if that has been determined, you can [...] experiment with what the customer likes. [...] And I think that is extremely important in this – for consumers – extremely complex matter.”*

Finally, it could also help to reduce **conflicts with existing assets and BMs**. As one of the interviewees mentioned:

> *”We are more looking at innovative business models that are difficult for us to generate, because, as you know, it’s always difficult to disrupt yourself. And so that’s where actually investing in some startups could be a way to have both a foot in and without the drawbacks of explaining that that will disrupt our own activities.”*

Leveraging complementary resources

What remains is two other CVC benefits that have been recognized. First of all, this is the possibility to add new products to existing distribution channels, thereby increasing efficiency and thus reducing costs. However, this benefit was not further discussed during the interviews, so no additional insights have been obtained. While it could be argued that the cost reduction might (slightly) decrease profitability problems of utilities in some areas, this argument cannot be substantiated.

Branding

Secondly, there is the benefit that CVC activities promote an innovative corporate image. This was recognized by almost all interviewees, with perceptions ranging from a clearly visible benefit to a beneficial side-effect. However, this might increase attractiveness of the utility in general, but cannot be easily related to a specific contribution to business model innovation.

Unconfirmed CVC benefits

Having discussed all the acknowledged potential benefits of CVC and their relation to the barriers to BMI of traditional utilities, it stands out that there is a considerably large number of benefits that have been found to be irrelevant to traditional utilities. In fact, this has been the case with ten benefits in total. Remarkable is that no single one of the benefits related to leveraging own technologies and platforms was recognized to be relevant. This seems to correspond with the perception among interviewees that CVC is an important component of the external part of the BM innovation strategy, next to the internal part which includes other instruments. So, it seems that the internal aspects, including a utility’s existing technologies and platforms, are outside the scope of CVC activities.

Furthermore, three indirect learning benefits were not acknowledged. Again, training junior management, learning about VC in general, and improving internal venturing activities are not reflected in the external and highly strategic scope of CVC activities as a driver of Business Model Innovation. Moreover, the same goes for improving internal manufacturing processes, and the utilization of excess plant space, time, and people. Finally, with respect to the option to identify and assess potential acquisition targets, it seems that this is left for the M&A department, as can be retrieved from one of the interviews wherein CVC and M&A were named as separate instruments.

Translation of interview quotes into relationships between CVC and BMI

Having discussed all relevant benefits of CVC and the barriers to BMI which they can help to overcome, an overview of individual relationships between CVC benefits and BMI barriers can be provided. However, it is insightful to first briefly touch upon the way in which the relationships were identified.

In that respect, two different methods were used. On the one hand, some of the identified relationships were literally asked and acknowledged during one or multiple interviews. As such, this leaves no room for a different interpretation by researcher. On the other hand, many relationships between CVC benefits and BMI barriers were retrieved by a structured analysis of the interviews, and were reflected in specific quotes by interviewees. As explained in Chapter 2, the interviews have not been formally coded. In the previously discussed interview results, many examples of quotes were already provided to indicate the existence of certain relationships. However, for clarity and reliability purposes a few examples of how interview quotes were translated into a relationship between specific CVC benefits and specific BMI barriers is provided in Table 7.9. Hereby, two things must be noted. On the one hand, a number of relationships was often further illustrated in other interviews, but only one quote has been provided that according to author best described the existence of the relationship. On the other hand, parts of the exact explanation of relationships were illustrated in other parts of the same interviews or in other interviews, rather than that all aspects of a specific relationship followed from only one quote. Therefore, the examples in Table 7.9 only provide quotes from which the basic existence of relationships could be retrieved; but sometimes these quotes do not fully capture the more detailed explanation of those relationships. However, according to author, most parts of these explanations can be retrieved from other quotes provided in this chapter.

Table 7.9: Examples of translation of interview quotes into relationships between specific CVC benefits and BMI barriers.

Quote	Keywords	CVC – BMI Relationship
”You really enlighten them with these new opportunities that they probably will not be aware of without you. [...] Then you are presenting some company that is promising to bring you a lot of money with a new business model, a new technology that nobody in the company was aware of, or it was only to some colleagues. [...] Sometimes they [a certain department] don’t see the full picture and they lack the business opportunities that we should have in mind.”	New opportunities, aware, lack the business opportunities	The CVC benefit *identification of, monitoring of, and exposure to new technologies, markets, and business models* can help to reduce the BMI barrier *lack of competencies to build and manage new capabilities due to cognitive barriers (managers failing to recognize business opportunities)*
”Bringing the external environment to the company has triggered and moved people to think differently, it has brought entrepreneurship to the company. Yes, that has definitely helped, culture-wise.”	Triggered and moved people, entrepreneurship, culture-wise	The CVC benefit *change corporate culture: promote entrepreneurship* can help to reduce the BMI barriers *non-supportive organizational design, culture, and structure* and *non-supportive human capital, skills, and psychology*
”The focus that we have for CVC is to look at companies which are developing solutions that we would not develop ourselves, that is the first point. So, there is a complementarity with what we do in other parts of the company”	Solutions, develop ourselves, complementarity	The CVC benefit *access and exploit new or complementary BMs, technologies, and services* can help to circumvent gaps in the product and service portfolio

Potential contribution by CVC benefits to overcome barriers to BMI

An overview of the recognized potential effects of CVC benefits to remove or circumvent barriers to BMI is presented in Table 7.10. Where possible, after each effect it is mentioned how the effect was identified. This is done by referring to a specific quote by an interviewees, or mentioning if it was acknowledged by an interviewee when asked. Also, the existence of one effect (CVC benefit 13 on BMI barrier 9) remains ambiguous, which is also indicated in the table. No sufficiently conclusive answer on this specific effect could be retrieved from the interviews. In line with the exploratory nature of this research, it was decided to not discard this effect, but rather to highlight its ambiguity.

Table 7.10: Potential contribution by CVC benefits to remove or circumvent barriers to BMI of electric utilities.

CVC Benefits (C)	Potential effect on BMI Barriers (B)
2. Identification of, monitoring of, and exposure to new technologies, markets, and business models	1. Lack of competencies to build and manage new capabilities due to cognitive barriers could be reduced as management level is provided with a better overview of potential new business opportunities and active discussions about these subjects (second quote p.92) 4. Search-related barriers could be reduced as increased exposure to new markets and BMs could provide guidance to the search (acknowledged) 9. Short-term focus of management could be reduced because they are forced to take positions on technologies and BMs which are long-term oriented (acknowledged)
3. External R&D	6. Lengthy BM innovation processes could be circumvented as external know-how and competencies which would take too long to develop internally are brought into the company (third quote p.92) 10. Profitability problems could be reduced as external know-how and competencies which would be too expensive to develop internally are brought into the company (third quote p.92)
5. Learn about specific market or technology pitfalls	10. Profitability problems of new business models and technologies could be circumvented as utilities can learn from the pitfalls experienced by ventures (acknowledged)
6. Change corporate culture: promote entrepreneurship	7. Non-supportive organizational design, culture, and structure effects could be reduced as bringing the external environment to the company can trigger and move people to think differently, thereby improving an entrepreneurial culture (first quote p.93) 8. Non-supportive human capital effects might be reduced because direct collaboration of employees with dynamic startups can change their mindset (first quote p.93; in-text quotes immediately after)
12. Accelerated market entry	6. Lengthy BM innovation processes could be reduced as the development of a market or development of market reach could be speeded up, and agility could be increased (second quote p.93)

13. Option to expand business	1. Lack of competencies to build and manage new capabilities could be circumvented, as new BMs and capabilities are developed externally and the utility will have the (future) opportunity to expand its business with these activities (acknowledged) 2. Gaps in the product and service portfolio (in the future) could be circumvented as a result of new business creation with new activities, which could not have been easily developed internally (acknowledged) 4. Search-related barriers could be reduced as different available options for future business expansion can provide a guidance to the complex search process and provide inspiration for BM innovations (acknowledged) 9. Short-term focus effect could be circumvented as the options for future business expansion with external BMs and capabilities would be available (ambiguous effect)
14. Access and exploit new or complementary BMs, technologies, and services	2. Gaps in the product and service portfolio could be circumvented as a result of exploiting external complementary products and services (second quote / bottom p.94) 3. Conflicts with existing assets and BMs could be reduced as this would be a way to have a foot in, but without the drawback that it will disrupt own activities (second quote p.95) 6. Lengthy BM innovation processes could be circumvented as the need for internal development of these BMs or technologies would be removed (acknowledged) 13. Lack of customer demand in certain areas could be reduced as accessing and exploiting specific solutions that identify customer behaviour can be used to experiment with new, tailored propositions to customers (first quote p.95) 25. Lack of skilled people for installation, O&M, etc. could be reduced as installation-related solutions can be exploited for diffusion of own propositions (acknowledged)
• Acceleration	• BMI in general could be accelerated because of the limited time frame of CVC activities and the creation of internal friction by CVC activities, which increases awareness and acceleration (third quote p.93; first quote / top p.94)

All in all, as can be seen in the table, CVC activities can help to remove or circumvent various barriers to BMI. As such, it can be concluded that for both traditional utilities, CVC is a highly useful instrument – next to other instruments – that can play an important role in the transition of their Business Model and helping them to realize all demanded changes. To further assess the extent to which CVC can contribute to overcome the barriers to BMI and better alignment of traditional utility BMs with the identified power sector developments, it is insightful to analyse in which types of ventures both utilities have invested. This reflects the more substantive component of both BMI and CVC, as was already discussed in Chapters 5 and 6. In that respect, the next section will address the portfolios of both CVC funds.

7.3. Case Study Results: Venture Portfolio Analysis

As already followed from Chapter 5, BMI also involves a more substantive component, which is reflected in multiple BM innovation opportunities for utilities. Also, a lack therein has been translated into the barriers *gaps in the product and service portfolio* and *lack of competencies to build and manage new capabilities due to cognitive barriers and the inability to allocate sufficient resources to new* *technologies*. From the previous section, it already followed that practical evidence suggests that CVC activities can help to remove these barriers.

However, more specifically with respect to better alignment of traditional utility BMs with the identified power sector developments, this substantive component would have to become clear in various domains. As such, to be able to assess the extent to which CVC can contribute to BMI of traditional utilities, it is insightful to identify the domains in which new BMs are targeted, and if this corresponds to the specific BM innovation opportunities that emerged from literature.

In this section, an analysis of the CVC portfolios of both utilities is presented, in which the specific activities and BM domain of each venture will become clear. In line with the relatively recent establishment of both CVC funds, and noting that past investments could already have been of important value or could still be in an active partnership with the utility, it was decided to also include ventures that are currently not in the portfolio anymore. The results are based on publicly available information, and are therefore not anonymized.

7.3.1. Case 1: Eneco and Eneco Ventures

Since its start, Eneco Ventures has invested in a total of twelve ventures. The ventures, their activities, and the energy sector developments that can be related to these activities are presented in Table 7.11 [77]. The relevant developments are assigned based on own insights and company websites.

As can be seen in the table, investments have been made in all of the six domains, with five being related to decarbonization, eight to decentralization, ten to digitalization, four to electrification of end-use sectors, four to energy system flexibility, and ten to energy efficiency. So, with a total current and past portfolio consisting of only twelve ventures, it could be argued that Eneco Ventures has been able to invest in a variety of ventures which develop solutions that positively affect multiple domains.

One investment especially stands out, as this tackles a problem that was identified as an institutional barrier to BMI: a lack of skilled people for installation and O&M. It can be seen that through investing in Roamler, Eneco tries to increase the number of technicians that can install and service its products. So, this is a clear example in which the contribution of CVC to barriers to BMI can be directly seen in practice.

Furthermore, it can be insightful to compare the solutions developed by ventures to the list of future BM opportunities for utilities that was presented in Chapter 5, again presented for convenience [23]:

- Become a **comprehensive energy solution provider**, i.e. consulting, installation, financing, O&M, and warranties of electricity generation and heating/cooling systems for a fee
- Shift to **energy-as-a-service**, offering a monthly flat-fee service contract to customers
- Build a **platform/virtual utility model**, connecting distributed generators with customers
- Reduce cost of energy by **technology experience effects** that reduce costs of distributed VRE
- Develop **alternative customer engagement routes**, i.e. media and entertainment, home automation, building security, energy saving, and data aggregation
- Generate additional revenue with **demand response and balancing**; which will provide extra services to grid operators
- Provide grid operators with assurance of large generating capacity, leading to **capacity payments**

It can be seen that multiple of these future BM opportunities are reflected in the activities of portfolio ventures. For example, Suniverse provides a variety of energy solutions which will probably also lead to technology experience effects in distributed energy, and reflect an energy-as-a-service model. Further, Thermondo provides heating-as-a-service solutions, NEXT Kraftwerke and Enyway both operate a virtual utility model, and Peeeks, Olisto, and Simaxx provide alternative customer engagement routes respectively through home energy management, internet of things, and building management. Luminext does the same, but then for the state or municipalities (which are also customers of traditional utilities). Jedlix and Greenflux provide smart EV charging solutions for customers that simultaneously provide grid balancing opportunities. In fact, the only future BM opportunity for utilities that is not reflected in the venture portfolio is that related to large generating capacity. However, this is not a remarkable observation, as this is quite a specific domain and Eneco Ventures is a relatively small fund that seems to mainly focus on integrated solutions that capture multiple domains at the same time.

So, besides the fact that obviously many other propositions exist that relate to these new BMs in other ways, by all means it is clear that these new models are on the radar of Eneco. While this should not be interpreted as CVC being fully responsible for this fact, it provides sufficient evidence that CVC activities can contribute to providing utilities with a range of relevant and innovative BMs that might become key elements in their future proposition.

Table 7.11: Venture portfolio of Eneco Ventures. Energy sector developments: [1] = decarbonization, [2] = decentralization, [3] = digitalization, [4] = electrification of end-use sectors, [5] = increased use of flexibility measures, [6] = increased use of efficiency technologies. Information retrieved from company website [77].

Venture	**Activities**	**Develop-ments**
Suniverse / Energie in huis	"Sustainable energy systems for homeowners and housing associations; next to offering a wide variety of energy systems (e.g. PV, heatpumps, PV boilers), the company also facilitates financing constructs."	[1], [2], [4], [6]
Enyway	"Energy marketplace where green energy producers sell directly to consumers, effectively a peer-to-peer platform for green energy."	[1], [2], [3]
Greenflux	"Enabler of electric driving and smart charging, providing an electric mobility infrastructure management platform that supports the operations of charge point operators all over the world."	[3], [4], [5], [6]
Luminext	"Robust smart street lighting solutions. The company does large scale lighting installations in cities, on highways, and in rural areas. By doing so, they create a safe, comfortable and sustainable environment with less illumination."	[3], [6]
NEXT Kraftwerke	"Virtual Power Plants and energy traders. Aggregates thousands of electricity producers, consumers, and storage units. By intelligently controlling their feed-in and consumption, power and flexibility can be valorised on different markets."	[1], [2], [3], [5], [6]
Thermondo	"Heating as a service provider that sells and installs residential heating systems, but has also developed software that can monitor and optimise energy consumption at individual household levels."	[1], [2], [3], [4], [6]
ONZO	"Analytics, insight and associated services that enable energy retailers to provide engaging solutions to their residential customers. Uses raw smart meter consumption data to derive these insights from."	[2], [3], [6]
Roamler	"Crowdsourcing platform, providing a B2B that answers the call of companies for efficiency with widespread, on-demand professionals and individuals."	[2]
Olisto	"Allows to couple smart devices and smart services. Connecting to the company enriches your product by adding new capabilities."	[3], [6]
Peeeks	"Brings smart energy management into homes, essentially connecting residential energy asset information (e.g. heatpumps, batteries, wallboxes, etc.) with smart control algorithms."	[2], [3], [5], [6]
Simaxx	"Provides a smart solution that shows how to improve the building performance in terms of well-being, operational costs and energy consumption based on building management systems, light control, and all sorts of sensors."	[2], [3], [6]
Jedlix	"Electric vehicle smart charging platform for consumers. With the solution, consumer EVs automatically charge at the times that are greenest and cheapest for the energy market."	[1], [3], [4], [5], [6]

7.3.2. Case 2: ENGIE and ENGIE New Ventures

Since its start, ENGIE New Ventures has invested in a total of 25 ventures. The ventures, their activities, and the energy sector developments that can be related to these activities are presented in Table 7.12 [189]. The relevant energy sector developments are assigned based on own insights and company websites.

As can be seen in the table, investments have been made in all of the six domains, with twelve being related to decarbonization, twelve to decentralization, seventeen to digitalization, four to electrification of end-use sectors, seven to energy system flexibility, and eight to energy efficiency. So, again all energy sector developments are well represented in the venture portfolio.

In comparison with Eneco Ventures, it stands out that ENGIE New Ventures has invested in more ventures that can only be related to one or two energy sector developments. Also, it stands out that ENGIE New Ventures seems to invest in a more broad range of solutions than Eneco Ventures, whose ventures were all tightly connected to Eneco in terms of activities. In the case of ENGIE, it stands out that it has a few investments concerning Internet of Things, without a necessary direct link to energy products or services. Also, especially its investment in Please stand out, which could not be directly related to one of the power sector developments, as Please is a delivery platform for small and medium sized cities in French overseas regions. This reflects another branch of ENGIE New Ventures' target group: smart cities, without a necessary link to energy. This is for example also reflected in Streetlight Data, which is not directly offering a decarbonization-related solution, but offers high-end data analytics of urban transportation. Another example of this broader investment range is reflected in ventures as Apix, H2SITE, and HomeBiogas, all active in the green gas domain. This domain was not reflected in the portfolio of Eneco Ventures.

Furthermore, as was also the case with Eneco Ventures, ENGIE New Ventures has invested in ventures that can be directly related to the BMI barrier regarding a lack of skilled people for installation and O&M. Its investment in Serviz provides more maintenance opportunities, while its investment in Vyntelligence circumvents the lack of skilled people by providing digital solutions that increase installation and O&M efficiency. Again, these are both clear examples of the practical contribution by CVC to barriers to BMI.

Finally, it can be insightful to compare the solutions developed by ventures to the identified future BM opportunities for utilities. It can be seen that each of these opportunities is reflected in the activities of portfolio ventures. As the venture portfolio is large, only a few examples will be provided. For example, Lancey energy storage and HomeBiogas provide a variety of energy solutions which will probably also lead to technology experience effects in distributed energy; Redaptive provides efficiency-as-a-service solutions which are part of the broader energy-as-a-service proposition; Kiwi power operates a virtual utility model; Connit, ENGIE M2M, Sigfox and UnaBiz provide alternative customer engagement routes internet of things, while Powerdale provides smart energy management solutions including smart EV charging, Tendril digital customer engagement opportunities, and Gogoro e-mobility solutions; Connected Energy provides grid balancing opportunities. Also, Opus One Solutions, Airware, and Advanced Microgrid Solutions provide solutions that allow for optimal large-scale RE generation management. So, this reflects opportunities for ensuring large generating capacities that can lead to capacity payments.

So, besides the fact that obviously many other propositions exist that relate to these new BMs in other ways, by all means it is clear that all of these new models are on the radar of ENGIE. An overview of the presence of the identified future BM opportunities in the portfolio ventures of both ENGIE New Ventures and Eneco Ventures is provided in Table 7.13.

Table 7.12: Venture portfolio of ENGIE New Ventures. Energy sector developments: [1] = decarbonization, [2] = decentralization, [3] = digitalization, [4] = electrification of end-use sectors, [5] = increased use of flexibility measures, [6] = increased use of efficiency technologies. Information retrieved from company website [189].

Venture	**Activities**	**Develop-ments**
Advanced Microgrid Solutions	”Artificial intelligence-powered software that maximizes the value of renewables, batteries, and entire asset portfolios so you can deploy and use more clean energy with higher ROI”	[1], [3], [5]
Airware	”Provider of end-to-end, visual intelligence solutions that enable enterprises to capture, manage and analyze their assets and turn the collected data into valuable business insights.”	[3]
Apix	”Miniaturized and modular gas analyzers for industrial analysis and OEM (original equipment manufacturer) use”	[1]
Connected Energy	”Second life battery energy storage systems using EV batteries. Sustainable energy storage batteries to manage grid constraint and manage grid flexibility.”	[1], [2], [5]
Connit	”Integrator of IoT solutions, the company designs, develops and industrializes wireless i-connected objects, low consumption and long range.”	[3]
Energyworx	”Provides a cloud based Energy Data Management solution helping utility companies monetizing their high volumes data coming from smart meters.”	[3], [6]
ENGIE M2M	”Sigfox network operator of Belgium and provider of end-to-end IoT solutions.”	[3]
Gogoro	”Reinventing urban transportation with an ecosystem of sustainable energy solutions for the world’s modern cities.”	[1], [3], [4]
H2SITE	”Commercialize a membrane reactor based system able to produce high purity hydrogen, on customer’s premises, from various hydrogen carriers such as methane, in particular bio-methane and ammonia, etc.”	[1], [2], [5]
Heliatek	”Produces flexible, efficient and truly green organic solar films for buildings.”	[1], [2]
HomeBiogas	”Developer of an off-grid backyard (B2C) biogas appliance that transforms organic waste into clean energy and liquid fertilizer.”	[1], [2], [6]
Kiwi power	”Provides a unique combination of technology and expertise to unlock distributed energy resource (DER) value and serve sustainable energy needs.” Virtual Power Plant solution.	[1], [2], [3], [5], [6]
kWh Analytics	”Solar risk management.”	[1], [2]
Lancey energy storage	”Develops smart space heater coupled with a battery to increase comfort, energy efficiency, and provide grid services.”	[1], [2], [3], [4], [5], [6]
Opus One Solutions	”Software engineering and solutions company that helps utilities optimize energy planning, operations and market management.”	[1], [2], [3], [5], [6]
Please	”Platform business for delivery of goods and services to residential clients of small and medium sized cities.”	
Powerdale	”Develops solutions for electric mobility and energy management for businesses and individuals.”	[2], [3], [4], [5], [6]
Redaptive	”Provides end-to-end building energy efficiency integration services with no upfront cost to customers to permit organizations to accelerate efficiency upgrades.”	[3], [6]
Serviz	”Online platform for booking home repair and maintenance services.”	[2]
Sigfox	”Service provider for Internet of Things.”	[3]
Streetlight data	”Combine machine learning with deep transportation knowledge to shed light on how our streets really work — and makes data available on-demand to the people shaping today’s transportation.”	[3]
Symbio	”Designs hydrogen fuel cell kits that can be integrated into several electric vehicle formats.”	[1], [4]
Tendril	”Energy Services Management (MSE) solutions.”	[2], [3], [6]
UnaBiz	”Sigfox Network Operator and provider of low-cost connected devices.”	[3]
Vyntelligence	”Enables digital transformation of paper and form based field processes with its patented and AI powered SmartVideoNotes technology.”	[2], [3]

Table 7.13: Overview of the future BM opportunities apparent in the venture portfolios of both cases.

BM Opportunities in Venture Portfolios [23]	Eneco	ENGIE
1) Become a comprehensive energy solution provider, i.e. consulting, installation, financing, O&M, and warranties of electricity generation and heating/cooling systems for a fee	Suniverse	Lancey energy storage
2) Shift to energy-as-a-service, offering a monthly flat-fee service contract to customers	Suniverse	Redaptive
3) Build a platform/virtual utility model, connecting distributed generators with customers	Enyway, NEXT Kraftwerke	Kiwi power
4) Reduce cost of energy by technology experience effects that reduce costs of distributed VRE	Suniverse	H2SITE, Heliatek, HomeBiogas, Lancey energy storage
5) Develop alternative customer engagement routes, i.e. media and entertainment, home automation, building security, energy saving, and data aggregation	Greenflux, Jedlix, Luminext, Olisto, ONZO, Peeeks, Simaxx, Thermondo	Connit, ENGIE M2M, Gogoro, Please, Powerdale, Redaptive, Serviz, Sigfox, Streetlight data, Tendril, UnaBiz
6) Generate additional revenue with demand response and balancing; which will provide extra services to grid operators	Greenflux, Jedlix	Connected Energy
7) Provide grid operators with assurance of large generating capacity, leading to capacity payments	-	Advanced Microgrid Solutions, Airware, Opus One Solutions

All in all, it has become clear that both CVC funds provide their parent utility with a range of innovative BMs and propositions related to all six major energy sector developments. The access to these new BMs and innovative solutions can clearly contribute to remove (future) gaps in the product portfolio, as well as circumvent a lack of capabilities to build and manage new capabilities. While this should not be interpreted as CVC being fully responsible for this fact, it provides sufficient evidence that CVC activities can contribute to providing utilities with a range of relevant and innovative BMs that might become key elements in their future proposition.

So, the substantive component of the potential contribution by CVC to overcome the barriers to BMI is clearly visible in practice, which further underlines the potential benefits of CVC activities.

7.4. Comparing Literature and Case Study Insights

While a more specific comparison between case study findings and literature study findings has already been made in the previous two paragraphs, this section provides a rather generalized comparison on the major subjects of this research.

First of all, with respect to the major developments in the energy industry, no significant differences between literature, industry experts and case study insights emerged. Especially the first two of the ”Three D’s” (decarbonization, decentralization, digitalization) were widely acknowledged, but the relevance of the third D and the other three trends (electrification of end-use sectors, energy system flexibility, and energy efficiency) was also extensively confirmed. While individual interviewees put a varying extent of emphasis on certain developments during the interviews, in the survey they all acknowledged the relevance of all six trends. Also, no additional developments were identified.

The current alignment of utility BMs with the six developments however, delivered some clear differences. It was found that in the case study, the traditional utility was evaluated to be considerably better aligned with the developments (relatively; compared to other BM types) than that followed from the results of industry experts. This might indicate a bias, as all interviewees worked at a traditional utility and might therefore have an (unjustified) more positive attitude towards their own utility. On the other hand, the cooperative utility was found to be badly aligned with almost all developments in the case study, while the industry experts were significantly more positive about this BM. As this cannot be easily explained through a certain bias, this is something that remains rather unclear, and could be further assessed in future research. However, the case study insights led to a similar conclusion on the need for fundamental business model innovation for traditional utilities, similar to what emerged from literature.

The extent to which the barriers to BMI were found to be relevant was divergent, but most of the barriers were recognized by at least one interviewee, which confirms literature insights. On the other hand, three barriers that emerged from literature insights were not recognized at all. These were a *lack of knowledge and information by utilities about markets for RE and potential customers*, *lack of standard procedures for grid connection*, and *metering issues*. The lack of acknowledgement of all three barriers can be explained by the fact that the energy sector is rapidly developing, and certain barriers that might have been relevant in the past are nowadays not relevant anymore. This was also confirmed by the more specific nature of these three barriers, addressing barriers that refer to early stages of the energy transition.

Furthermore, one of the interviewees proposed a few additional barriers in the survey. However, according to author, all of these can be classified as being part of one of the barriers that are already in the list, or present another sub-classification. For example, market readiness was proposed as another financial and profitability barrier, but according to author this can be seen as one of the causes for profitability problems. Therefore, this will be included in the description of profitability problems. Secondly, the relevance of a lack of incentives for customers was highlighted, who consequently miss the general belief that they would benefit from investing in certain solutions. However, according to author this is already reflected in misplaced incentives and a lack of customer demand, which when combined lead to this observation. Finally, resistance from incumbent players, especially DSOs, was identified as additional barrier. However, it is expected that this resistance occurs in the form of a fear for grid management issues, which were already captured in a limited grid capacity and system performance risks. Therefore, there would be too much overlap if this would be included as a separate barrier.

So, in line with the exploratory nature of this research, it is chosen to only discard the three barriers that were not recognized by any interviewee. This research assesses European traditional utilities as a whole, and therefore it was found to be inappropriate to also discard barriers that were only recognized by one utility. As such, we end up with a final list of 28 barriers that hinder European traditional utilities in BMI and better aligned with the energy sector developments. However, for clarity purposes the numbering of barriers will remain the same as how it was presented in Tables 7.7 and 5.1.

With respect to the potential benefits of CVC activities, some differences between case study and literature emerged. First of all, the interviewees were much more united about the relevance of CVC benefits than was the case with BMI barriers. This could be due to the fact that CVC activities are found in a rather comparable form in a range of different industries, and CVC in the energy sector was not found to be significantly different than CVC in other sectors. Also, the benefits that CVC activities can deliver to a company are dependent on the approach and strategy of the CVC unit, as each company can have a different investment angle. In industries undergoing rapid change, it emerged from literature that CVC is often more strategically oriented, which was confirmed in the case study. As a result, ten potential benefits that appeared in literature were not acknowledged. These included *improve manufacturing processes*, the three indirect learning benefits *train junior management*, *learn about VC in general*, and *improve internal venturing*, as well as all four of the leveraging own technologies and platforms benefits *increase demand for technology and products*, *shape markets*, *steer standard development*, and *support development of new applications for products.* Finally, this also included *identify and assess potential acquisition targets* and *utilize excess plant space, time, and people*.

So, it can be seen that interviewees mainly acknowledged the benefits of CVC activities that are more strategic, and these less strategic ones were not recognized to be important. As the overview of potential benefits of CVC activities that followed from literature was not tailored to electric utilities, due to the academic knowledge gap in this area, it was decided to discard the ten CVC benefits that were not recognized at all. Here, it is assumed that the insights obtained through the case study provide more reliable results than the too general literature.

Finally, not all potential contributing effects of CVC activities to removal or circumvention of BMI barriers became visible. This is mainly due to the discarding of BMI barriers and CVC benefits. Many of the other previously identified possible relations were acknowledged, except for two. An overview of the differences is provided in Table 7.14. Here, the relations that have been confirmed in the case study are presented in bold. It must be noted that the descriptions of these bold relations have been adapted to the findings of the case study, as was previously presented in Table 7.10.

Table 7.14: Literature and Case Study comparison of contribution by CVC benefits to remove or circumvent barriers to BMI of electric utilities. Bold = confirmed in case study, italic = emerged in case study.

CVC Benefits (C)	Potential effect on BMI Barriers (B)
1. Financial gains	10. Profitability problems of certain BMIs could be decreased as high costs and small project sizes would be less of a problem
2. Identification of, monitoring of, and exposure to new technologies, markets, and business models	1. **Lack of competencies to build and manage new capabilities due to cognitive barriers could be reduced as management level is provided with a better overview of potential new business opportunities and active discussions about these subjects** 4. **Search-related barriers could be reduced as increased exposure to new markets and BMs could provide guidance to the search** 9. **Short-term focus of management could be reduced because they are forced to take positions on technologies and BMs which are long-term oriented** 15. Lack of knowledge about markets for RE and potential customers by utilities could be reduced as a result of increased market insights
3. External R&D	6. **Lengthy BM innovation processes could be circumvented as external know-how and competencies which would take too long to develop internally are brought into the company** 10. **Profitability problems could be reduced as external know-how and competencies which would be too expensive to develop internally are brought into the company**
5. Learn about specific market or technology pitfalls	4. Search-related barriers could be reduced as a result of a more thorough market and technology overview 10. **Profitability problems of new business models and technologies could be circumvented as utilities can learn from the pitfalls experienced by ventures**
6. Change corporate culture: promote entrepreneurship	7. **Non-supportive organizational design, culture, and structure effects could be reduced as bringing the external environment to the company can trigger and move people to think differently, thereby improving an entrepreneurial culture** 8. **Non-supportive human capital effects might be reduced because direct collaboration of employees with dynamic startups can change their mindset**

7. Train junior management	1. Lack of competencies to build and manage new capabilities could be circumvented in the future by early training of junior management through intensive collaboration with ventures
11. Identify and assess potential acquisition targets	2. Gaps in the product and service portfolio could be reduced by simply acquiring ventures that offer the needed products or services 3. Conflicts with existing assets and BMs could be decreased when an acquired company would operate with a certain degree of autonomy 6. Lengthy innovation processes could be circumvented as a result of acquisitions 25. Lack of skilled people for installation, O&M, etc. could be reduced if an installation company would be acquired
12. Accelerated market entry	6. **Lengthy BM innovation processes could be reduced as the development of a market or development of market reach could be speeded up, and agility could be increased**
13. Option to expand business	1. *Lack of competencies to build and manage new capabilities could be circumvented, as new BMs and capabilities are developed externally and the utility will have the (future) opportunity to expand its business with these activities* 2. **Gaps in the product and service portfolio (in the future) could be circumvented as a result of new business creation with new activities, which could not have been easily developed internally** 4. **Search-related barriers could be reduced as different available options for future business expansion can provide a guidance to the complex search process and provide inspiration for BM innovations** 9. **Short-term focus effect could be circumvented as the options for future business expansion with external BMs and capabilities would be available (ambiguous effect)**
14. Access and exploit new or complementary BMs, technologies, and services	2. **Gaps in the product and service portfolio could be circumvented as a result of exploiting external complementary products and services** 3. **Conflicts with existing assets and BMs could be reduced as this would be a way to have a foot in, but without the drawback that it will disrupt own activities** 6. **Lengthy BM innovation processes could be circumvented as the need for internal development of these BMs or technologies would be removed** 13. **Lack of customer demand in certain areas could be reduced as accessing and exploiting specific solutions that identify customer behaviour can be used to experiment with new, tailored propositions to customers** 25. **Lack of skilled people for installation, O&M, etc. could be reduced as installation-related solutions can be exploited for diffusion of own propositions**
15. Increase demand for technology and products	13. Lack of customer demand could be reduced if demand for own technology and products would be increased

18. Support development of new applications for products	2. Gaps in the product and service portfolio could be reduced as new applications for products or services could help to fill these gaps 13. Lack of customer demand could be reduced if solutions would be wider applicable, thereby increasing customer attractiveness
19. Add new products to existing distribution channels	3. Conflicts with existing assets and BMs could be reduced as cost benefits and increased synergies would be achieved as a result of more efficient use of existing distribution channels
• Acceleration	• *BMI in general could be accelerated because of the limited time frame of CVC activities and the creation of internal friction by CVC activities, which increases awareness and acceleration*

As can be seen in the table, seventeen of the identified potential relations in Chapter 6 were acknowledged, and one additional relation emerged. Also, a more general accelerating effect of CVC on BMI was identified. The financial gains were found to be important, but not sufficiently important to help overcome a barrier to BMI. Again, as the case study on this subject addresses a gap in literature, it was decided to discard the relations that were not acknowledged during the case study. So, we end up with eighteen different relations, in which seven CVC benefits affect eleven BMI barriers.

The substantive component of BMI (reflected in the two substantive barriers) and the contribution to this by CVC was further assessed in a venture portfolio analysis. The results indicated that each of the venture portfolios provide utilities with a range of innovative BMs and propositions, that correspond to the future BM opportunities for utilities that followed from literature. As such, this is another confirmation that the potential contribution of CVC activities to BMI of traditional utilities can be found in practice.

All in all, it can be concluded that the case study resulted in a clear illustration and concretization of the findings that emerged from literature. Both literature and case study insights confirm that CVC can be a highly useful instrument to contribute to BMI. On the other hand, multiple subtle differences were found between the more general insights that followed from literature, and specific insights for traditional utilities that followed from the case study. Combined, this has led to a specific, tailored insight on the potential contribution of CVC activities to incumbent utilities to overcome barriers to BMI and better align with the energy sector developments.

The outcomes of these combined insights can be clearly represented in a conceptual framework, which is presented in the following section.

7.5. Conceptual Framework: Potential Effect of CVC on BMI for Electric Utilities

Now all results have been gathered, they can be combined and translated into a conceptual model that describes the potential contribution of CVC activities to BMI of incumbent traditional utilities. While all individual relations between CVC benefits and BMI barriers have just been presented in Table 7.14, for clarity purposes all relevant barriers to BMI for utilities (so also the ones that cannot be affected by CVC) are presented in a slightly different manner. In this way, combined with Table 7.14, the conceptual model can be well understood. As such, the 28 relevant barriers to BMI are presented in Table 7.15. In this table, their relevance for specific energy sector developments is indicated. As mentioned before, the numbering of barriers is kept the same as before to avoid misunderstandings.

Now all elements are present, the conceptual framework can be presented, which is showed in Figure 7.2. As can be seen in the figure, the model has the same outline as the final graphical chapter summary that was presented in Chapter 6. However, its outline is adapted to the final results of this research, as described in the previous section.

The models is built up in several steps, each reflecting an important subject in the research. First of all, it can be seen that the six edges of the spider web figure each represent a specific energy sector development, as were identified in literature and confirmed in the case study. Secondly, the current rate of adaptation of the Traditional Utility BM with each development is shown. This score is based on the case study results, as was discussed before. Thirdly, the model reflects the barriers to BMI of traditional utilities. The generic barriers to BMI are presented in a red hexagon shape in the core of the figure, and hinder all BMIs in general. The numbers inside it refer to the numbering in Table 7.15.

In addition, the specific barriers that hinder BMI of traditional utilities in specific areas related to the energy sector developments are presented as red circles. In line with their nature, they are presented in the specific areas in which they are relevant. Hereby, it is again referred to Table 7.15 for both their numbering and their relevance for certain energy sector developments. As such, it stands out that many of these specific barriers appear in more than one energy sector developments. The larger red circles with different numbers inside them reflect a collection of different specific barriers that are not presented separately for clarity purposes.

Furthermore, all CVC benefits are included as green squares. The numbers inside these squares refer to the numbers of CVC benefits, as presented in Table 7.14. The position of these CVC benefits is not random. In fact, it stands out that it can overlap with (multiple) barriers to BMI. In case an overlap is visible, this indicates that the specific CVC benefit can help to remove or circumvent the specific BMI barrier. This is based on the identified relations between these factors, as described in Table 7.14. Hereby, it can occur that multiple BMI barriers are affected by one CVC benefit, or multiple CVC benefits affect one BMI barrier. Furthermore, one additional element is shown. This green hexagon at the core of the figure represents the accelerating effect of CVC on BMI. Finally, it must be noted that the four CVC benefits that could not be related to specific BMI barriers are not shown in the figure. This is because the figure exclusively depicts the potential contribution of CVC to BMI of traditional utilities.

So, with this conceptual framework, the potential contribution of CVC activities to BMI of incumbent, traditional utilities has been graphically described, simultaneously summarizing the results of this research. In the next chapter, an answer to all research questions will be formulated.

Table 7.15: Potential barriers to BMI of incumbent, traditional utilities, related to energy sector developments. DCB = decarbonization, DCN = decentralization, DIG = digitalization, ELC = electrification of end-use sectors, FLX = energy system flexibility, EFF = energy efficiency, GNR = generic. X = relevant.

Barriers to BMI for Traditional Utilities	**DCB**	**DCN**	**DIG**	**ELC**	**FLX**	**EFF**	**GNR**
1. Lack of competencies to build and manage new capabilities due to cognitive barriers (managers failing to recognize business opportunities) and the inability to allocate sufficient resources to new technologies	X	X	X	X	X	X	
2. Gaps in the product and service portfolio	X	X	X	X	X	X	
3. Conflicts with existing assets and business models							X
4. Search-related barriers (where, what, how to innovate) due to complexity of BMI							X
5. Lack of customer-focused orientation, leading to a missing logic of how to reach them in the BMIs themselves							X
6. Lengthy innovation processes							X
7. Non-supportive organizational values, culture, and design							X
8. Non-supportive human capital, skills, and psychology							X
9. Short-term focus, i.e. mainly focusing on maximizing shareholder value							X
10. Profitability problems for utilities in certain markets due to high costs, small project sizes, and high additional costs (i.e. O&M, transaction costs for grid interconnection, and high cost of batteries) **or market readiness**	X	X		X	X	X	
11. High initial investment costs for customers, lowering demand and thus lowering market attractiveness for utilities	X	X				X	
12. Misinformation or lack of knowledge about benefits of RE technologies by customers leading to lower customer awareness and acceptance		X	X	X		X	
13. Lack of customer demand in certain areas, blocking the justification of utility BM development in these fields		X		X	X	X	
14. Behavioural barriers and concerns (risk-aversion, customers unresponsive to novelty, etc.) limiting market potential for new utility activities		X			X	X	
16. Shortcomings of legal framework (inconsistency, incompleteness, immaturity) hindering utility activity in certain areas		X		X	X	X	
17. Issues about feed-in tariffs and taxation, limiting interest for novel utility BMs	X	X			X		
18. Low electricity price, limiting customer interest and demand for new utility BMs		X				X	
19. Unpredictable regulations leading to lack of long-term planning reliability	X	X		X	X	X	
20. Misplaced incentives leading to uncertain development cycles for utilities	X	X			X		
21. Privacy and internet security law limiting digital BMIs		X	X			X	
22. Competition law and consumer protection, limiting BM acquisition opportunities or profitability of certain BMIs		X		X		X	
23. Resistance from informal social institutions (e.g. on nuclear, biomass), blocking certain BMIs	X						
24. Generalized trust, which if lacking can limit partnering opportunities							X
25. Lack of skilled people for installation, O&M, etc. limiting new BM activities	X	X	X		X	X	
26. Limited grid capacity, constraining new RE integration and thus limiting utility BMI activity in this area	X	X		X			
27. System performance risks, constraining new RE integration and requiring innovative flexibility enhancing BMIs	X	X		X	X		
28. Strong competition of RE technologies with existing technologies, posing limitations to some applications of RE and thus BMIs in these areas	X	X		X	X	X	
29. Risk of customer comfort reduction, limiting the market potential for certain BMIs		X		X		X	

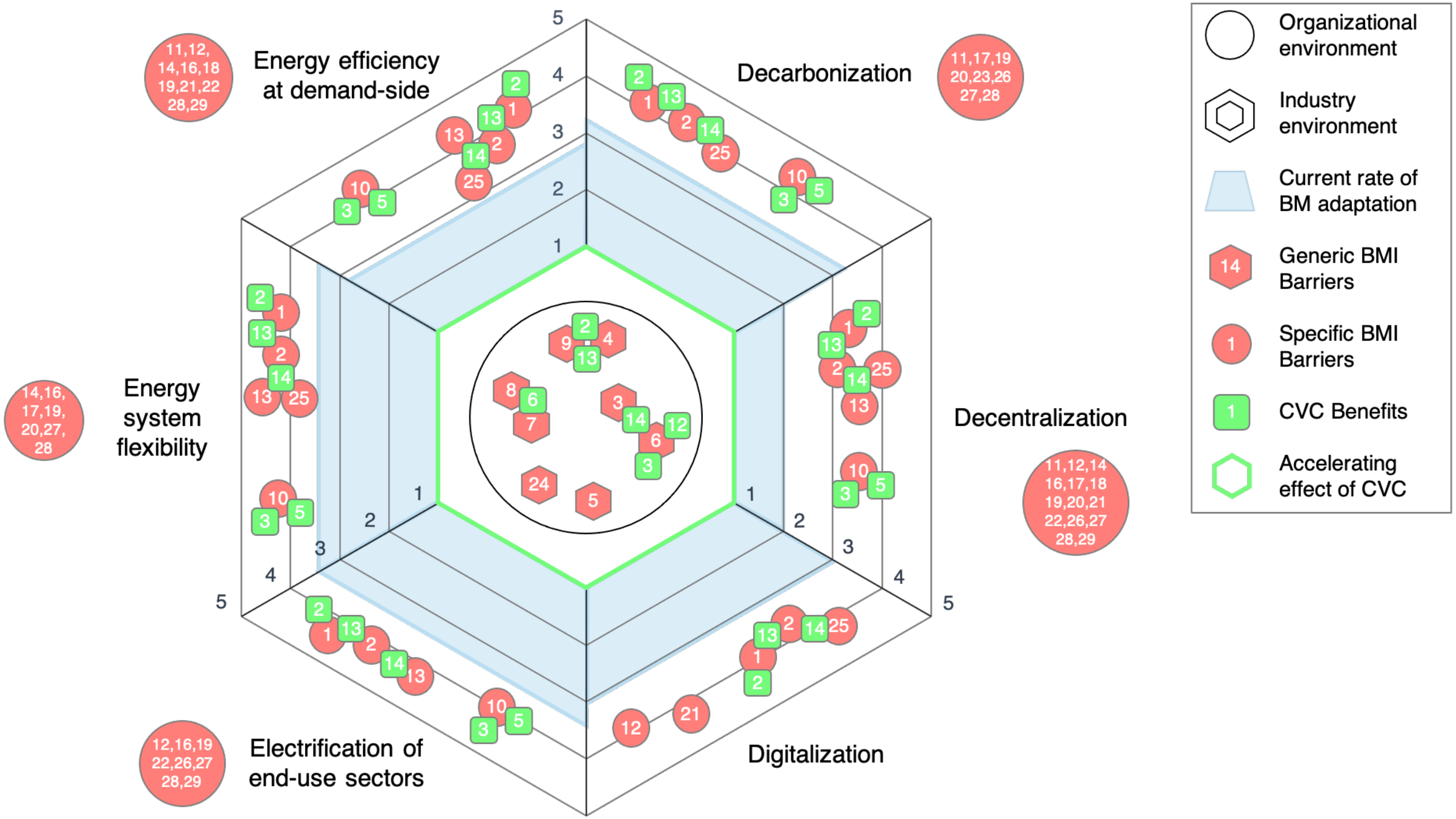


Figure 7.2: Conceptual Framework representing the potential contribution of Corporate Venture Capital activities to Business Model Innovation of traditional electric utilities. The framework must be read together with Tables 7.14 and 7.15. Own illustration.

7.6. Chapter Summary

The goal of this seventh chapter was to obtain a thorough understanding of the extent to which the potential contribution of CVC to BMI can be found in utility practice. An extensive case study on two European incumbent utilities has been performed, which has led to sufficient insights to answer the fifth sub research question of this thesis:

To what extent can the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments be seen in practice?

The six identified major developments in the energy sector that emerged from literature are clearly visible in practice as well. Each of the six developments (decarbonization, decentralization, digitalization, electrification of end-use sectors, energy system flexibility, energy efficiency) was acknowledged as being relevant, and no additional developments became visible. On the other hand, the extent to which the four utility BMs are currently adapted to all developments delivered some clear differences with the previously obtained insights from literature and industry experts. Especially the cooperative and traditional BM stood out. Where the cooperative BM was evaluated to be much worse adapted to two developments than was the case according to industry experts, the traditional, incumbent utility was evaluated to be relatively better adapted (so compared to other BM types); not absolutely) to the developments than that followed from industry experts. Nevertheless, all interviewees still agreed on the need for fundamental BMI for traditional utilities in order to be able to better adapt to all energy sector developments. So, a confirmation of the literature on this subject.

Also, it was recognized that this BMI is a highly complex process subject to many potential barriers. While significant variability in the recognition of potential barriers was found, almost all barriers to BMI that followed from literature were confirmed by at least one interviewee. Three barriers were not recognized at all, which could all be related to the fact that the energy sector developments have surpassed their early stages, and therefore these barriers are not being active obstacles anymore. What remained is a list of 28 barriers to BMI of traditional utilities that have all been found to be relevant, although to a varying extent.

Moving on to CVC activities of traditional utilities, all interviewees agreed upon the added value of CVC to help them realize the demanded BMI. With respect to the specific benefits of these activities, the results were considerably less divergent than was the case with the barriers to BMI. Of the eleven acknowledged benefits, nine were acknowledged by at least half of the interviewees. Most important was found to be the exposure to new technologies, markets, and business models. On the other hand, ten of the potential benefits of CVC that emerged from literature were not recognized at all, so there is a significant difference. However, this can be explained by the fact that utilities see CVC as a highly strategic instrument that captures (parts of) the external domain of their BM innovation strategy. As such, they are not much interested in the more internally oriented benefits that CVC can deliver.

With respect to the contribution of individual CVC benefits to overcome BMI barriers, it became clear that seventeen of the identified potential relations were recognized, one additional relation emerged, and a more general accelerating effect of CVC on BMI was found as well. However, not all potential contributions were recognized, which could be related to the fact that not all benefits and barriers were found to be relevant, as well as some, less important contributions have not been explicitly discussed during the interviews.

To assess the more substantive component of BMI that has been captured in the barriers 'gaps in the product and service portfolio' and 'lack of competencies to build and manage new capabilities', an analysis of the venture portfolios of both CVC funds was performed. It turned out that in both cases, the portfolios reflect a range of innovative BMs that relate to all six of the energy sector developments and correspond to the different future BM opportunities for utilities that emerged from literature. Therefore, the potential contribution of CVC to overcome these more substantive barriers to BMI can be clearly seen in practice.

So, it can be concluded that several subtle differences between literature and practice can be observed, however both confirm the strategic relevance of CVC as one of the instruments for utilities to realize BMI.

8 Conclusion

Now all results of this research have been presented, the five sub research questions can be answered. This will be done in sections 8.1 through 8.5. Finally, with answers to the different sub questions, an answer to the main research question of this thesis can be formulated. This is presented in section 8.6.

8.1. What are the currently existing types of business models for electric utilities?

Utilities are a part of the larger electricity value chain, consisting of generation, transmission, distribution, retailing, and consumption. Their activities can span from either one segment to across the entire value chain. Traditionally, the flow of power and money were one-way: power flowing from generation to consumption, and money flowing the other way around. This results in a straightforward business model for an electric utility: the *Traditional Utility* business model. Basically, this model is based on the bulk supply of reliable, efficient, and low-cost electricity, gas, and heat, mainly produced by fossil fuels.

However, the energy transition posed some serious threats to this classical model, among others due to increasing amounts of renewable energy, a shift towards decentralized electricity generation, and digitalization. As a result, during the past decade multiple new business models for utilities have been emerging. The first one is the *Green Utility* BM, which is characterized by a quite comparable model as traditional utilities, except their offered electricity is completely generated by Renewable Energy Sources (RES). The second emerging BM is the *Cooperative Utility*. In a cooperative, each customer is also shareholder, and all shareholders have the same voting power. Cooperative utilities focus on providing renewable energy to their community members in a low- or non-profit way. In case of profit, it is used to support the local community. Finally, the third emerging BM is the *Prosumer Utility*. This model is built around the provision of (smart) storage equipment to customers, while also encouraging them to install self-generation assets. In that way, prosumer utilities aim at building a virtual capacity base (Virtual Power Plant (VPP)), in which customers can trade energy with each other (P2P trading). This VPP aggregates all distributed generation and storage resources into one virtual facility that enables a local energy sharing community. So, basically seen, a prosumer utility still delivers (renewable and local) electricity to its end-consumers, but in a completely different, digital, way.

So, it can be concluded that currently four types of business models for electric utilities exist. Of these four types, the prosumer utility model seems to be the most innovative.

8.2. What are the major developments in the energy sector and to what extent are current electric utility business models adapted to these developments?

The energy sector is in the middle of profound change in multiple areas. In that respect, six major developments emerged that all have a major effect on the electric power industry. The first one is *decarbonization*, also known as the energy transition, which implies replacing fossil fuels with renewable, clean energy sources. Secondly, *decentralization* of energy generation and management is happening. This includes an increase in the use of Distributed Energy Resources as local battery storage, EVs, and other (smart) resources. The latter already implies the third major trend: *digitalization*. The power sector is shifting towards a smart energy system in which the use of digital technologies must lead to more optimal energy management, for example through smart homes and smart EV charging systems. Fourthly, *electrification of end-use sectors* is happening, for example in heat and mobility. This also affects the power sector, as this means an increase in electricity demand and electric (digital) technologies as EV charging infrastructure. Furthermore, in response to challenges resulting from the variable nature of RES, we see *increased use of energy system flexibility measures*, for example more interconnections with power grids of neighboring countries and use of centralized and decentralized energy storage options. Finally, there is *increased use of energy efficiency technologies*, which mainly focuses on the consumption side of the power system. This implies Demand-Side Management through a range of behind-the-meter options, including smart homes and Demand Response.

None of the four utility BMs is sufficiently adapted to all developments, and their rate of adaptation varies heavily across different developments. Especially traditional utilities seem to be insufficiently adapted, as they had the lowest score compared to other utility types on four of the six developments, the lowest of which were on increased use of energy efficiency and decentralization. So, it can be concluded that each of the utility types, but especially traditional utilities, are insufficiently adapted to the identified power sector developments, which results in a need for fundamental BM innovation.

8.3. What are the barriers to Business Model Innovation of traditional electric utilities in order to adapt to the energy sector developments?

Business Model Innovation is a highly complex process that is subject to many potential barriers. Barriers to Business Model Innovation can be divided into five categories, and can be either described as generic barriers to BMI – independent from sector or company activities – or can be directly linked to one or multiple of the identified power sector developments. First of all, the *organizational and company resource barriers* mainly include generic barriers. The most widely acknowledged is the lack of competencies to build and manage new capabilities, due to cognitive barriers or insufficient resource allocation to new technologies. Also, together with gaps in the product and service portfolio, this barrier forms the highly important substantive component of BMI. Besides these two, other barriers can include conflicts with existing assets and business models, a non-supportive organizational culture, design, and human capital, and a short-term focus (i.e. on maximizing shareholder value). The remaining four categories mostly include specific barriers for BMI utilities in the domains of the energy sector developments. *Financial and profitability barriers* can refer to high initial investment costs for customers or profitability problems for utilities in certain domains. *Awareness and behavioural barriers* mainly include misinformation and poor knowledge about benefits of renewable energy technologies by customers, a general lack of customer demand, or behavioural barriers and concerns (customers unresponsive to novelty in general). *Regulatory and institutional barriers* can range from general shortcomings of the legal framework and unpredictable regulations, to misplaced incentives, issues about feed-in tariffs and taxation, and privacy and internet security law. Also, a lack of skilled people for installation and O&M seems to limit the development and diffusion of new BM activities of utilities. Finally, *technological barriers* can refer to the limited grid capacity and system performance risks due to the variable nature of RES, but i.e. also to strong competition of new technologies with existing technologies.

So, on the road to business model innovation and better adaptation to the energy sector developments, traditional utilities will have to tackle many potential barriers.

8.4. What is the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments?

Corporate Venture Capital is one of the instruments which is increasingly seen as an important means for stimulating business model innovation of traditional, incumbent utilities. Therefore, CVC often has a mainly strategic rationale and can deliver many different potential benefits. Besides the fact that CVC can lead to financial gains, the strategic benefits are dominant. These benefits can be classified into *market-level learning*, *venture-specific learning*, *indirect learning*, *options to acquire companies*, *options to enter new markets*, *options to exploit external BM innovations*, *leveraging own technologies and platforms*, *leveraging own complementary resources*, and *branding*. It seems that many of these potential benefits of CVC could contribute to removal or circumvention of barriers to BMI and better adaptation of traditional utilities to the energy sector developments.

One of the most eminent examples is that the exposure to new technologies, markets, and BMs could help utilities to remove the lack of competencies to build and manage new capabilities, as increased exposure might clarify new business opportunities and positively affect sufficient resource allocation. Also, it could help reduce a short-term focus as utility management could scrutinize the need for BMI as a result of better market overview and identification of potential future competitive threats. Further, the promotion of entrepreneurship in the corporate culture could reduce a non-supportive organizational culture with respect to BM innovation, and the collaboration between employees and dynamic startups might reduce non-supportive human capital. Other relationships can be found in the options building benefits of CVC, as accelerated market entry could reduce lengthy BM innovation processes, and options for future business expansion can circumvent future gaps in the product and service portfolio, as different potential viable options would be on the table. Also, being able to access and exploit external BMs, technologies, and services can reduce conflicts with existing assets and BMs, as these external BMs and technologies would not experience the tensions that emerge between two internal competing BMs or solutions. Besides these, many other potential relations emerged. Although increasing utility attractiveness in general, branding related benefits could not be directly related to BMI.

So, in the BMI journey of incumbent utilities, CVC activities have diverging range of potential benefits that can contribute to remove or circumvent many identified barriers to BMI. In that respect, the potential contribution of CVC is estimated to be significant.

8.5. To what extent can the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments be seen in practice?

First of all, each of the six identified major developments in the energy sector (decarbonization, decentralization, digitalization, electrification of end-use sectors, energy system flexibility, energy efficiency) is clearly visible in practice. Although the traditional, incumbent utility was overall evaluated to be relatively (significantly) better adapted to the developments than that previously followed from the two external industry experts, the need for fundamental BMI for traditional utilities was clearly recognized. This BMI is found to be a highly complex process subject to many potential barriers. While subject to significant variability, all but three of the potential barriers to BMI were confirmed, leading to a list of 28 relevant barriers to BMI of traditional utilities. Moving on to CVC activities of traditional utilities, it stood out that the added value of CVC to help utilities realize the demanded BMI is well recognized in practice. Of the 21 potential benefits of CVC, eleven were acknowledged to be relevant. Most important was found to be the exposure to new technologies, markets, and business models.

With respect to the contribution of individual CVC benefits to overcome BMI barriers, it became clear that many of the earlier identified potential ways are recognized in practice. It seems that seven of the eleven relevant benefits of CVC activities can contribute to remove or circumvent a total of eleven barriers to BMI of traditional utilities, in a total of eighteen individual relationships. Not all possible contributions that emerged from literature insights were recognized, due to the fact that not all benefits and barriers were found to be relevant, and less explicit or less important relations have not become visible. The potential of CVC activities to overcome the two barriers to BMI that reflect the substantive component was confirmed as well. As such, it turns out that in both cases, the CVC venture portfolios reflect a range of innovative BMs that relate to all six of the energy sector developments and correspond to different future BM opportunities for utilities that emerged from literature.

So, several subtle differences between literature and practice can be observed, but the potential contribution of CVC for traditional utilities to remove or circumvent the barriers to BMI and adapt to the energy sector developments is clearly seen in practice. An overview of this is provided in Table 8.1.

Table 8.1: Potential contribution by CVC benefits to remove or circumvent barriers to BMI of traditional electric utilities.

CVC Benefits (C)	Potential effect on BMI Barriers (B)
2. Identification of, monitoring of, and exposure to new technologies, markets, and business models	1. Lack of competencies to build and manage new capabilities due to cognitive barriers could be reduced as management level is provided with a better overview of potential new business opportunities and active discussions about these subjects 4. Search-related barriers could be reduced as increased exposure to new markets and BMs could provide guidance to the search 9. Short-term focus of management could be reduced because they are forced to take positions on technologies and BMs which are long-term oriented
3. External R&D	6. Lengthy BM innovation processes could be circumvented as external know-how and competencies which would take too long to develop internally are brought into the company 10. Profitability problems could be reduced as external know-how and competencies which would be too expensive to develop internally are brought into the company
5. Learn about specific market or technology pitfalls	10. Profitability problems of new business models and technologies could be circumvented as utilities can learn from the pitfalls experienced by ventures
6. Change corporate culture: promote entrepreneurship	7. Non-supportive organizational design, culture, and structure effects could be reduced as bringing the external environment to the company can trigger and move people to think differently, thereby improving an entrepreneurial culture 8. Non-supportive human capital effects might be reduced because direct collaboration of employees with dynamic startups can change their mindset
12. Accelerated market entry	6. Lengthy BM innovation processes could be reduced as the development of a market or development of market reach could be speeded up, and agility could be increased
13. Option to expand business	1. Lack of competencies to build and manage new capabilities could be circumvented, as new BMs and capabilities are are developed externally and the utility will have the (future) opportunity to expand its business with these activities 2. Gaps in the product and service portfolio (in the future) could be circumvented as a result of new business creation with new activities, which could not have been easily developed internally 4. Search-related barriers could be circumvented as a result of different available options to expand the business with different innovative BMs (not explicitly acknowledged) 9. Short-term focus effect could be circumvented as the options for future business expansion with external BMs and capabilities would be available (ambiguous effect)

14. Access and exploit new or complementary BMs, technologies, and services	2. Gaps in the product and service portfolio could be circumvented as a result of exploiting external complementary products and services 3. Conflicts with existing assets and BMs could be reduced as this would be a way to have both a foot in, without the drawback that it will disrupt own activities 6. Lengthy BM innovation processes could be circumvented as the need for internal development of these BMs or technologies would be removed 13. Lack of customer demand in certain areas could be reduced as accessing and exploiting specific solutions that identify customer behaviour can be used to experiment with new, tailored propositions to customers 25. Lack of skilled people for installation, O&M, etc. could be reduced as installation-related solutions can be exploited for diffusing own propositions
• Acceleration	• BMI in general could be accelerated because of the limited time frame of CVC activities and the creation of internal friction by CVC activities, which increases awareness and acceleration

By combining the answers to the five sub research questions of this thesis, the main research question can be answered. In that respect, it is insightful to provide an overview of the answers to each sub question, which is presented in Table 8.2.

Table 8.2: Overview of answers to the five sub research questions of this thesis.

Sub Research Question	**Methods**	**Answer**
1. What are the currently existing types of business models for electric utilities?	Literature study & expert consultations	Currently, four types of business models for electric utilities exist: the Traditional Utility, the Green Utility, the Cooperative Utility, and the Prosumer Utility.
2. What are the major developments in the energy sector and to what extent are current electric utility business models adapted to these developments?	Literature study & expert consultations	The major developments in the energy sector are decarbonization, decentralization, digitalization, electrification of end-use sectors, energy system flexibility measures, and energy efficiency. None of the four types of business models is fully adapted to these developments, and the Traditional Utility is least adapted.
3. What are the barriers to Business Model Innovation of traditional electric utilities in order to adapt to the energy sector developments?	Literature study & expert consultations	The barriers to Business Model Innovation of electric utilities include both generic barriers that hinder all BM innovations in general, and specific barriers that hinder BMI of electric utilities in specific areas related to the energy sector developments. Five categories of barriers exist: organizational and company resource barriers, financial and profitability barriers, awareness and behavioural barriers, regulatory and institutional barriers, and technological barriers.

4. What is the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments?	Literature study & expert consultations	Corporate Venture Capital activities can deliver a wide range of benefits that can be classified as financial objectives, market-level learning, venture-specific learning, options to acquire companies, options to enter new markets, options to exploit external BM innovations, leveraging own technologies and platforms, leveraging own complementary resources, and branding. Many benefits can contribute to remove or circumvent barriers to BMI of electric utilities, so its potential is significant. However, also many, more external barriers remain that cannot be positively affected by CVC.
5. To what extent can the potential contribution of Corporate Venture Capital for traditional electric utilities to remove or circumvent the barriers to Business Model Innovation and adapt to the energy sector developments be seen in practice?	Desk research & expert interviews	In utility practice, the potential of Corporate Venture Capital activities to stimulate Business Model Innovation is well recognized. Although multiple subtle differences with the theoretical outcomes can be observed, the potential contribution of CVC for electric utilities to remove or circumvent the barriers to BMI and adapt to the energy sector developments is clearly seen in practice. Nevertheless, also many barriers to BMI remain unaffected by CVC.

8.6. How can Corporate Venture Capital contribute to Business Model Innovation of electric utilities in response to the developments in the energy sector?

Now each of the five sub research questions have been answered, an answer to the main research question of this thesis can be provided. First of all, it is important to stretch that the contribution of Corporate Venture Capital to Business Model Innovation of electric utilities (in Europe) is limited to traditional utilities. The cause for this is obvious: this is the only utility type that pursues CVC activities. This can be mainly related to their large size and incumbent nature, which on the one hand enables the possibility to engage in these capital-intensive activities, and on the other hand lead to a higher need to pursue these activities as incumbent players often struggle to come up timely, with the right BM innovations.

This need for BM innovation for traditional utilities stems from six major developments that are rapidly and fundamentally changing the energy sector, which used to be a static and stable industry. As a result of these changes, new market entrants have seen valuable opportunities to conquer the energy market and challenge the existence of traditional utilities. As it turns out that traditional utilities are not sufficiently adapted to all developments, they will have to come up with a more effective response, which leads to a need for fundamental BMI. The traditional BM has been subject to decreasing profitability, and a wide range of new BM opportunities have been identified that utilities can pursue. However, BMI is a highly complex process, including many potential barriers that will have to be tackled in order to allow for an adequate response to all developments. These barriers include both generic barriers that hinder all BM innovations in general, and specific barriers that hinder BMI of electric utilities in specific areas related to the energy sector developments. Moreover, five different categories of barriers exist: organizational and company resource barriers, financial and profitability barriers, awareness and behavioural barriers, regulatory and institutional barriers, and technological barriers. Also, the barriers can be both internal and external. In total, 31 potential barriers emerged, of which 28 seem to be, to a varying extent, relevant for traditional utilities in practice.

To tackle these barriers to BMI, traditional utilities make use of a range of both internal and external instruments. External collaboration with startups and scale-ups is identified as an essential element of the BMI strategy of incumbent utilities. Corporate Venture Capital is one of those instruments, and has been rapidly gaining ground during the past years. CVC programs can be financially or strategically oriented, but for traditional utilities a strategic rationale is both most appropriate and most commonly found. Nevertheless, also with this strategic rationale CVC activities must still deliver some financial gains. Besides this, there exist a total of twenty strategic benefits that can follow from CVC activities. These can be divided into market-level learning, venture-specific learning, options to acquire companies, options to enter new markets, options to exploit external BM innovations, leveraging own technologies and platforms, leveraging own complementary resources, and branding. As these benefits are quite divergent, it is not remarkable that their relevance will depend on the specific rationale behind the CVC activities. As such, it seems that for traditional utilities, with a strategic rationale for CVC as an important instrument to stimulate BMI, only eleven of these potential benefits are relevant. These are the more strategic benefits, for example related to learning and options building. On the contrary, traditional utilities seem to be not really interested in leveraging related benefits.

When integrating both subjects, it seems that seven of these eleven benefits of CVC activities can contribute to remove or circumvent a total of eleven barriers to BMI of traditional utilities, in a total of eighteen individual relationships, which will help them to better adapt to the energy sector developments. Hereby, it must be noted that some benefits can contribute to overcome multiple barriers, while others contribute to overcome a single barrier, leading to a total of eighteen individual relationships. It turns out that the benefits of CVC mainly affect organizational and company resource related barriers to BMI, as eight out of nine barriers from that category can be positively affected. One of the most eminent examples is that the exposure to new markets, technologies, and BMs that result from CVC activities can help to remove a lack of competencies to build and manage new capabilities, search-related barriers, and a short-term focus. Furthermore, CVC can contribute to overcome one profitability barrier, one awareness barrier, and one institutional barrier. Also, a general accelerating effect on BMI was found to be resulting from CVC activities, which goes beyond accelerated entry in new markets.

Obviously, it is also important that traditional utilities address the right BM innovations. This more substantive component of the process can be translated in two barriers. To assess the potential contribution of CVC activities, an analysis of the venture portfolios was performed. As a result, it seems that the CVC units of traditional utilities have a well-balanced portfolio of ventures, in which all six major energy sector developments become apparent. Moreover, they include a variety of innovative BMs, in which many of the identified future BM opportunities for utilities are reflected. So, CVC can also be a valuable contribution to overcome the two barriers that reflect the substantive component of BMI. Also, it could be that specific investments in ventures could help to overcome some technological or profitability barriers, but this will be strongly dependent on specific propositions of ventures and therefore this assumption cannot be concretized.

All in all, it can be concluded that Corporate Venture Capital can deliver a valuable contribution to overcome multiple, important barriers to Business Model Innovation of traditional utilities. However, these mainly include organizational and company resource barriers, and one of the two financial and profitability barriers. As such, the contribution of CVC to BMI of traditional utilities does not extend to most regulatory, technological, and awareness barriers to BMI. Nevertheless, its potential value is clear.

9 Discussion and Recommendations

Having presented the results of this thesis in the previous chapter, this chapter will provide a reflection on the research and its outcomes. First of all, a reflection on the research approach is provided in section 9.1. This is followed by an elaboration upon potential biases in the work in section 9.2. Furthermore, section 9.3 will reflect on underlying assumptions and generalization. Here after, section 9.4 will reflect upon the disagreement between interviewees and external industry experts that emerged in this research, and section 9.5 will address the differences between expectations and real proof of the effects of CVC activities. Finally, section 9.6 will reflect on the wider implications of this research, and some recommendations for further research will be provided in section 9.7.

9.1. Reflection on the Research Approach and Methodology

The goal of this research was to improve the understanding of the potential contribution of Corporate Venture Capital activities to business model innovation of European electric utilities. The power industry used to be a highly stable industry, dominated by a few incumbent utilities. After the world, and Europe at the forefront, recently began to scrutinize the sustainability of power systems, the business model of these incumbent utilities was challenged by a range of new market entrants, which resulted in a need for business model innovation for these incumbent utilities. Moreover, to stimulate this BMI, many European incumbent utilities have set their sights on external collaboration with startups. While different option exist to shape this collaboration, it was noticed that during the past years many European utilities started CVC activities.

As a result of these relatively new phenomena for utilities, the current state of knowledge of both business model innovation and CVC activities of electric utilities is highly limited. Moreover, as followed from the academic knowledge gap, integrated research on BMI and CVC has to the best of author's knowledge not been conducted before. Therefore, an exploratory qualitative research approach was chosen to conduct this research. In an exploratory research approach, the aim is rather to provide general first insights into certain subjects of which little is known, than to provide concrete answers to specific problems. However, the downside of this choice is that it leads to large amounts of qualitative data, which can be difficult to interpret and might lead to biases in interpretation. The latter is further addressed in section 9.2.

The little knowledge in academic literature on this subject was complemented by a case study. While a case study approach is useful to holistically analyse emergent phenomena as BMI and CVC in the context of European utilities, in an exploratory research setting, and of which parts are not yet described in literature, it has some downsides as well, as it may lead to a risk of multiple biases, not only in interpretation of case study results by the researcher, but also on the side of case study participants. The case study included interviews with a total of six interviewees, which can all have their own (unconscious) bias. Again, this is further addressed in section 9.2.

More specifically, the case study addressed two different cases, each concerning a traditional utility. The choice to assess two different cases was mainly based on the comparison opportunities that it would enable, while simultaneously still obtaining a sufficient level of detailed information. If only one case had been chosen, the comparison advantages would be lost. On the other hand, if three cases had been chosen, the comparison advantages would be increased, but the level of detail in the results would be lower. Therefore, the choice for two cases seemed a good compromise, which resulted in three interviews per case. For both cases, these three interviews included two different perspectives. Per utility, one interviewee was selected from the CVC perspective, and two from the incumbent utility (Strategy and/or Innovation departments) perspective. In this way, a holistic approach would be guaranteed. In line with the complexity of BMI, this seemed a more valuable contribution than if per case two CVC managers were interviewed, and only one utility manager. This turned out to be a good choice, as the interviewees were much more united about the contribution of CVC than about BMI.

Regarding the specific choice for utilities, it was chosen to analyse utilities that are both active in multiple countries, and of which one is even globally active. In this way, a broader insight would be obtained and also differences due to geographic issues or company size issues would be identified.

With respect to interpretation of the results, it was chosen to include all results that had been recognized by at least one interviewee. So, this also included results recognized by only a single interviewee. Although it could be argued that this is a too insufficient level of recognition for a subject to be relevant, the exploratory nature of this research must here be highlighted again. This is not aimed at deriving highly specific conclusions, but to provide general first answers to subjects. Therefore, excluding observations that had only been recognized by one interviewee would not be in line with this approach.

Finally, the two different methods used in the case study deserve some additional reflection. While some downsides of conducting interviews (i.e. potential biases) have already been covered in the reflection on the case study, it is important to briefly touch upon some other issues that emerged in this specific case. In that respect, it was chosen to add a survey to the interviews, in which all interviewees were asked to assess the relevance of some subjects. This had two objectives. On the one hand, its purpose was to provide an additional possibility for assessing the relevance of subjects that for some reason (i.e. time constraints) would not be discussed during the interviews. On the other hand, its aim was to further substantiate the results of the interviews and simultaneously remove the risk for interpretation bias, as will be further discussed in the next section. However, it turned out that some subjects that had not been discussed during the interviews were later still marked as relevant in the survey. As a result, in-depth insights on the relevance of these specific subjects is sometimes lacking. However, it can be expected that the most relevant subjects would at least have been discussed during one interview, and therefore the risk of having missed a highly relevant issue is limited.

Also, a potential limitation might emerge from the anonymity of the interviews. As the anonymity of interviews was only discussed at the end of each interview, there is the risk that interviewees have been to implicit in their sayings, leading to (partly) missing results. This is more relevant for the incumbent utility perspective, because CVC funds are in general quite transparent as this is a requirement for attracting ventures. However, as almost all interviewees did not have any large concerns with respect to anonymity, except for some specific examples involving company names for which they explicitly asked to exclude the names, it seems that this has not been a major issue. On the other hand, due to concerns of a few interviewees who explicitly it was chosen to handle all results with full anonymity. Although for some research anonymity can lead to less clarity in the analysis of results, according to author this has not been the case here. In line with the exploratory nature of this research, attaching specific interviewee and company names to observations would not be of added value.

Furthermore, a final note has to be taken with respect to the desk research methodology that has been used to perform the analysis of the venture portfolios. This analysis was based on secondary data, mainly obtained from the websites of both CVC funds, and if needed from the websites of ventures. As a result, this data might be outdated, incomplete, biased, or false. However, as this concerned the CVC funds, again the previously illustrated point of their need for transparency can be made, which will decrease the risk for any of these risks to be true. Moreover, the analysis rather included a general assessment of the basic activities of all ventures, which is not the type of data that comes with a high risk of subjectivity or falsity. Therefore, it is expected that the potential risks of using secondary data have not been a major issue.

In this reflection on the research approach and methodology, the risk of potential biases came forward, which requires additional attention. The next section will address this issue in more detail.

9.2. On Potential Biases

As emerged from the previous section, there is a risk of potential biases in the results of this research. First of all, in line with the large amounts of qualitative data in this research, a potential bias might have emerged in interpretation of this data. More specifically, one part in the literature study might be subject to a potential bias. This was the part about the currently existing types of BMs for European electric utilities. In response to a lack in research on this subject, in 2018 a study by Bryant et al. [23] was conducted on the existing types of business models for utilities in Europe, Asia, and Australia. Because of this earlier lack and the recent publication, it was decided to use the results by Bryant et al. as a starting point. Of course, other research was searched and analysed to validate these findings. However, especially in line with the rapid changes in the energy sector, it could be the case that after publication of this work, new types of utility BMs have emerged. Besides the fact that the two industry experts as well as the interviewees did not come up with other possibilities, still a bias might have occurred by using the findings by Bryant et al. as starting point. Nevertheless, the effect on the outcomes of this research will be highly limited, as the traditional utility was the only BM type that was further analysed, and this specific model is widely recognized in literature.

Secondly, a potential bias might have emerged during interpretation of the case study results. A few measures have been taken to decrease the chances for and potential impact of a bias. First of all, for reliability purposes, all interviews have been recorded and transcribed to avoid the possibility of subjective remembrance of certain subjects and to provide availability to assess the raw data in case of doubts. Secondly, a survey was sent to all interviewees, which had two objectives. On the one hand, its purpose was to provide an additional possibility for assessing the relevance of subjects that for some reason (i.e. time constraints) would not be discussed during the interviews. On the other hand, its aim was to further substantiate the results of the interviews and simultaneously remove the risk for interpretation bias. Finally, in the results section, the conclusions drawn by author have been illustrated by many different quotes from interviewees, which decreases the risk for misinterpretation.

Furthermore, biases might have emerged at another side than author's. For example, a potential bias might have been emerged during the consultations with the two external industry experts. Despite the fact that the experts have no intention to be biased, because neither themselves nor their companies would have any conflicting interests, still the possibility exists. However, to avoid the potential impact this could have on the results of this research, two experts have been selected that represented different perspectives. As such, the expert working at Dutch research institute TNO [48] represents an independent research perspective, and the expert working at management consulting firm Strategy& [187] represents an independent business perspective. Combining both perspectives led to a well-balanced external insight on the literature study findings of this research, and therefore the possibility of bias effects in this area is highly limited.

Finally, two biases might have had an impact on the case study results. On the one hand, this concerns the decision by author to send the survey – that was used as further concretization of interview results – in advance of the interviews. The benefit of this choice was that the results of this survey could be further discussed during the interviews, thereby leading to more specific, detailed insights in some subjects. However, the downside of this choice was that a potential bias might have appeared, as the interviewees were presented with a range of options from which they could choose which was relevant. To minimize this risk, an extra open question was added to each subject in the survey, in which the interviewees were asked to include any missing elements that they found relevant. Two interviewees made use of this option, which indicates that in their case a bias was avoided. Furthermore, only three of the interviewees completed the survey in advance of the interview (of which one addressed the open questions), and one interviewee did not complete it at all. Therefore, the potential impact of this bias is limited to only two interviewees. Moreover, seeing the clear distinction between survey and interview results in Chapter 7, and noticing that during the interviews many additional insights emerged that were not marked in the survey, it is estimated that the potential impact of a bias in this area is limited.

On the other hand, another bias might have emerged at the interviewees side. As all interviewees represented traditional utilities, it could be the case that they would have a too positive attitude towards their own utility type, which cannot be justified. When assessing the scores on the alignment of utility BM with the power sector developments in Chapter 7, it stood out that the traditional utility model was evaluated to be significantly better aligned with the developments (relatively; so compared to other utility BM types) as was the case in the eyes of the industry experts. While their scores could be a true representation of the situation, in case a bias would be present this would exactly be the way in which it would affect the results. Therefore, the existence of a bias in this area cannot be fully refuted. However, the BM scores were used to give a rough estimation of the situation, and in no way aimed at providing concrete, statistically significant results on the actual alignment of utility BMs on the power sector developments. In addition, all interviewees still agreed on the need for fundamental BMI for traditional utilities, which indicates still sufficient room for improvement. Finally, one interviewee has clearly not been biased in this area, as very low scores were provided to the traditional utility. The disagreement between interviewees and external industry experts is further addressed in section 9.4.

9.3. On Underlying Assumptions and Generalization

A third subject requiring further attention is the effect of underlying assumptions and generalizations on this research. In a theoretical analysis of complex, real-world problems, it is inevitable that some assumptions and generalizations have to be made. In this research, this is no different. First of all, with respect to the alignment of utility business models with the identified energy sector developments, it was decided to translate the potential causes for the limited adaptation of utility BMs to the developments into a list of mutually exclusive potential barriers to Business Model Innovation. The advantage of this choice is that it enhanced the clarity and distinction between different types of barriers, enabling the possibility for a structured analysis. However, this list of individual potential barriers is a simplification of the situation in the real world, as for example it does not capture interrelationships between different barriers, and does not address the possibility that some barriers to BMI are not only negatively affecting utilities. A specific example of the latter emerged during the case study, as the large sleeping customer base of traditional utilities seem to both hinder BMI (by decreasing customer demand in certain areas and decreasing the urgency of BMI within the utilities), and facilitates BMI through being the cash-cow for utilities which are therefore able to finance new BM development.

Secondly, it was assumed that all barriers are equally important, as their relative importance has not been assessed. Obviously, in the real world some barriers might have a far larger hindering impact on BMI than others. The advantage of this choice is that it allowed for increased generalization of the results to other European incumbent utilities, as this relative importance is expected to be significantly divergent across different utilities. Despite the fact that in the case study the amount of recognition of all BMI barriers was visualized in a table, this had no consequences for the conceptual model or conclusions. However, seeing the exploratory purpose of this research, this choice can be defended. It could be interesting for further research to assess this subject in more detail.

Furthermore, with respect to the different benefits of CVC activities, roughly the same two assumptions have been made. On the one hand, it was decided to translate the positive effects of CVC activities into a list of mutually exclusive potential benefits of CVC. Again, this is a simplification of the real world, as it does not capture the interrelationships between different benefits, which could for example have a reinforcing effect on each other. Moreover, this method does not account for the effect of CVC as a whole. A specific example of the existence of this effect emerged from the case study, in which a general accelerating effect of CVC on BMI was unveiled, that reaches far beyond accelerated entry in new markets. Therefore, a more specific assessment of these effects can provide an interesting window for future research.

Besides in case of the barriers to BMI, it was also assumed that all CVC benefits are equally important. Obviously, in the real world this is not expected to be the case. While the case study findings indicated differences in the level of recognition of several CVC benefits – although to a lesser extent than was the case with BMI barriers – this had no further consequences. Again, future work could include the relative importance of different CVC benefits as well.

Two other simplifications were made in the analysis of the potential contribution of specific CVC benefits to remove or circumvent specific barriers to BMI, both in the analysis and in the conceptual framework. Firstly, the degree to which one or multiple CVC benefits can contribute to remove or circumvent one or multiple barriers to BMI (i.e. partly or fully) was not addressed; it was only addressed that benefits can help to overcome barriers in a general way. This exclusion was almost inevitable, as this effect is hardly possible to measure, is expected to be strongly depending on other individual effects of CVC activities, and is expected to be strongly dependent on the effect of other instruments that can stimulate BMI; indeed, CVC is only one of a range of important instruments, and with CVC alone utilities are not expected to be able to realize the demanded changes. Most importantly however, the potential contribution of CVC to BMI is also highly dependent on a wide range of factors that determine the performance of the CVC fund as such.

This already reveals the second simplification: in the assessment of the potential contribution of CVC to BMI, the necessary conditions for good CVC fund performance were excluded. For example, it does obviously matter if the CVC fund is managed properly, if it has sufficient autonomy and resources, et cetera. Despite the fact that a list of potential factors positively and negatively affecting CVC fund performance has been included in the appendix of this research, this subject demands more attention. Therefore, future research could address this subject in more detail, for example by extending the conceptual framework in a way that it takes these factors into account.

Finally, the assumption was made that in the ideal situation, utilities will best aligned (so with a score of five) with all energy sector developments. However, this does not have to be necessarily true for all incumbent utilities. It could be the case that different possibilities for a well-aligned business model exist, without necessarily optimal alignment to all six developments. However, from the case study it followed that incumbent utilities seem to be too large to not adapt to all developments. So, while underlining the importance that incumbent utilities adapt to all developments, this could be achieved through a range of different business models existing next to each other that each sufficiently adapt to one or multiple developments. As such, different 'optimal' profiles (and conceptual models) could exist. This opens an interesting window for further research, which could for example identify different combinations of business model types which combined could enable incumbent utilities to sufficiently adapt to all energy sector developments.

An overview of these assumptions and their expected consequences is provided in Table 9.1. Having reflected upon the research approach and methodology, potential biases, and underlying assumptions and generalization, the next section will reflect on a more specific subject: the disagreement between external industry experts and interviewees.

Table 9.1: Assumptions and generalizations and their main consequence.

Assumption	**Main consequence**
Potential causes for limited alignment of utility BMs to energy sector developments translated into mutually exclusive list of potential barriers to BMI	Interrelationships between barriers and potential positive effects of barriers are not captured.
All barriers to BMI are equally important	In reality, some barriers might be more important than others.
Positive effects of CVC activities translated into mutually exclusive list of potential benefits of CVC activities	Interrelationships between benefits and the effect of CVC as a whole are not captured.
All benefits of CVC are equally important	In reality, some benefits will be more important than others.
Exclusion of the degree to which CVC benefits can contribute to remove or circumvent barriers to BMI (fully/partly)	The degree of the contribution of CVC to overcome individual barriers to BMI remains unclear. However, this will be strongly dependent on a wide range of factors, so it will be impossible to provide a clear-cut answer to this question.
Exclusion of the necessary conditions for good CVC fund performance	In reality, the potential contribution of CVC to BMI will strongly depend on a range of conditions that will have to be satisfied.
In an ideal situation, incumbent utilities will be best aligned with all energy sector developments	In reality, it could be that different 'optimal' profiles exist that combined lead to best alignment of incumbent utilities to all energy sector developments.

9.4. On the Disagreement between External Industry Experts and Interviewees

As followed from the case study results presented in Chapter 7, on one topic significant disagreement between the external industry experts and the interviewees emerged. This topic addressed the current alignment of the four utility BM types to the six energy sector developments. Specifically, two main differences stood out. On the one hand, the traditional utility model was relatively better evaluated by the interviewees than by the external industry experts. On the other hand, the cooperative utility model was relatively worse evaluated by the interviewees than by the external industry experts (which was the result of significantly lower scores specifically on decarbonization and energy system flexibility). Obviously, these differences are intertwined. Because of the lower scores for the cooperative model on the two mentioned developments, the traditional model scored higher than the cooperative model on these developments, which was not the case according to the external industry experts. In addition, on the alignment with (demand-side) energy efficiency, the traditional utility received a much higher score by the interviewees than by the industry experts, resulting in a higher score than the cooperative utility. Again, according to the industry experts this was the other way around.

The cause for this disagreement can be related to a few observations. First of all, traditional utility and CVC managers seem to be sceptic about cooperative utilities in general. This observation was confirmed in one of the interviews, in which the complexity of energy was highlighted, as well as that cooperative utilities have had the illusion that they could take over the role of traditional energy companies, in which they did not succeed. Secondly, as already followed from section 9.2, potential biases may have emerged, both at interviewee-side and at industry expert-side. The former may seem to be most plausible, as all interviewees worked at traditional utilities and could therefore have a more positive attitude against it. This also corresponds to the observed effect (traditional utility being better evaluated by interviewees). However, a bias at the industry expert-side can also not be fully excluded, although it is not expected that the two industry experts would have any conflicting interests.

Thirdly, it was observed that strong differences between the scores of individual interviewees exist. More specifically, one interviewee provided significantly lower scores (except to the prosumer utility model) than all other interviewees. This seems to be the result of personal scepticism (which was confirmed in the interview), rather than a bias. In addition, some people tend to be generally more modest in their opinions than others, which is for example reflected in the fact that one interviewee only provided scores of 3 and 4, and no single score other than that, thereby avoiding the 'extremes'. Again, this rather indicates general differences between individuals in their natural way of scoring, rather than certain biases. Moreover, since the number of people that provided scores is limited (especially for the external industry experts), the results are highly sensitive for this effect. For example, if the scores of the most sceptic interviewee would be removed, the aggregated results of all interviewees would look very different.

All in all, it is assumed that these observations together provide the cause for the differences between the opinions of external industry experts and interviewees.

Despite these apparent differences, the BM scores were used to give a rough estimation of the situation, and in no way aimed at providing concrete, statistically significant results on the actual alignment of utility BMs on the power sector developments. Also, the analysis of this research was centered around business model innovation of the traditional, incumbent utility. Therefore, it is not a highly relevant issue whether the BM scores provided by the interviewees or by the external experts would be most valid. While acknowledging the differences, the scores provided by the interviewees still indicated sufficient room for improvement for traditional utilities on all six developments. In addition, all interviewees still agreed on the need for fundamental BMI for traditional utilities. Therefore, their more positive evaluation of the traditional utility than the external industry experts does not lead to different conclusions. Eventually, the need for fundamental business model innovation for traditional utilities was unanimously acknowledged.

9.5. On the Differences between Expectation and Proof of CVC Effects

Another subject worth further discussing is the difference between the expectation of the positive effects of CVC activities, and actual proof that these effects have become reality. This is relevant for both this specific research, and for CVC in a broader perspective.

First of all, we have seen that CVC is no new phenomenon, and has been used by many incumbent organizations in a variety of industries. However, as was already mentioned in the introduction of this thesis, CVC activity follows waves, and many CVC activities (in different industries) have been stopped in the past. The same goes for the energy sector, as CVC in this industry is no new phenomenon as well, and programs have failed before. This already indicates that an expectation of the beneficial effects CVC can have, has not always corresponded to what is seen in practice.

However, it must be noted that in the past CVC activities used to be mainly aimed at generating financial returns, and their success was thus mainly evaluated in financial terms. Nowadays, in many industries the focus has shifted to generating strategic benefits, e.g. CVC as an instrument to drive (BM) innovation and fuel new business opportunities. As a result, the means of evaluation of CVC activities must be aligned with the changed purpose of these activities. Obviously, this is the case for the energy sector as well. The major trends in this sector are quite recent, and consequently incumbent utilities have only recently put their focus on fundamental BM innovation. Moreover, electric utilities (opposed to other types of energy companies) are relative newcomers in CVC investing. Therefore, the past experiences with CVC might not be fully relevant for the current situation anymore.

This changed aim of CVC activities has also led to a changed expectation of the beneficial effects CVC can deliver for incumbent organizations, which are now mainly strategic. However, also in this new situation a real proof of the expected beneficial effects of CVC is not clearly visible, neither in the energy sector, nor in other sectors. The characteristics of CVC in different industries are quite similar, which was confirmed during the interviews. In that respect, for example the telecommunications and financial sectors show considerable similarities with the energy sector. Both industries also used to be stable, dominated by a few large, incumbent players, and without a need for real change for a long time. However, at some point both industries experienced multiple, fundamental changes, which were threatening their incumbent business model and leading to the entrance of many new market players smelling opportunities. In both sectors, many incumbents established CVC (or other Corporate Entrepreneurship related) programs. However, real proof of substantial beneficial effects is still limited, despite the confidence in the added value of these programs.

The cause for this limited proof might be partly attributed to the relatively young age of many CVC programs. Many of these programs (in the energy sector, but also in the telecommunications and financial sectors) are established somewhere in the mid 2010s. This has also been the case for the two CVC funds analysed in this research, which were founded in 2014 and 2015. Obviously, it takes quite some time before a considerable number of investments is made and a fruitful collaboration with the utility's normal business unit is established. Moreover, it takes even more time before specific beneficial effects of these activities would be visible. So, it could be that we simply have to wait a little longer to be able to see the expected positive effects. This was also acknowledged during the interviews. Interviewees specifically mentioned that some effects are not fully visible yet due to the relatively short existence of the CVC programs.

In addition, it also emerged that it is very hard to measure the exact contribution by CVC activities to certain changes. This makes sense, as strategic benefits can be much harder to measure than financial benefits, specifically with CVC benefits for example related to providing managers with exposure to new markets and business models or promoting entrepreneurship in the corporate culture. Moreover, in line with the observation that CVC is only one of the instruments applied by incumbent organizations to drive BM innovation (and not the only instrument), it will be even harder to determine which part of the effect will have directly resulted from the CVC activities.

For the outcomes of this specific research, this difference between expectation and proof of CVC effects should be kept in mind as well. This is relevant for the total of eighteen individual effects of CVC benefits on BMI barriers that has been identified in this research. During the interviews, in some cases the real practical contribution of specific CVC investments was specified, as well as some beneficial effects of the CVC program as a whole. On the other hand, many effects were only acknowledged but have not been supported by practical evidence. So, while it could be argued that this is an actual proof that these effects happened, this still only followed from the perception of individuals (interviewees) rather than that they have been measured or concretized.

As the overall sentiment with respect to the real contribution of CVC activities to BMI of incumbent organizations (such as traditional utilities) is subject to scepticism, it would be very interesting for further research to address this issue. This is further elaborated upon in section 9.7.

9.6. On the Wider Implications of this Research

This research has some important implications on multiple levels. These include a scientific level, a managerial level, and a societal level.

9.6.1. Scientific Relevance

First of all, the scientific implications of this research can be best described by assessing the academic knowledge gap, as was identified in section 1.3. This gap consisted of a few layers. First of all, there was a lack of knowledge of business model innovation in the energy sector, which is a highly important and relevant subject for many firms to respond to the large challenges of the rapidly changing energy industry. Secondly, there was a general lack knowledge of knowledge of Corporate Venture Capital in the energy sector, and an even more severe lack of knowledge of CVC for (European) electric utilities. Thirdly, there was a general lack of integrated knowledge of BMI and CVC combined. For utilities, this integrated knowledge was – to best of author's knowledge – even not existing at all. As a result, it was unknown how CVC activities can contribute to BMI, both in general and for electric utilities in specific.

To address these gaps, multiple steps have been taken. First of all, an extensive literature study, insights from external industry experts, and in-depth interviews with utility and utility CVC managers led to a clear view on the currently existing types of business models for European electric utilities, the major developments in the energy sector, and a need for fundamental business model innovation for incumbent, *traditional utilities*. While this need for BMI appeared frequently in literature, there was a lack of concrete foundation of this observation, except for a general notice that this followed from the rapidly changing energy sector. In response to this, two external industry experts and utility interviewees were asked to attach a score to the current alignment of utility BMs to all six identified developments, which was visualized in spider web diagrams. This provides an innovative and interesting new method to visually depict BM adaptation, which allows for usage in a variety of industries. Secondly, this tool provides a clear visual foundation to assess the need for BMI for corporations. Such a tool seemed to be lacking in literature before.

As a result, it followed that especially traditional utilities are indeed in a need for fundamental business model innovation. In that respect, this subject could be assessed in more detail. Again, a thorough assessment of literature was performed (complemented with insights from external industry experts) on all factors that potentially hindering business model innovation of utilities. By looking much further than barriers to BMI that emerged from general BMI literature, also a wide range of specific factors emerged that can hinder new BM development of utilities in certain, specific areas that relate to better alignment with one or multiple of the major energy sector developments. Subsequently, their relevance for incumbent utilities was assessed through a case study. This resulted in a thorough overview of all relevant barriers that can hinder BMI of electric utilities, which, to the best of author's knowledge, has not been identified before.

With respect to Corporate Venture Capital, again an extensive literature study was conducted to assess the potential benefits of CVC activities in general. Subsequently, a case study was performed which led to in-depth knowledge of the rationale behind CVC activities of incumbent utilities and the relevant benefits that these activities can deliver. To best of author's knowledge, such an overview of relevant CVC benefits for utilities was lacking before.

Finally, moving on to integration of BMI and CVC in the context of electric utilities, an in-depth case study led to detailed results on the potential of individual CVC benefits to help remove or circumvent individual barriers to BMI. As a result, a clear overview of the total potential contribution of CVC activities to BMI of utilities was obtained, which to best of author's knowledge has not been identified before. While some of these relations are utility-specific, other relations emerged that hold for BMI and CVC in general, thereby allowing for some degree of generalization of the results.

Moreover, a new, innovative and clear conceptual framework has been developed that visually captures the potential contribution of CVC activities to BMI. While the framework in this research has been tailored to (traditional) utilities, its modular composition allows for usage in analysis of a variety of different industries and corporations. Therefore, this tool provides a new, easy-to-use and structured way of graphically capturing the changes in an industry, alignment of BMs to those changes, factors hindering BMI (both generically and specifically for better alignment with the industry changes), benefits of CVC activities in an industry, and the relation of these CVC benefits and BMI barriers. To best of author's knowledge, such a tool has not been developed before and can be highly useful for other research, also for more general research on BMI in a certain industry.

So, in line with the above, this research has significant scientific relevance, contributing to research on BMI and CVC in general, BMI and CVC in the energy sector and for utilities, and most importantly, to integrated research on BMI and CVC in general, in the energy sector, and for utilities. To the best of author's knowledge, this research is the first to specifically connect these two subjects, which are highly relevant in the global journey towards a sustainable energy system.

9.6.2. Managerial Relevance

Secondly, the outcomes of this research have significant managerial relevance as well, which concerns different actors.

Implications for Utility Managers with CVC Programs

With respect to (incumbent) utility managers, it is often mentioned that they are unable to (timely) identify the right new business capabilities, are lacking a long-term vision, or do not timely recognize potential competitive threats. A variety of examples exist in which incumbent players in different industries are responding too late to changes or disruptions by new market entrants, which lead to severe threats to their future competitive position.

These factors indeed all appear in the barriers to BMI of electric utilities, which underlines their importance. So, first of all, this research provides utility managers with a clear idea of where they currently stand, and which factors are hindering innovation of their business models. This can be highly useful in the development of new strategies. Secondly, it was observed that during the past five or six years, many European utilities started CVC activities, with the strategic rationale that external collaboration with startups would be one of the key elements to stimulate BMI. However, while the general potential added value of CVC activities was clear (and not so different from other industries), for its purpose to stimulate BMI of a specific company (or utility) a more concrete idea of how it can serve this purpose would be beneficial. By shedding a light on the actual potential contribution of CVC activities to business model innovation, utilities could re-evaluate their strategies and activities to make sure they are well aligned with the long term goals of fundamental business model innovation, the energy transition, and other identified key changes in the power sector. Furthermore, they will be able to use this CVC instrument in the right way.

Implications for Utility Managers without CVC Programs

Secondly, also managers from utilities that are currently not pursuing CVC activities could benefit from this research. First of all, the conceptual framework can provide them with a clear overview of where they stand, and which factors hinder innovation of their business model and better alignment with the energy sector developments. Subsequently, they could reevaluate their own instruments to stimulate this BMI process, and compare the expected outcome of those with pursuing CVC activities. For example, it could turn out that CVC activities can help to address barriers to BMI that are not addressed with other instruments. In that respect, they could for example decide to start CVC activities as well, as they now have a clear idea of the potential contribution it can deliver.

Implications for CVC Managers

Thirdly, this research has implications for CVC managers. Indeed, CVC managers have the highly complex task to both successfully manage their CVC fund so that it is financially healthy, and invest in the right ventures that will each contribute something to BMI of utilities and better alignment with the energy sector developments. All in all, that is often the reason they have been established. The CVC fund forms the important link between a dynamic startup environment and a slow, risk-averse corporate environment. Obviously, this can lead to friction, and establishing synergies between these environments is therefore a challenging task.

A clearer overview of the alignment of a utility with each of the energy sector developments, the barriers to BMI and better alignment of utilities, and the contribution to this by CVC, can help them to identify the key terrains on which most is still to win. They could use this in the identification and assessment of specific ventures, in which an investment by the CVC fund in specific ventures could help to address specific barriers or developments. Moreover, an increased overview of the corporate rationale behind the CVC fund could help to better align interests and reduce potential conflicts or tensions between the CVC fund and the corporate, which will be beneficial for both the CVC and corporate performance.

Implications for Ventures

Fourthly, taking the venture perspective, this research has some implications as well. For ventures looking for funding, different options are on the table. To make a well-balance decision which type of funding they would like to pursue, a clear assessment of the advantages and disadvantages will be required. With the emergence of many CVC funds during the past years, this has increased the options for funding for ventures in the energy sector. However, with this increased number of options, it is also necessary that the overview of the advantages and disadvantages of these options is enhanced. In that respect, a more clearly defined relation between CVC activities and business model innovation of incumbent utilities leads to better insight in their rationale behind CVC.

Obviously, when looking for funding from a corporate partner that has a strategic rationale, it is important to know what that rationale exactly is in order to establish the best working relation and most aligned interests. The outcomes of this research could help ventures to assess whether funding from a corporate partner is beneficial for them, and how they can establish the most synergies. In this way, the chances for a successful parent-venture collaboration could increase, which would not only lead to higher success rates of CVC programs, but can also lead to increased value of a venture and more successful exits (i.e. an IPO). Moreover, this would also mean an eventual higher contribution to the energy transition.

Implications for Policy Makers

Finally, this research has some implications for policy makers. During the past years, many new regulations and policies have been proposed and implemented that are aimed at stimulating the transition towards a sustainable society, obviously including stimulation of decarbonization of the energy supply. Despite these good efforts, we have seen that current efforts do not suffice. As such, regulatory and institutional barriers are found to be play an important role in the hindrance of Business Model Innovation of electric utilities. Examples include shortcomings in the legal framework, misplaced incentives, and issues with feed-in tariffs and taxation, among others. Moreover, we have seen that Corporate Venture Capital is no suited instrument to address these regulatory barriers. As such, other measures will have to be taken. While on the utility side, for example lobbying efforts might already spur more, effective legislation and incentives, this will not suffice. In the end, it are the policy makers who should address these issues and make sure that their legislation is effective in meeting its goals, and the right incentives will be provided for people wanting to contribute their part.

Therefore, it is called upon policy makers to take this issues seriously and develop more effective legislation, and provide more, tailored incentives to companies and citizens. Because only then, the energy transition can be realized.

9.6.3. Societal Relevance

Finally, the outcomes of this research will have societal relevance as well. What is already captured in the term ’utility’, is that the subject of concern is relevant to every human on this planet. Energy is an unmissable element in human well-being and the economy. Often, especially in Western economies, people tend to forget the fact that energy is not a certainty. Few people know the highly complex system that makes that the light actually switches on when they press the switch. However, this whole complex system is changing, and this directly affects the way of living and working of each and every citizen. On the other hand, a considerable amount of people have also have some expectations of the power system themselves. For example. a continuously increasing share of the population has some level of demands regarding the carbon footprint of the electricity they consume. Also, more and more customers are interested in generating their own electricity, or buying an electric car. These are all subjects that people find 'normal'. In other words, they just expect that to be possible, without knowing the complexities that come with it. Moreover, many customers do still not care where their energy comes from.

However, in this rapidly changing energy landscape, many innovative propositions emerge that are all focusing on enhancing the reliability, quality (also environmentally), and possibilities of energy supply. For new ventures, access to funding is essential, and access to the large customer base of utilities through corporate VC enables them to speed up the diffusion of their propositions. For incumbent utilities, the collaboration with ventures, for example through CVC, is essential for them to survive. However, both are dependent on, among others, increased interest and demand from society. The possibilities with energy are enormous, but in order for these possibilities to become reality they need certainties in demand.

Not only will this increased interest and demand lead to faster achievement of the goals of the energy transition, it will spur even more innovative propositions, thereby opening a wide range of new products and services that allow consumers to access and use electricity in the way they want, and the moment at which they want it. Therefore, it is called upon consumers to wake up, develop interest for energy, increase demand for innovative propositions, and increase urgency for the energy transition. Because it does matter where energy comes from. Only if these conditions are met, innovative ventures will thrive, utilities will be able to innovate their business models, and, most importantly, the energy transition will become a reality. All aimed at providing a better habitat for all the people on this planet.

9.7. Recommendations for Further Research

As emerged from section 9.3, this research has made several assumptions and generalizations which were inevitable to conduct this research. However, this simultaneously creates interesting opportunities for further research, which will be discussed in this section.

First of all, as was already described in the assumptions, future research could look into the interrelationships between different barriers to BMI, and assess their relative importance, which were both excluded in this research. This will provide a valuable, more detailed addition to the findings of this research, and would improve the conceptual framework.

The same goes for the different benefits of CVC activities. Future work could take the interrelationships between different CVC benefits into account, as well as the effects of CVC as a whole. With respect to the latter, it could be interesting to further assess the acceleration effect that was found in this research. Furthermore, the relative importance of CVC benefits could be assessed. All these three subjects would be a valuable addition to the findings of this research and would improve the conceptual framework.

Besides this, future research could analyse the necessary conditions for optimal CVC performance, specifically for the energy sector and utilities. Despite the fact that general literature on this subject already exists, it has not been addressed for utilities before. This would provide a valuable contribution to the overall picture of how CVC can contribute to BMI, as with this new research a more specific answer could be provided.

The final opportunity that followed from the assumptions made in this research addresses the adaptation to energy sector developments by utilities. While this research assumed that the optimal situation emerges when a utility BM is best aligned to all developments, in reality this might not be the case. In that respect, additional research could be conducted on different combinations of new business models for utilities that would combined lead to high adaptation to all energy sector developments.

Besides specific opportunities for further research that emerged as a result of the assumptions and generalizations in this research, a few other interesting opportunities could be explored. First of all, the identified possible relationships between benefits of CVC activities and barriers to BMI of traditional utilities are only the first step in integrated research on these subjects. Where some of these relationships have been supported by real practical examples, also multiple relationships were based only on the perceptions of different interviewees, rather than on concrete, practical proof. Moreover, one of the eighteen identified relations remained ambiguous, so the relevance of this relationship should receive special attention. As we have seen, this all corresponds to a more general observation about CVC activities in various industries. In that respect, we have seen that a difference exists between the high expectations about the positive contribution of CVC activities, and real proof that these effects actually happened in practice. This opens a highly interesting opportunity for further research, which should take the findings of this work to the next level and perform a quantitative study on this subject.

Moreover, as it emerged from the case study that it can be hard to measure the specific strategic contribution of CVC activities to BMI of traditional utilities and better adaptation to the energy sector developments, this further underlines the relevance of devoting additional, quantitative research on this topic. For example, a set of innovative, strategic Key Performance Indicator (KPI)s could be developed with which the contribution of CVC activities to BMI could be quantitatively assessed. To determine the KPIs, one could for example think of percentages of new business enabled by CVC investments, but also the attitude of human capital towards (BM) innovation over time. The latter could for example be assessed in two points in time, including human capital that directly collaborated with portfolio ventures. However, in line with the relative short existence of the CVC programs of utilities, it would be best to wait a few more years in order for the effects to become fully visible.

Secondly, it would be highly interesting to investigate what would happen if utilities would not or only partly adapt to all energy sector developments. While it followed from the case study that incumbent utilities think they are too large to focus on only a few developments, it might be that this is not true. Especially in line with all innovations and new propositions emerging at the customer-side, it could be the case that it would be better for utilities to focus on a domain that is most close to their historical competencies: the large-scale generation of power. In that sense, it could for example be investigated whether it would be viable for utilities to solely focus on large-scale renewable energy generation.

In addition, it was already highlighted that the alignment of current utility BMs with the six energy sector development was subject to disagreement, mainly between the external industry experts and interviewees, but also between individual interviewees. Therefore, it could be interesting to explore the current alignment of European electric utilities in more detail, and potentially in a statistically significant way. For example, the requirements for full adaptation to each development could be further specified, and tested with certain Key Performance Indicators (KPIs). Then, a large number of utilities could be assessed, based on quantitative data or a large number of survey respondents representing all different utility types and a reference group of external industry experts.

Also, while this research focused specifically on CVC as an instrument to stimulate BMI of incumbent utilities, it was already highlighted that a range of other important instruments exist. While CVC was a logical instrument to research because of its rapid increase in popularity during the past years, it might be interesting to investigate what other instruments might contribute to BMI, or even further, which combination of instruments would provide utilities with the best 'package' to stimulate BMI.

Furthermore, we have not yet addressed the venture perspective. In CVC, not only the utility and CVC unit matter, but obviously also ventures are highly important. In the end, the whole effectiveness of CVC as an instrument for BMI of incumbent utilities comes down to venture performance. Therefore, it is highly important to assess their perspective as well. In that respect, research could for example look into the factors required for optimal synergies between incumbents and ventures, or optimal development of ventures.

With respect to the conceptual framework that has been proposed in this research, it has already been stretched that its usage is not limited to the energy industry or utilities. Also, it provides an innovative and structured way to research Business Model Innovation in a variety of industries or companies. To improve the model and its reliability, researchers could therefore apply this framework to other companies in the energy industry or to complete other industries to test its usability and validity. Also, this would allow for a concise, general comparison between industries, which might lead to interesting results. Therefore, it is encouraged for further research to explore these opportunities by applying this framework.

Finally, we have seen that the energy sector changes with an enormous speed. As such, literature that has been conducted in this industry is rapidly becoming outdated, and therefore it is important that the risk of a lack of knowledge about this industry will be avoided. In that respect, the findings of this research could be assessed again in a few years from now. This could for example lead to a modified conceptual framework, with new developments, new business models, new barriers to BMI, and a different contribution of CVC. It would however be most interesting to combine this with a more quantitative assessment of the contribution of CVC activities, as indicated above.

Bibliography

[1] Accenture. *The New Energy World: The Consumer Perspective*. Retrieved from https://www.accenture.com/t20150527t210642__w__/es-es/_acnmedia/accenture/conversion-assets/dotcom/documents/local/es-es/pdf_2/accenture-the-new-energy-world.pdf, 2015. Accessed: 2020-08-19.

[2] European Environment Agency. *CO2 Intensity of Electricity Generation*. Retrieved from https://www.eea.europa.eu/data-and-maps/data/co2-intensity-of-electricity-generation, 2020. Accessed: 2020-08-13.

[3] International Energy Agency. *Non-traditional energy companies lead a record year for corporate investment in energy start-ups*. Retrieved from https://www.iea.org/commentaries/non-traditional-energy-companies-lead-a-record-year-for-corporate-investment-in-energy-start-ups, 2019. Accessed: 2020-08-06.

[4] International Energy Agency. *Corporate venture capital and growth equity by sector of investor, 2010-2019*. Retrieved from https://www.iea.org/data-and-statistics/charts/corporate-venture-capital-and-growth-equity-by-sector-of-investor-2010-2019, 2019. Accessed: 2020-08-06.

[5] Julio Romero Aguero, Amin Khodaei, and Ralph Masiello. The utility and grid of the future: Challenges, needs, and trends. *IEEE Power and Energy Magazine*, 14(5):29–37, 2016.

[6] Raphael Amit and Christoph Zott. Value creation in e-business. *Strategic management journal*, 22(6-7):493–520, 2001.

[7] Raphael Amit and Christoph Zott. Creating value through business model innovation. *2012*, 2012.

[8] Sergey Anokhin, Joakim Wincent, and Pejvak Oghazi. Strategic effects of corporate venture capital investments. *Journal of Business Venturing Insights*, 5:63–69, 2016.

[9] Peter Asmus. Microgrids, virtual power plants and our distributed energy future. *The Electricity Journal*, 23(10):72–82, 2010.

[10] Makhmoor Bashir and Rajesh Verma. Why business model innovation is the new competitive advantage. *IUP Journal of Business Strategy*, 14(1):7, 2017.

[11] Sandip Basu, Corey Phelps, and Suresh Kotha. Towards understanding who makes corporate venture capital investments and why. *Journal of Business Venturing*, 26(2):153–171, 2011.

[12] Simona Benedettini, Guglielmo Brugnetta, Franco Fumiatti, Paolo Gentili, Giulia Ghiglione, Vincenzo Giordano, Aviv Gidron, Gerd Küpper, Pavla Mandatova, Roberta Masci, et al. *Assessment and Roadmap for the Digital Transformation of the Energy Sector Towards an Innovative Internal Market*. Publications Office of the European Union, 2020.

[13] David Benson and Rosemarie H Ziedonis. Corporate venture capital as a window on new technologies: Implications for the performance of corporate investors when acquiring startups. *Organization Science*, 20(2):329–351, 2009.

[14] Roland Berger. *Power to the people: the future of Europe's Decentralized Energy Market*. Retrieved from https://www.rolandberger.com/en/Insights/Publications/The-future-of-Europe%27s-decentralized-energy-market.html, 2017.

[15] Will Blyth, Rob Gross, Jamie Speirs, Steve Sorrell, Jack Nicholls, Alexandra Dorgan, and Nick Hughes. Low carbon jobs: The evidence for net job creation from policy support for energy efficiency and renewable energy. *London: UK Energy Research Centre*, 2014.

[16] William Blyth, Rory McCarthy, and Robert Gross. Ukerc energy strategy under uncertainties. financing the power sector: Is the money available. Technical report, UKERC working paper, 2014.

[17] Nancy MP Bocken and Thijs HJ Geradts. Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities. *Long Range Planning*, 53(4):101950, 2020.

[18] Nancy MP Bocken, Samuel W Short, Padmakshi Rana, and Steve Evans. A literature and practice review to develop sustainable business model archetypes. *Journal of cleaner production*, 65:42–56, 2014.

[19] Jonas Böhm, Maximilian Palmié, Jonas Kahlert, and Oliver Gassmann. Business models for the electrical power sector: A strategic group perspective based on insights from the uk, usa, and india. 2018.

[20] Timo Phillip Böttcher and Jörg Weking. Identifying antecedents and outcomes of digital business model innovation. In *ECIS*, 2020.

[21] Michael Brigl, Nico Dehnert, Stefan Groß-Selbeck, Alexander Roos, Florian Schmieg, and Steffen Simon. How the best corporate venturers keep getting better. *The Boston Consulting Group, Boston, MA*, 2018.

[22] Vasco Brummer, Carsten Herbes, and Naomi Gericke. Conflict handling in renewable energy cooperatives (recs): Organizational effects and member well-being. *Annals of Public and Cooperative Economics*, 88(2):179–202, 2017.

[23] Scott T Bryant, Karla Straker, and Cara Wrigley. The typologies of power: Energy utility business models in an increasingly renewable sector. *Journal of Cleaner Production*, 195:1032–1046, 2018.

[24] Iñigo Capellán-Pérez, Álvaro Campos-Celador, and Jon Terés-Zubiaga. Renewable energy cooperatives as an instrument towards the energy transition in spain. *Energy Policy*, 123:215–229, 2018.

[25] Ramon Casadesus-Masanell and Feng Zhu. Business model innovation and competitive imitation: The case of sponsor-based business models. *Strategic management journal*, 34(4): 464–482, 2013.

[26] Mark Casey, Daan Witteveen, Elise Lufting, Nils Beers, Job Nijs, and Marieke Bax. The next chapter for corporate venture capital - ”future-proof” the netherlands. *Deloitte The Netherlands*, 2019.

[27] Cristina Cattaneo. Internal and external barriers to energy efficiency: which role for policy interventions? *Energy efficiency*, 12(5):1293–1311, 2019.

[28] Friedrich Chasin, Ute Paukstadt, Torsten Gollhardt, and Jörg Becker. Smart energy driven business model innovation: An analysis of existing business models and implications for business model change in the energy sector. *Journal of Cleaner Production*, page 122083, 2020.

[29] S Cheng, B Zeng, and YZ Huang. Research on application model of blockchain technology in distributed electricity market. In *IOP Conference Series: Earth and Environmental Science*, volume 93, page 012065. IOP Publishing, 2017.

[30] Henry Chesbrough. Open innovation: a new paradigm for understanding industrial innovation. *Open innovation: Researching a new paradigm*, 400:0–19, 2006.

[31] Henry Chesbrough and Christopher L Tucci. Corporate venture capital in the context of corporate innovation. Technical report, 2002.

[32] Henry W Chesbrough. Making sense of corporate venture capital. *Harvard business review*, 80 (3):90–99, 2002.

[33] Henry W Chesbrough. Business model innovation: opportunities and barriers. *Long range planning*, 43(2-3):354–363, 2010.

[34] Henry W Chesbrough and Richard S Rosenbloom. The role of the business model in capturing value from innovation: evidence from xerox corporation's technology spin-off companies. *Industrial and corporate change*, 11(3):529–555, 2002.

[35] Timothy Chiang et al. *Capturing and measuring the strategic value in corporate venture capital*. PhD thesis, Massachusetts Institute of Technology, 2018.

[36] Michael Child, Claudia Kemfert, Dmitrii Bogdanov, and Christian Breyer. Flexible electricity generation, grid exchange and storage for the transition to a 100% renewable energy system in europe. *Renewable energy*, 139:80–101, 2019.

[37] Clayton M Christensen, Thomas Bartman, and Derek Van Bever. The hard truth about business model innovation. *MIT Sloan Management Review*, 58(1):31, 2016.

[38] Paolo Colbertaldo, Stacey Britni Agustin, Stefano Campanari, and Jack Brouwer. Impact of hydrogen energy storage on california electric power system: Towards 100% renewable electricity. *International Journal of Hydrogen Energy*, 44(19):9558–9576, 2019.

[39] Jill Collis and Roger Hussey. *Business research: A practical guide for undergraduate and postgraduate students*. Macmillan International Higher Education, 2013.

[40] European Commission. *The European Green Deal*. Retrieved from `https://ec.europa.eu/commission/presscorner/detail/en/ip_19_6691`. Accessed: 2020-07-22.

[41] Julian Critchlow. *What is the future of electricity?* Retrieved from `https://www.weforum.org/agenda/2015/04/what-is-the-future-of-electricity/`, April 2015. Accessed: 2020-08-21.

[42] TU Delft. *MSc Sustainable Energy Technology*. Retrieved from `www.tudelft.nl/en/education/programmes/masters/sustainable-energy-technology/msc-sustainable-energy-technology/`. Accessed: 2020-06-25.

[43] Dominik Dellermann, Alexander Fliaster, and Michael Kolloch. Innovation risk in digital business models: the german energy sector. *Journal of Business Strategy*, 2017.

[44] Maria Luisa Di Silvestre, Salvatore Favuzza, Eleonora Riva Sanseverino, and Gaetano Zizzo. How decarbonization, digitalization and decentralization are changing key power infrastructures. *Renewable and Sustainable Energy Reviews*, 93:483–498, 2018.

[45] Millán Diaz-Foncea and Carmen Marcuello. Entrepreneurs and the context of cooperative organizations: A definition of cooperative entrepreneur. *Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration*, 30(4):238–251, 2013.

[46] JF Donker and X van Tilburg. Grid integration in indonesia. contributions of variable renewable power sources to energy and climate targets. Technical report, TNO, 2018.

[47] JF Donker, Annelies Huygen, Richard Westerga, Rob Weterings, and Opdrachtgever Mart van Bracht. *Naar een toekomstbestendig energiesysteem: Flexibiliteit met waarde*. Delft: TNO, 2015.

[48] Jasper Donker (TNO). Personal communication, 2021.

[49] Will Drover, Lowell Busenitz, Sharon Matusik, David Townsend, Aaron Anglin, and Gary Dushnitsky. A review and road map of entrepreneurial equity financing research: venture capital, corporate venture capital, angel investment, crowdfunding, and accelerators. *Journal of management*, 43(6):1820–1853, 2017.

[50] Roger Duncan. Renewable energy and the utility: the next 20 years. *Renewable Energy World*, 2(3), 2010.

[51] G Dushnitsky. Corporate venture capital: Past evidence and future directions. *Oxford Handbook of Entrepreneurship*, pages 387–431, 2006.

[52] Gary Dushnitsky. Riding the next wave of corporate venture captial. *Business Strategy Review*, 22(3):44–49, 2011.

[53] Gary Dushnitsky. Corporate venture capital in the 21st century: An integral part of firms' innovation toolkit. *Oxford handbooks: The Oxford handbook of venture capital*, pages 156–210, 2012.

[54] Gary Dushnitsky and Michael J Lenox. When do incumbents learn from entrepreneurial ventures?: Corporate venture capital and investing firm innovation rates. *Research Policy*, 34(5): 615–639, 2005.

[55] Gary Dushnitsky and Michael J Lenox. When does corporate venture capital investment create firm value? *Journal of business venturing*, 21(6):753–772, 2006.

[56] Gary Dushnitsky and Zur Shapira. Entrepreneurial finance meets organizational reality: Comparing investment practices and performance of corporate and independent venture capitalists. *Strategic Management Journal*, 31(9):990–1017, 2010.

[57] Gary Dushnitsky and J Myles Shaver. Limitations to interorganizational knowledge acquisition: The paradox of corporate venture capital. *Strategic Management Journal*, 30(10):1045–1064, 2009.

[58] M Easwaramoorthy and Fataneh Zarinpoush. Interviewing for research. *Canada Volunteerism Initiative*, pages 1–2, 2006.

[59] Ecotricity. *A day in the life of an energy trader*. Retrieved from `https://www.ecotricity.co.uk/news/news-archive/2018/a-day-in-the-life-of-an-energy-trader`, 2018. Accessed: 2020-08-19.

[60] Ecotricity. *Green Gas*. Retrieved from `https://www.ecotricity.co.uk/our-green-energy/green-gas`, 2021. Accessed: 2021-03-04.

[61] Eneco. *Who we are*. Retrieved from `https://www.eneco.com/who-we-are/`, 2021. Accessed: 2021-02-05.

[62] Maximilian Engelken, Benedikt Römer, Marcus Drescher, Isabell M Welpe, and Arnold Picot. Comparing drivers, barriers, and opportunities of business models for renewable energies: A review. *Renewable and Sustainable Energy Reviews*, 60:795–809, 2016.

[63] ENGIE. *Group – Who we are*. Retrieved from `https://www.engie.com/en/group/who-we-are`, 2021. Accessed: 2021-03-07.

[64] Jim Euchner and Abhijit Ganguly. Business model innovation in practice. *Research-Technology Management*, 57(6):33–39, 2014.

[65] Eurelectric. *Utilities: Powerhouses of Innovation*. Retrieved from `https://www.eurelectric.org/media/1799/utilities_powerhouses_of_innovation_findings_and_recommendations_final-2013-104-0002-01-e.pdf`, 2013. Accessed: 2020-06-05.

[66] Eurostat. *Renewable energy statistics*. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics#Wind_and_water_provide_most_renewable_electricity.3B_sola growing_energy_source, 2021. Accessed: 2021-03-04.

[67] Nicolai J Foss and Tina Saebi. Fifteen years of research on business model innovation: How far have we come, and where should we go? *Journal of Management*, 43(1):200–227, 2017.

[68] Nicolai J Foss and Tina Saebi. Business models and business model innovation: Between wicked and paradigmatic problems. *Long Range Planning*, 51(1):9–21, 2018.

[69] Karolin Frankenberger, Tobias Weiblen, Michaela Csik, and Oliver Gassmann. The 4i-framework of business model innovation: A structured view on process phases and challenges. *International journal of product development*, 18(3-4):249–273, 2013.

[70] Christoph W Frei. What if...? utility vision 2020. *Energy Policy*, 36(10):3640–3645, 2008.

[71] Fanny Frei, Simon R Sinsel, Ahmed Hanafy, and Joern Hoppmann. Leaders or laggards? the evolution of electric utilities' business portfolios during the energy transition. *Energy Policy*, 120: 655–665, 2018.

[72] Boris Fritscher and Yves Pigneur. Extending the business model canvas: A dynamic perspective. In *Proc. International Symposium on Business Modeling and Software Design*, volume 5, pages 86–96. ScitePress, 2015.

[73] Vibha Gaba and Alan D Meyer. Crossing the organizational species barrier: How venture capital practices infiltrated the information technology sector. *Academy of Management Journal*, 51(5): 976–998, 2008.

[74] Martin Geissdoerfer, Nancy MP Bocken, and Erik Jan Hultink. Design thinking to enhance the sustainable business modelling process–a workshop based on a value mapping process. *Journal of Cleaner Production*, 135:1218–1232, 2016.

[75] Martin Geissdoerfer, Doroteya Vladimirova, and Steve Evans. Sustainable business model innovation: A review. *Journal of cleaner production*, 198:401–416, 2018.

[76] Edward Giesen, Saul J Berman, Ragna Bell, and Amy Blitz. Three ways to successfully innovate your business model. *Strategy & leadership*, 2007.

[77] Eneco Group. *Ventures*. Retrieved from https://www.eneco.com/what-we-do/ventures/, 2021. Accessed: 2021-03-07.

[78] Sonnen Group. *sonnenCommunity*. Retrieved from https://sonnengroup.com/sonnencommunity/, 2020. Accessed: 2020-08-20.

[79] Petra Gsodam, Romana Rauter, and Rupert J Baumgartner. The renewable energy debate: how austrian electric utilities are changing their business models. *Energy, Sustainability and Society*, 5(1):1–12, 2015.

[80] Marta Guerra-Mota, Thereza Aquino, and Isabel Soares. European electricity utilities managing energy transition challenges. *Environment, Development and Sustainability*, 20(1):213–230, 2018.

[81] Tobias Gutmann. Harmonizing corporate venturing modes: an integrative review and research agenda. *Management Review Quarterly*, 69(2):121–157, 2019.

[82] Stephen Hall and Katy Roelich. Business model innovation in electricity supply markets: The role of complex value in the united kingdom. *Energy Policy*, 92:286–298, 2016.

[83] Juho Hamari, Mimmi Sjöklint, and Antti Ukkonen. The sharing economy: Why people participate in collaborative consumption. *Journal of the association for information science and technology*, 67(9):2047–2059, 2016.

[84] Michael Hamwi and Iban Lizarralde. A review of business models towards service-oriented electricity systems. 2017.

[85] Matthew J Hannon, Timothy J Foxon, and William F Gale. The co-evolutionary relationship between energy service companies and the uk energy system: Implications for a low-carbon transition. *Energy Policy*, 61:1031–1045, 2013.

[86] Thorsten Helms. Asset transformation and the challenges to servitize a utility business model. *Energy Policy*, 91:98–112, 2016.

[87] Thorsten Helms, Moritz Loock, and René Bohnsack. Timing-based business models for flexibility creation in the electric power sector. *Energy Policy*, 92:348–358, 2016.

[88] Iñaki Heras-Saizarbitoria, Lucía Sáez, Erlantz Allur, and Jon Morandeira. The emergence of renewable energy cooperatives in spain: A review. *Renewable and Sustainable Energy Reviews*, 94:1036–1043, 2018.

[89] Carsten Herbes and Iris Ramme. Online marketing of green electricity in germany—a content analysis of providers' websites. *Energy Policy*, 66:257–266, 2014.

[90] Carsten Herbes, Vasco Brummer, Judith Rognli, Susanne Blazejewski, and Naomi Gericke. Responding to policy change: New business models for renewable energy cooperatives–barriers perceived by cooperatives' members. *Energy Policy*, 109:82–95, 2017.

[91] Dóra Horváth and Roland Zs Szabó. Evolution of photovoltaic business models: Overcoming the main barriers of distributed energy deployment. *Renewable and Sustainable Energy Reviews*, 90:623–635, 2018.

[92] Hao-Chen Huang, Mei-Chi Lai, Lee-Hsuan Lin, and Chien-Tsai Chen. Overcoming organizational inertia to strengthen business model innovation. *Journal of Organizational Change Management*, 2013.

[93] IEA. System integration of renewables - an update on best practice. Technical report, OECD/IEA, Paris, 2018.

[94] IEA. World energy outlook 2020. Technical report, IEA, Paris, 2020.

[95] MIT Energy Initiative et al. Utility of the future: An mit energy initiative response to an industry in transition. *available athttps://energy. mit. edu/wp-content/uploads/2016/12/Utility-of-the-Future-Full-Report. pdf, accessed on December*, 20:2017, 2016.

[96] CB Insights. *The 2019 Global CVC Report*. Retrieved from `https://www.cbinsights.com/research/report/corporate-venture-capital-trends-2019/`. Accessed: 2020-08-05.

[97] Felicia Jackson. Corporates' venture: Corporate venture capital could prove the vital lifeline for renewable energy developers facing an exodus of private equity investors from the market. *Renewable Energy Focus*, 12(5):30–33, 2011.

[98] Mark W Johnson, Clayton M Christensen, and Henning Kagermann. Reinventing your business model. *Harvard business review*, 86(12):57–68, 2008.

[99] Alexandre Joyce and Raymond L Paquin. The triple layered business model canvas: A tool to design more sustainable business models. *Journal of cleaner production*, 135:1474–1486, 2016.

[100] Martijn Kemper. A corporate venturing unit at evis: A msc-thesis research in external corporate venturing objectives and crucial factors for a corporate venturing unit engaged in external corporate venturing. 2020.

[101] Saeed Khanagha, Henk Volberda, and Ilan Oshri. Business model renewal and ambidexterity: structural alteration and strategy formation process during transition to a c loud business model. *R&D Management*, 44(3):322–340, 2014.

[102] Clement Kirui, Li Hong, Wilson Cheruiyot, and Hillary Kirui. Predicting customer churn in mobile telephony industry using probabilistic classifiers in data mining. *International Journal of Computer Science Issues (IJCSI)*, 10(2 Part 1):165, 2013.

[103] B Klagge and T Meister. Energy cooperatives in germany–an example of successful alternative economies? *Local Environment*, 23(7):697–716, 2018.

[104] Merla Kubli, Moritz Loock, and Rolf Wüstenhagen. The flexible prosumer: Measuring the willingness to co-create distributed flexibility. *Energy policy*, 114:540–548, 2018.

[105] Jean-Sébastien Lantz, Jean-Michel Sahut, and Frédéric Teulon. What is the real role of corporate venture capital? *International Journal of Business*, 16(4):367, 2011.

[106] Rafael Leal-Arcas, Juan Alemany Rios, and Nelson Akondo. Energy decentralization in the european union. *Georgetown Environmental Law Review*, 32, 2019.

[107] Ronald L Lehr. New utility business models: utility and regulatory models for the modern era. *The Electricity Journal*, 26(8):35–53, 2013.

[108] Alessandro Li Vigni. A model for the corporate entrepreneurship journey. framing forms and practices from explorations in the energy sector. 2019.

[109] Marcos Lima and Patricia Baudier. Business model canvas acceptance among french entrepreneurship students: Principles for enhancing innovation artefacts in business education. *Journal of Innovation Economics Management*, (2):159–183, 2017.

[110] Z Lindgardt, M Reeves, G Stalk, and MS Deimler. Business model innovation: When the game gets tough, change the game. *Boston: Boston Consulting Group*, 2009.

[111] Antonios D Livieratos and Panagiotis Lepeniotis. Corporate venture capital programs of european electric utilities: Motives, trends, strategies and challenges. *The Electricity Journal*, 30(2): 30–40, 2017.

[112] Sabine Löbbe and André Hackbarth. The transformation of the german electricity sector and the emergence of new business models in distributed energy systems. In *Innovation and Disruption at the Grid's Edge*, pages 287–318. Elsevier, 2017.

[113] Enrique Loredo, Nuria Lopez-Mielgo, Gustavo Pineiro-Villaverde, and María Teresa García-Álvarez. Utilities: Innovation and sustainability. *Sustainability*, 11(4):1085, 2019.

[114] Jens Lowitzsch and Florian Hanke. Renewable energy cooperatives. In *Energy Transition*, pages 139–162. Springer, 2019.

[115] Peter D Lund, Juuso Lindgren, Jani Mikkola, and Jyri Salpakari. Review of energy system flexibility measures to enable high levels of variable renewable electricity. *Renewable and Sustainable Energy Reviews*, 45:785–807, 2015.

[116] Joan Magretta. Why business models matter, 2002.

[117] Jeff D Makholm. The new "three ds" in regulation—decarbonization, decentralization, and digitization. *Natural Gas & Electricity*, 35(2):18–22, 2018.

[118] Vito Manfredi Latilla, Andrea Urbinati, Davide Chiaroni, and Federico Frattini. Harnessing open innovation in the reorganization of an energy utility. 2017.

[119] Constantinos Markides. Disruptive innovation: In need of better theory. *Journal of product innovation management*, 23(1):19–25, 2006.

[120] Lorenzo Massa and Christopher L Tucci. Business model innovation. *The Oxford handbook of innovation management*, 20(18):420–441, 2013.

[121] Markku Maula and Gordon Murray. Complementary value-adding roles of corporate venture capital and independent venture capital investors. *The Journal of BioLaw & Business*, 5(2), 2001.

[122] Markku VJ Maula. Corporate venture capital as a strategic tool for corporations. *Handbook of research on venture capital*, 1:371–392, 2007.

[123] Markku VJ Maula et al. *Corporate venture capital and the value-added for technology-based new firms*. Helsinki University of Technology, 2001.

[124] Hannes Maxin. Corporate venture capital and the nature of innovation. *Economics of Innovation and New Technology*, 29(1):1–30, 2020.

[125] Kevin McNally. *Corporate Venture Capital: Bridging the equity gap in the small business sector*. Routledge, 1997.

[126] Donald W Mitchell and Carol Bruckner Coles. Business model innovation breakthrough moves. *Journal of business strategy*, 25(1):16–27, 2004.

[127] Nicolette Andrea Mudaly et al. *Business model innovation: the drivers, enablers and inhibitors of firms facing disruptive change*. PhD thesis, University of Pretoria, 2017.

[128] Johann Jakob Napp and Tim Minshall. Corporate venture capital investments for enhancing innovation: Challenges and solutions. *Research-Technology Management*, 54(2):27–36, 2011.

[129] VK Narayanan, Yi Yang, and Shaker A Zahra. Corporate venturing and value creation: A review and proposed framework. *Research policy*, 38(1):58–76, 2009.

[130] Natuur&Milieu. *Stroomranking 2020*. Retrieved from `https://www.natuurenmilieu.nl/themas/energie/projecten-energie/stroomranking/`, 2021. Accessed: 2021-03-04.

[131] Abhishek Neeli. A step towards successful implementation of business model innovation: Philips perspective. 2019.

[132] Paul Nillesen and Michael Pollitt. New business models for utilities to meet the challenge of the energy transition. In *Future of Utilities Utilities of the Future*, pages 283–301. Elsevier, 2016.

[133] Paul Nillesen, Michael Pollitt, and Eva Witteler. New utility business model: A global view. In *Distributed generation and its implications for the utility industry*, pages 33–47. Elsevier, 2014.

[134] NU.nl. *Tekort aan loodgieters en elektriciens zal komende jaren verdubbelen*. Retrieved from `https://www.nu.nl/economie/6107225/tekort-aan-loodgieters-en-elektriciens-zal-komende-jaren-verdubbelen.html`, January 2021. Accessed: 2021-03-05.

[135] Lasse Okkonen and Niko Suhonen. Business models of heat entrepreneurship in finland. *Energy Policy*, 38(7):3443–3452, 2010.

[136] Alexander Osterwalder and Yves Pigneur. *Business Model Generation: a handbook for visionaries, game changers, and challengers*. John Wiley Sons, Inc., 2010.

[137] Peter Palensky and Dietmar Dietrich. Demand side management: Demand response, intelligent energy systems, and smart loads. *IEEE transactions on industrial informatics*, 7(3):381–388, 2011.

[138] Lee Won Park, Sanghoon Lee, and Hangbae Chang. A sustainable home energy prosumer-chain methodology with energy tags over the blockchain. *Sustainability*, 10(3):658, 2018.

[139] Sarah Park and Joseph A LiPuma. New venture internationalization: The role of venture capital types and reputation. *Journal of World Business*, 55(1):101025, 2020.

[140] Felix Pinkow and Jasper Iversen. Strategic objectives of corporate venture capital as a tool for open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 6(4):157, 2020.

[141] Aaron Praktiknjo and Georg Erdmann. Renewable electricity and backup capacities: an (un-) resolvable problem? *The energy journal*, 37(Bollino-Madlener Special Issue), 2016.

[142] PwC. Energy transformation: the impact on the power sector business model. *The 13th PwC Global Power and Utilities Survey*, 2013.

[143] PwC. A different energy future: Where energy transformation is leading us. *The 14th PwC Global Power and Utilities Survey*, 2015.

[144] PwC. The narrowing window for energy transformation. *The 15th PwC Global Power and Utilities Survey*, 2018.

[145] Christian Redl, Fabian Hein, Matthias Buck, Patrick Graichen, and Dave Jones. The european power sector in 2019: Up-to-date analysis on the electricity transition. *Agora Energiewende and Sandbag*, 2020.

[146] Mario Richter. Utilities' business models for renewable energy: A review. *Renewable and Sustainable Energy Reviews*, 16(5):2483–2493, 2012.

[147] Mario Richter. Business model innovation for sustainable energy: German utilities and renewable energy. *Energy Policy*, 62:1226–1237, 2013.

[148] Mario Richter. German utilities and distributed pv: How to overcome barriers to business model innovation. *Renewable Energy*, 55:456–466, 2013.

[149] Roamler. *De nieuwe manier van installeren*. Retrieved from `https://www.roamler.com/nl/tech`, 2021. Accessed: 2021-03-06.

[150] Jesús Rodríguez-Molina, Margarita Martínez-Núñez, José-Fernán Martínez, and Waldo Pérez-Aguiar. Business models in the smart grid: Challenges, opportunities and proposals for prosumer profitability. *Energies*, 7(9):6142–6171, 2014.

[151] Stephen Rogers, Mathhias Von Bechtolsheim, Nick White, David Borras, Robin Francis, and Kirsty Ingham. Radical change for european power utilities: Innovative responses to the renewables glut – transformation or extinction? *Arthur D. Little - Prism*, 2, 2014.

[152] Stephen Rogers, Jaap Kalkman, David Borras, Rodolfo Guzman, Daniel Monzon, Yotaro Akamine, Michael Kruse, Ilya Epikhin, and Elias Ghantous. Energy journal – utilities: Perspectives on the utilities industry 2018. *Arthur D. Little*, 2018.

[153] María Camila Romero, Jorge Villalobos, and Mario Sanchez. Simulating the business model canvas using system dynamics. In *2015 10th Computing Colombian Conference (10CCC)*, pages 527–534. IEEE, 2015.

[154] Salvatore Ruggiero, Vilja Varho, and Pasi Rikkonen. Transition to distributed energy generation in finland: Prospects and barriers. *Energy Policy*, 86:433–443, 2015.

[155] Marcelo Sandoval and Santiago Grijalva. Future grid business model innovation: distributed energy resources services platform for renewable energy integration. In *2015 Asia-Pacific Conference on Computer Aided System Engineering*, pages 72–77. IEEE, 2015.

[156] Ruggero Schleicher-Tappeser. How renewables will change electricity markets in the next five years. *Energy policy*, 48:64–75, 2012.

[157] Andreas Schumacher, Wilfried Sihn, and Selim Erol. Automation, digitization and digitalization and their implications for manufacturing processes. In *Innovation and Sustainability Conference Bukarest*, 2016.

[158] Uma Sekaran and Roger Bougie. *Research methods for business: A skill building approach*. John Wiley & Sons, 2016.

[159] Souvik Sen and Sourav Ganguly. Opportunities, barriers and issues with renewable energy development–a discussion. *Renewable and Sustainable Energy Reviews*, 69:1170–1181, 2017.

[160] David Soto Setzke, Lotta Opderbeck, Markus Böhm, and Helmut Krcmar. Pathways to successful business model innovation in the context of digital transformation. *Pathways*, 6:22–2020, 2020.

[161] Fereidoon P Sioshansi. *Distributed generation and its implications for the utility industry*. Academic Press, 2014.

[162] Steven C Smith, PK Sen, and Benjamin Kroposki. Advancement of energy storage devices and applications in electrical power system. In *2008 IEEE Power and Energy Society General Meeting-Conversion and Delivery of Electrical Energy in the 21st Century*, pages 1–8. IEEE, 2008.

[163] Hannah Snyder. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104:333–339, 2019.

[164] Marc Sosna, Rosa Nelly Trevinyo-Rodríguez, and S Ramakrishna Velamuri. Business model innovation through trial-and-error learning: The naturhouse case. *Long range planning*, 43(2-3): 383–407, 2010.

[165] Benjamin K Sovacool, Johannes Kester, Lance Noel, and Gerardo Zarazua de Rubens. Actors, business models, and innovation activity systems for vehicle-to-grid (v2g) technology: A comprehensive review. *Renewable and Sustainable Energy Reviews*, 131:109963, 2020.

[166] Jan Martin Specht and Reinhard Madlener. Energy supplier 2.0: A conceptual business model for energy suppliers aggregating flexible distributed assets and policy issues raised. *Energy Policy*, 135:110911, 2019.

[167] Georg Stampfl. *The process of business model innovation: an empirical exploration*. Springer, 2015.

[168] Daniel Steinberg, Dave Bielen, Josh Eichman, Kelly Eurek, Jeff Logan, Trieu Mai, Colin McMillan, Andrew Parker, Laura Vimmerstedt, and Eric Wilson. Electrification and decarbonization: Exploring us energy use and greenhouse gas emissions in scenarios with widespread electrification and power sector decarbonization. Technical report, National Renewable Energy Lab.(NREL), Golden, CO (United States), 2017.

[169] Jennie C Stephens, Daniel J Kopin, Elizabeth J Wilson, and Tarla Rai Peterson. Framing of customer engagement opportunities and renewable energy integration by electric utility representatives. *Utilities Policy*, 47:69–74, 2017.

[170] Lars Strupeit and Alvar Palm. Overcoming barriers to renewable energy diffusion: business models for customer-sited solar photovoltaics in japan, germany and the united states. *Journal of Cleaner Production*, 123:124–136, 2016.

[171] Hollister B Sykes. Corporate venture capital: Strategies for success. *Journal of Business Venturing*, 5(1):37–47, 1990.

[172] Sarosh Talukdar, Venkataraman C Ramesh, Richard Quadrel, and Richard Christie. Multiagent organizations for real-time operations. *Proceedings of the IEEE*, 80(5):765–778, 1992.

[173] Mumtaz Tarhan. Renewable energy cooperatives: a review of demonstrated impacts and limitations. *Journal of Entrepreneurial and Organizational Diversity*, 4(1):104–120, 2015.

[174] Dev Tayal and Vanessa Rauland. Future business models for western australian electricity utilities. *Sustainable Energy Technologies and Assessments*, 19:59–69, 2017.

[175] David J Teece. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic management journal*, 28(13):1319–1350, 2007.

[176] David J Teece. Business models, business strategy and innovation. *Long range planning*, 43 (2-3):172–194, 2010.

[177] TenneT. *Wind op Zee – Programma 2030*. Retrieved from `https://www.tennet.eu/nl/ons-hoogspanningsnet/net-op-zee-projecten-nl/programma-2030/`, 2021. Accessed: 2021-03-05.

[178] Tarja Teppo and Rolf Wüstenhagen. Corporate venture capital, organizational culture and industry context: The case of the energy sector. *SILICON VALLEY REVIEW OF GLOBAL ENTREPRENEURSHIP RESEARCH*, page 221, 2005.

[179] Tarja Teppo and Rolf Wüstenhagen. Corporate venture capital in the european energy sector: A key driver for commercializing sustainable technologies?, 2006.

[180] Tarja Teppo and Rolf Wustenhagen. Why corporate venture capital funds fail–evidence from the european energy industry. *World Review of Entrepreneurship, Management and Sustainable Development*, 5(4):353–375, 2009.

[181] Michael L Tushman and Charles A O'Reilly III. Ambidextrous organizations: Managing evolutionary and revolutionary change. *California management review*, 38(4):8–29, 1996.

[182] Maria Urbaniec and Agnieszka Żur. Business model innovation in corporate entrepreneurship: exploratory insights from corporate accelerators. *International Entrepreneurship and Management Journal*, pages 1–24, 2020.

[183] Kathleen Vaillancourt, Olivier Bahn, Erik Frenette, and Oskar Sigvaldason. Exploring deep decarbonization pathways to 2050 for canada using an optimization energy model framework. *Applied Energy*, 195:774–785, 2017.

[184] Michael Valocchi, John Juliano, and Allan Schurr. Switching perspectives: Creating new business models for a changing world of energy. In *Smart grid applications and developments*, pages 165–182. Springer, 2014.

[185] Vareska Van de Vrande, Jeroen PJ De Jong, Wim Vanhaverbeke, and Maurice De Rochemont. Open innovation in smes: Trends, motives and management challenges. *Technovation*, 29(6-7): 423–437, 2009.

[186] Martijn van Gils. Analyzing the effect of corporate venture capital investments on a corporation's innovative performance. 2012.

[187] Rob van Nunen (Strategy&). Personal communication, 2021.

[188] Wim Vanhaverbeke, Vareska Van de Vrande, and Henry Chesbrough. Understanding the advantages of open innovation practices in corporate venturing in terms of real options. *Creativity and innovation management*, 17(4):251–258, 2008.

[189] ENGIE New Ventures. *About us*. Retrieved from `https://www.engieventures.com`, 2021. Accessed: 2021-03-07.

[190] Stephan Friedrich von den Eichen, Joerg Freiling, and Kurt Matzler. Why business model innovations fail. *Journal of Business Strategy*, 2015.

[191] Anu Wadhwa and Suresh Kotha. Knowledge creation through external venturing: Evidence from the telecommunications equipment manufacturing industry. *Academy of Management journal*, 49(4):819–835, 2006.

[192] Anu Wadhwa, Corey Phelps, and Suresh Kotha. Creating exploratory innovations by learning from entrepreneurial ventures. In *New frontiers in entrepreneurship*, pages 147–173. Springer, 2009.

[193] Anu Wadhwa, Corey Phelps, and Suresh Kotha. Corporate venture capital portfolios and firm innovation. *Journal of Business Venturing*, 31(1):95–112, 2016.

[194] Rahul Walawalkar, Jay Apt, and Rick Mancini. Economics of electric energy storage for energy arbitrage and regulation in new york. *Energy Policy*, 35(4):2558–2568, 2007.

[195] Florian Waldner, Marion K Poetz, Christoph Grimpe, and Markus Eurich. Antecedents and consequences of business model innovation: The role of industry structure. In *Business models and modelling*. Emerald Group Publishing Limited, 2015.

[196] Wase Wind. *Werking*. Retrieved from `https://www.wasewind.be/over-wase-wind/werking`, 2020. Accessed: 2020-08-20.

[197] R Wüstenhagen and Jasper Boehnke. Business models for sustainable energy. *Perspectives on Radical Changes to Sustain-able Consumption and Production (SCP)*, 20:253, 2006.

[198] Robert K Yin. *Case Study Research and Applications: Design and Methods*. Los Angeles, CA: Sage Publications, 2017.

[199] William P Zarakas. Two-sided markets and the utility of the future: How services and transactions can shape the utility platform. *The Electricity Journal*, 30(7):43–46, 2017.

[200] Chenghua Zhang, Jianzhong Wu, Yue Zhou, Meng Cheng, and Chao Long. Peer-to-peer energy trading in a microgrid. *Applied Energy*, 220:1–12, 2018.

[201] Christoph Zott and Raphael Amit. The fit between product market strategy and business model: implications for firm performance. *Strategic management journal*, 29(1):1–26, 2008.

[202] Christoph Zott, Raphael Amit, and Lorenzo Massa. The business model: recent developments and future research. *Journal of management*, 37(4):1019–1042, 2011.

A

Interview Questions

In this appendix, the interview questions are presented that were used to conduct the semi-structured interviews, as was addressed in section 2.2. Section A.1 contains the questions used for incumbent utility managers, and section A.2 the questions used for CVC managers.

A.1. Interview Questions for Utility Managers

Phase 0: Introduction and explanation of research

Phase 1: Energy sector developments

1. What do you think that are the most important developments that are changing the energy sector?
   (a) *In case not all six developments are mentioned: ask directly*
2. What is the impact of these developments on the business model of traditional, incumbent utilities?
   (a) Do you think that the BM of incumbent utilities is well adapted to these developments? Why?
   (b) Do you think it is important for incumbent utilities to adapt to all developments?
   (c) Would you say for incumbent, traditional utilities a fundamental innovation of their business model would be required to maintain a strong competitive position?

Phase 2: Business Model Innovation

3. What is the innovation strategy that is applied within [utility name]]? Internal / external / combination?
   (a) Why is this specific strategy applied?
   (b) Why is this strategy more promising than other strategies?
4. What do you think that are the most important barriers that hinder business model innovation? Both internal and external.
   (a) *If needed: examples are cognitive barriers (internal), feed-in tariff issues (external; regulatory)*
   (b) Are these barriers utility-specific? If no, do those also exist? If yes, can you also think of more generally applicable challenges to business model innovation that are relevant for [utility name]?
5. What do you think that are the most important stimulating factors that facilitate business model innovation?
   (a) *If needed: examples are an innovative culture, entrepreneurship, open innovation, etc.*
   (b) Are there any utility-specific stimulating factors as well?

Phase 3: Corporate Venture Capital

6. With which aim has the CVC unit been established?
   (a) Financial vs. Strategic aim?
   (b) What are the most important specific benefits that a CVC program can deliver? *If needed: examples are a general overview of new markets, technologies and business models, access to external technologies, etc.*
   (c) Is the CVC unit also established with the specific goal to help facilitate business model innovation of the overall company?
   (d) What are the long-term goals of the utility with the CVC unit? Integral part of the innovation strategy or only for a few years?
7. Do you think that CVC is a necessary component of the strategy of incumbent utilities to innovate their BM and adapt to the energy sector changes? If yes, why?
   (a) Would it also be possible with a different model?
   (b) Would it also be possible strictly internally, so without open innovation or external collaboration?
8. Has [utility name] already visibly benefited from the CVC activities?
   (a) Has the parent's BM advanced because of the CVC program? If yes, how?
   (b) Can CVC activities help to remove or circumvent the barriers to business model innovation?
   (c) If not mentioned: are there any indirect impacts visible (such as promotion of an innovative/entrepreneurial culture?
9. Do the CVC activities also have specifically contributed to increased adaptation of [utility name] to the identified energy sector developments?
   (a) If yes, can you specify this? If no, do you think this will become visible in the future?
   (b) Does the ,scvc also have negative impacts on the utility?
10. How is the performance of the CVC unit evaluated? On basis of financial result or strategic KPIs?

Phase 4: Wrap-up

11. Is there anything you would like to add yourself?

A.2. Interview Questions for CVC Managers

Phase 0: Introduction and explanation of research

Phase 1: Raison d'être

1. Why has the CVC unit been established, and what are its goals?
   (a) What are the specific goals of the parent with the CVC unit?
   (b) How does the parent evaluate performance of the CVC unit?
   (c) How are financial/strategic targets balanced?
   (d) What does the CVC unit expect of the parent?
   (e) What are the goals of the CVC itself? Same as the goals of the parent for the CVC unit?

Phase 2: Energy sector developments and role of Corporate Venture Capital

2. What do you think that are the most important developments that are changing the energy sector, and their effect on incumbent utilities?

   (a) Do you think that the BM of incumbent utilities is well adapted to these developments? If yes, why? If no, why not?
   (b) Do you think it is important for incumbent utilities to adapt to all developments?

3. Do you think that CVC is a necessary component of the strategy of incumbent utilities to innovate their CVC and adapt to the energy sector changes? If yes, why?
   (a) What specific contributions can CVC deliver to innovation of the corporate BM?
   (b) How does CVC in the electric utility industry compare to other sectors? Is CVC in this sector different, and if yes, what makes it different?

Phase 3: CVC fund characteristics

4. Which types of ventures are targeted by [name fund] (in terms of activities)?
5. Are the ‘normal’ business units of the utility involved in the investment process, and if yes, how? Note: this relates mainly to the link between the strategic aspects of every investment and the daily business, so not to legal, finance, etc.
   (a) Which specific business units are involved?
   (b) How are the expected (financial/strategic) benefits of each investment determined?
   (c) Is each investment expected to contribute something to individual business units? And to the overall corporate BM?
6. After the investment has been done, what does the collaboration look like?
   (a) How is the interaction between ventures and corporate business units? Active / passive?
   (b) Is performance continuously measured? If yes, on basis of what / what are the KPIs?
   (c) Is the contribution of specific investments to innovation of the corporate (BM / business units) measured as well? If yes, how?
7. What are common exit strategies for investments (IPO, acquisition, integration)?
   (a) What is the average duration of an investment?
   (b) When is it decided to exit?
   (c) Do cases exist in which (parts of) ventures are integrated in the parent? If yes, when?
8. Do all ventures have to deliver financial results? If yes, how do you balance between strategic and financial contribution?
9. What are the most significant challenges the CVC unit experiences?

Phase 4: Impact of CVC activities on BMI

10. Are there any visible, concrete impacts of the CVC activities on business model innovation of [utility name]? If yes, which?
    (a) Has the parent’s BM developed because of the CVC activities? If yes, how?
    (b) Have the CVC activities contributed to increased adaptation of [utility name] on the identified major power sector developments?
    (c) If not mentioned: are there any indirect impacts visible (such as promotion of an innovative/entrepreneurial culture?
    (d) Do the CVC activities have negative impacts as well?

B

Summary of Expert Consultations

As discussed in Chapter 2, in this appendix a *summary of the outcomes of the expert consultations* is provided. Unfortunately, only one expert gave permission for this, so a summary of the second consultation could not be included.

B.1. Consultation with Expert from TNO

First of all, with respect to the energy systems in different European countries, it was noted that after the deregulation of the European energy markets, the exact degree to which countries have implemented the deregulation differs. For example, in the Netherlands this liberalization has been taken very seriously and is therefore relatively strictly implemented; Eneco and Stedin are now completely separate entities. In other countries, this might be different, and traditional utilities might be still much more integrated than in the Netherlands. This is something that had to be kept in mind.

Regarding the currently existing business model types for electric utilities, no additional insights emerged. However, it was stretched that the definition of a utility itself has changed as a result of all developments in the energy industry. For example, there are now utilities which are only active in generation, and other utilities which do not do generation but only retail. For the energy sector developments, the six identified trends in literature (decarbonization, decentralization, digitalization, electrification of end-use sectors, increased energy storage, energy efficiency) were indeed recognized as the most important ones, but a few additional notes had to be taken. First of all, decarbonization of heat (besides electricity) is also an important theme, so that deserved to be mentioned more explicitly in the overall decarbonization trend. Also, the importance of changing ‘increased use of energy storage’ into the broader ‘increased use of energy system flexibility measures’ was highlighted, as this also includes increased interconnections between power systems. Furthermore, it was mentioned that the strict boundaries between different energy vectors (electricity, gas, and heat) are blurring. For example, heat can be generated by electricity through a heat pump or can be recovered, green gases (e.g. hydrogen) can be produced by electricity and can be used to store energy or power vehicles. It all flows over in each other, which is something that had to be noted in the electrification of end-use sectors trend as well. With respect to decentralization, it is important to note that increasingly local energy initiatives emerge, e.g. neighborhoods with own plans to be independent of natural gas, going all electric. Incumbent utilities could subsequently play a role in facilitating that, but these bottom-up initiatives are an important social trend that had to be mentioned as well. Finally, for incumbent utilities in particular it was highlighted that the ‘outcome’ of all developments combined will require a shift from an anonymous energy relation to energy as a service.

With respect to the business model innovation, the relevance of individual barriers was assessed in a survey. In addition, one example of regulatory issues was highlighted. In other European countries, with the installation of smart meters also smart thermostats were installed to increase conscious energy use by consumers, consequently leading to lower energy use. In the Netherlands, it was decided to leave this to the open market. However, it turned out that customers lacked interest, and as such the diffusion of smart thermostats has failed. This is a good example of shortcomings in regulations. Also, an example of incumbent utilities experiencing conflicts of BMIs with existing assets or BMs was illustrated. If for them, their traditional model (selling as much electricity as possible) is their cash-cow, why would they be interested in smart meters, which would lead to decreased energy usage and thus lower sales? These were both seen as important subjects.

Regarding the benefits of CVC activities, no additional insights emerged, but again a few notes had to be made. Through CVC, utilities are mainly looking to internalize external (BM) innovations. They want to create a range of different options as it is uncertain what will work out well and what will not, which is reflected in the large percentage of ventures that fail. Furthermore, the aim can be to simply buy external innovations, or to mitigate potential competitive threats by those ventures through acquiring a stake. Also, CVC activities are seen as important to promote an innovative corporate image, which can increase utility attractiveness. Furthermore, it was highlighted that CVC is also a bit hyped, as not all innovation origins from startups. CVC is an interesting way to bring certain technologies and business models to the market, but is definitely not the only way to achieve BM innovation. For example, incubators, public-private partnerships, etc. are also good options. However, companies have fear of missing out on CVC and thereby create too much hype. Finally, two other subjects were seen as important for determining the contribution of CVC. On the one hand, this included the assessment of why startups would engage in CVC. On the other hand, this referred to the presence of a good startup and knowledge sharing climate, which is strongly dependent on geography.

C
Definitions

This appendix contains two overviews of different existing definitions. Table C.1 addresses the existing *definitions of a business model*, discussed in section 3.1. Table C.2 addresses the existing *definitions of Business Model Innovation*, discussed in section 5.1.

Table C.1: Overview of some existing 'business model' definitions. Refers to 'definitions of a business model' in section 3.1.

Research	**Definition**
Amit & Zott (2001, p.511) [6]	*"A business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities."*
Chesbrough (2010, p.354) [33]	*"Companies commercialize new ideas and technologies through their business models."*
Chesbrough & Rosenbloom (2002; p.532) [34]	*"The business model provides a coherent framework that takes technological characteristics and potentials as inputs, and converts them through customers and markets into economic outputs. The business model is thus conceived as a focusing device that mediates between technology development and economic value creation."*
Euchner & Ganguly (2014, p.33) [64]	*"The business model is the means by which a firm creates and sustains margins or growth."*
Johnson et al. (2008, p.60) [98]	*"A business model, from our point of view, consists of four interlocking elements that, taken together, create and deliver value."*
Magretta (2002; p.4) [116]	*"A good business model answers Peter Drucker's age-old questions: Who is the customer? And what does the customer value? It also answers the fundamental questions every manager must ask: How do we make money in this business? What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?"*
Osterwalder & Pigneur (2010, p.14) [136]	*"A business model describes the rationale of how an organization creates, delivers, and captures value."*
Teece (2010; p.179) [176]	*"A business model articulates the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value. In short, it's about the benefit the enterprise will deliver to customers, how it will organize to do so, and how it will capture a portion of the value that it delivers."*
Zott & Amit (2008, p.5) [201]	*"A structural template of how a focal firm transacts with customers, partners, and vendors. It captures the pattern of the firm's boundary spanning connections with factor and product markets."*

Table C.2: Overview of some existing 'business model innovation' definitions. Refers to 'definitions of Business Model Innovation' in section 5.1.

Research	Definition
Casadesus-Masanell & Zhu (2013, p.464) [25]	*"Business model innovation refers to the search for new logics of the firm and new ways to create and capture value for its stakeholders; it focuses primarily on finding new ways to generate revenues and define value propositions for customers, suppliers, and partners."*
Foss & Saebi (2017, p.201) [67]	*"[Business model innovation can be defined as] designed, novel, nontrivial changes to the key elements of a firm's business model and/or the architecture linking these elements."*
Frankenberger et al. (2013, p.253) [69]	*"Business model innovation can be defined as a novel way of how to create and capture value, which is achieved through a change of one or multiple components in the business model."*
Geissdoerfer et al. (2016, p.1220) [74]	*"Business model innovation describes either a process of transformation from one business model to another within incumbent companies or after mergers and acquisitions, or the creation of entirely new business models in start-ups."*
Geissdoerfer et al. (2018, p.405) [75]	*"[Business model innovation is] the conceptualisation and implementation of new business models. This can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another. The transformation can affect the entire business model or individual or a combination of its value proposition, value creation and deliver, and value capture elements, the interrelations between the elements, and the value network."*
Khanagha et al. (2014, p.324) [101]	*"Business model innovation concerns the redefinition of existing products or service and how they are provided to customers."*
Lindgardt et al. (2009, p.2) [110]	*"Innovation becomes BMI [business model innovation] when two or more elements of a business model are reinvented to deliver value in a new way."*
Markides (2006, p.20) [119]	*"Business-model innovation is the discovery of a fundamentally different business model in an existing business."*
Mitchell & Coles (2004, p.17) [126]	*"By business model innovation, we mean business model replacements that provide product or service offerings to customers and end users that were not previously available. We also refer to the process of developing these novel replacements as business model innovation."*
Richter (2013, p.458) [148]	*"[Business model innovation is] the development of new organizational forms for the creation, delivery, and capture of value."*

D

Background Information on Business Model Innovation

This appendix provides additional background information on different aspects of business model innovation. As such, it elaborates upon subjects discussed in Chapter 4 and 5. In section D.1, the triggers for business model innovation are addressed, where after section D.2 discusses some general outlines of business model innovation for electric utilities. Finally, section D.3 addresses the different typologies of BMI.

D.1. Triggers for Business Model Innovation

This appendix provides an elaboration of the analysis about the need for fundamental business model innovation for traditional utilities. In section 4.3, it was stated that this unveiled need for BMI could be compared with general *Triggers for Business Model Innovation*. As such, this section will elaborate on this subject.

In their extensive literature review, Foss & Saebi [67] found that triggers of BMI differ in nature, in levels at which they exist, and that they can be internal or external to a firm. These findings are confirmed by other papers as well (e.g. [20], [127] and it seems that the classification in internal and external triggers is the common standard. However, it must be noted that external triggers are found to be more important [127].

First of all, the most important **external triggers** are often associated with changes in the market environment. For example, business model innovation can be triggered as a reaction to changing customer needs, market structures, competitive pressure, or demographic shifts [20], [67], [91], [167], [195]. Also, the emergence of new technologies is a widely recognized important trigger [20], [67], [91], [160], [195]. Especially emerging digital technologies (ICT) are reported to unveil new opportunities. Furthermore, changing stakeholder demands are identified as another external trigger [20], [67], as well as changes in the regulatory environment [20], [127], [195]. The latter may include both greater regulatory oversight and increased deregulation of markets (such as the energy market), as well as new regulations. Other external triggers are new market entrants (e.g. start-ups or cross-entrants) or shifts across the value chain [20], [28], [127].

Finally, external triggers can also exist at a macro level. Mainly two trends stand out: Böttcher & Weking [20] identified globalization as a major economic trend, while Foss & Saebi [67] addressed the need for greater environmental and social sustainability. The latter is not only confirmed by the increasing popularity of for example the sharing economy or the targeting of low-income consumers [67], but is also reflected in the growing amount of literature on *sustainable business model innovation* (e.g. [17], [18], [75]).

Secondly, also various **internal triggers** have been pointed out. The most important and widely recognized one is the existence of dynamic capabilities [20], [67], [127], [160]. According to Teece [175], dynamic capabilities can be subdivided into three capabilities: the ”capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets" (p.1319). As this already implies, the existence of these capabilities within a firm can be an important trigger of business model innovation, as in this way for example untapped market opportunities can be identified and harvested [67], [127]. Furthermore, business model innovation may also result from financial needs [20], [91], specific skills or knowledge in a certain (digital) technology [20], [160], [167], servitization (e.g. the integration of service components in the activity range) [67], [195], or changed internal stakeholder demands [127].

Finally, business model innovation can be driven by a strategic perspective, for example from the desire of ensuring business sustainability when managers recognize limitations or failure of the current business model [17], [20], [91], [127], [167].

When applying the possible triggers for BMI to the energy sector, it turns out that all identified major developments in the power sector, as described in section 4.1, can be immediately related to 'changes in the market environment'. Furthermore, specifically the digitalization and energy efficiency trends can be related to 'emergence of new (digital) technologies', and the decarbonization trend to the 'need for sustainability'. As we have seen in the more detailed analysis of these trends and their impact on the traditional utility business model and stakeholder demands (see Table 4.1), more connections can be made. In fact, one could argue that maybe except for globalization, all external triggers for BMI are directly relevant for the power sector as well.

The internal triggers can obviously be less easily retrieved from an environmental analysis. Nevertheless, it could be argued that financial needs (e.g. the decrease in profitability of the traditional utility business model), a shift towards servitization (e.g. offering a range of energy services instead of the bulk sale of electricity), and striving for business sustainability due to limitations of the current BM (the traditional utility model is outdated) are all apparent internal drivers.

An overview of all triggers of business model innovation that followed from the literature review is presented in Table D.1. In this table, the triggers that apply to electric utilities are highlighted.

Table D.1: Triggers for business model innovation of electric utilities. The triggers which apply to traditional electric utilities are highlighted.

Classification	Elements	Related papers
External	• **Changes in the market environment** • **Emergence of new (digital) technologies** • **Changing stakeholder demands** • **Changing regulatory environment** • **New market entrants** • **Shifts across the value chain** • Globalization • **Need for sustainability (environmental/social)**	[20], [28], [67], [91], [127], [160], [167], [195]
Internal	• Dynamic capabilities • **Financial needs** • Specific skills or knowledge in certain (digital) technology • **Shift towards servitization** • Changed internal stakeholder demands • **Strive for business sustainability due to limitations or failure of current BM**	[17], [20], [67], [91], [127], [160], [167], [195]

D.2. Innovation of Current Utility Business Models

As mentioned in *BMI for traditional utilities* in section 4.3, this section will discuss the general outlines for innovation of traditional electric utility business models.

The identified disrupting trends unveiled a strong need for innovation of - especially incumbent - electric utility business models, as was already acknowledged almost a decade ago. In 2012 and 2013, Richter [146], [147], [148] was one of the first to apply the concept of business model innovation to the energy sector. He recognized the fundamental changes that the energy industry is facing and found that utilities will have to adapt their business models to maintain their competitive position. Also, he stretched the need for new business models that go way beyond the delivery of electricity as a commodity, with a focus on active customer interface management [146].

A year later, these findings were confirmed by Valocchi et al. [184] who further addressed the typology of those future business models. In that sense, they found that new industry business models will be more consumer-driven, focusing on serving a business platform function that supports consumer participation, information exchange, and new services. However, despite these discoveries, utilities have not paid sufficient attention to the need for new business models, especially with respect to small-scale and decentralized renewable energy, as well as local supply models [79], [82]. So, it goes without saying that traditional utilities will have to fundamentally innovate their business models if they want to succeed in the changed environment [50], [86], [156], [166].

Now it has become clear that business model innovation is happening, the burning question remains what exactly is going to change. According to Osterwalder & Pigneur [136], there are four epicenters of business model innovation. In case of *resource-driven* innovations the epicenter is at an organization's existing infrastructure or partnerships, while with *offer-driven* innovations the starting point of business model change is at the value proposition [136]. *Customer-driven* addresses changed customer needs, facilitated access or increased convenience, affecting other business model elements as a result [136]. Finally, *finance-driven* innovations start with new revenue streams, pricing mechanisms, or reduced cost structures [136]. A schematic depiction of these epicenters is presented in Figure D.1.

When concerning electric utilities, the business model orientation of a traditional utility can obviously be categorized as resource-driven [166], as it is a capital-intensive model based on tangible assets [86], [132]. As we have seen, these tangible assets mainly included the large-scale centralized generation and distribution infrastructure, which immediately validates the sensibility of a resource-driven business model [166]. However, the profitability of this traditional model has been declining, and a new orientation of the business model will be required.

In the ongoing major trends in the energy industry, we have seen that there is a need for energy system flexibility for all actors [87], [104], [115]. On one hand, the increase of fluctuating renewable energy sources in the generation mix has led to more challenges in balancing supply and demand [87], [104]. Luckily, on the other hand decentralization and digitalization trends have created large potential for flexibility, for example through distributed battery storage or demand response [104], [115]. As can be seen in Table 4.1, for all actors this is a welcome fact, which has resulted in a search for business models that deploy distributed flexibility options [87]. However, in all cases the economic viability of these models will ultimately depend on whether they create customer value [104], [166]. In that sense, an example of a factor that is found to potentially create extra customer value is the offering of renewables-based electricity products [104]. By all means, utilities will have to develop significant higher levels of customer engagement, and offer new services and support [104], [146], [166]. As a result, it could be argued that the business model orientation of traditional utilities is shifting towards a customer-driven epicenter, shown in Figure D.1c [5], [166].

Despite this finding amongst other research, it must be noted that the BMI epicenter in case of traditional utilities cannot be seen as purely customer-driven. In line with the finding from Osterwalder & Pigneur [136] that BMI can also origin from a combination of two or more of the identified epicenters, it could be argued that for traditional utilities this is definitely the case. In fact, an argument in favor of an offer-driven epicenter could be the *servitization* trend. Likewise, one could also say that the BMI is finance-driven, as utilities are required to look for new ways of generating revenue due to the decreasing profitability of their business model.

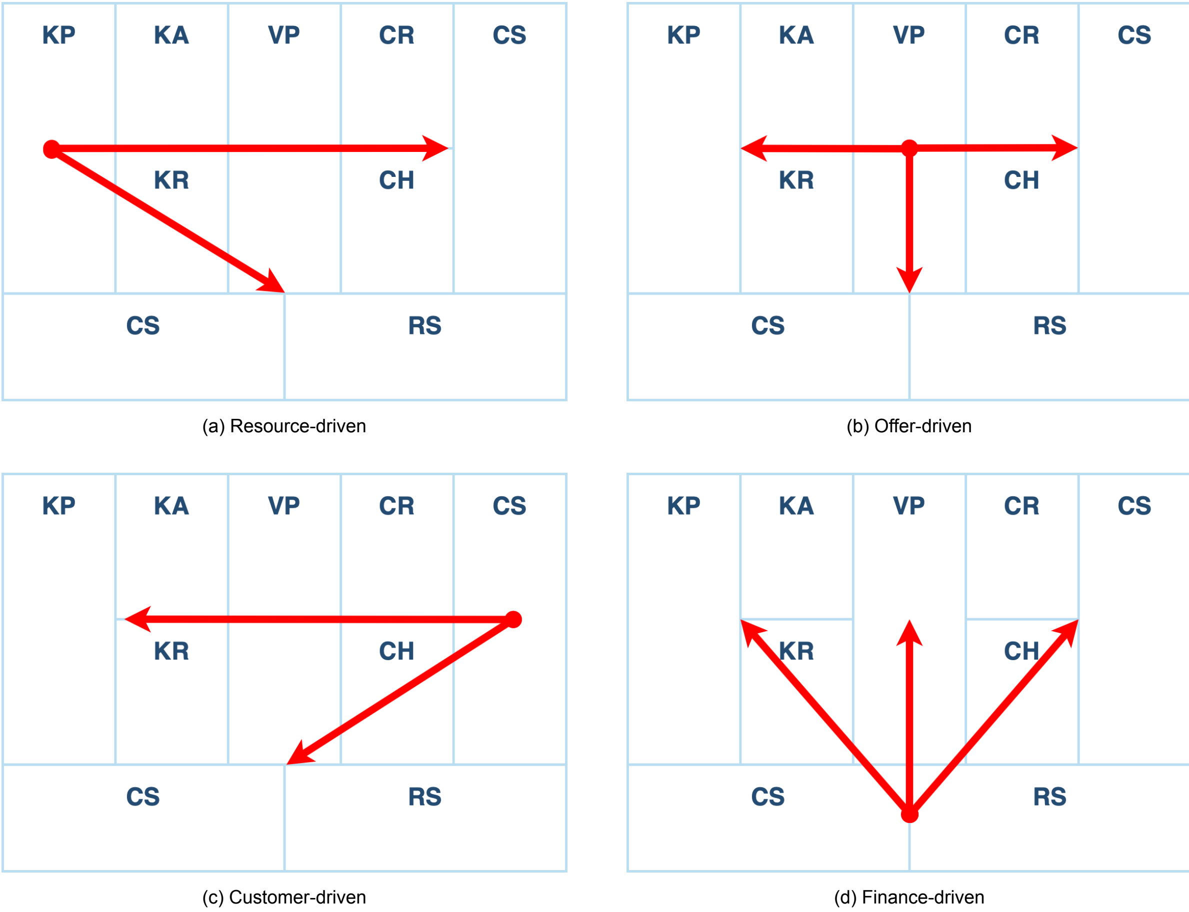


Figure D.1: Four epicenters of business model innovation. A combination of different epicenters is possible as well. Adapted from Osterwalder & Pigneur [136].

So, although the customer-driven epicenter might be most eminent, this obviously does not cover the full perspective.

This combination of BMI orientations is also reflected in the opportunities for utilities that Bryant et al. [23] identified (p.1034/1035):

- Become a **comprehensive energy solution provider**, i.e. consulting, installation, financing, operation, maintenance and warranties of electricity generation and heating/cooling systems for a fee
- Shift to **energy-as-a-service**, offering a monthly flat-fee service contract to customers
- Build a **platform/virtual utility model**, connecting distributed generators with customers
- Reduce cost of energy by **technology experience effects** that reduce costs of distributed VRE
- Develop **alternative customer engagement routes**, i.e. media and entertainment, home automation, building security, energy saving, and data aggregation
- Generate additional revenue with **demand response and balancing**; which will provide extra services to grid operators
- Providing grid operators with assurance of large generating capacity, leading to **capacity payments**

As the items in this list show, all four BMI epicenters are eminent. In fact, the shift towards a comprehensive energy solution provider implies an offer-driven innovation, whereas a shift to energy-as-a-service reflects a finance-driven epicenter of BMI. Likewise, building a virtual utility model means a resource-driven epicenter, and the development of alternative customer engagement routes is merely implying a customer-driven epicenter. As such, the classification of this BMI case as consisting of a combination of epicenters is arguably a better reflection.

Many researchers have dived into possible future business models for utilities. Despite the fact that obviously there will be no universally suited business model for every utility around the world, there seems to be agreement on what the general outlines of new business models will be. As Europe is an exemplary market in terms of high (expected) penetration of distributed generation and a high degree of customer freedom, the ’virtual utility model’ seems to be one of the suited models [132]. The same goes for the ’Energy Service Company’ [82], [133], ’Energy Supplier 2.0’ [166], or ’Utility of the Future’ [95]. This research will not go into detail on an analysis of the possible future business models themselves, but rather briefly address some general outlines researchers agree upon. Basically seen, it all comes down to sufficiently adapting to some or all of the major power sector developments.

As was mentioned before, utilities will have to shift from being simple commodity suppliers to comprehensive energy solution providers that win and bind customers [146], [166]. So, the focus of the value proposition will be on allowing customers to efficiently produce and consume their own electricity (e.g. prosumers) [133]. This implies a more intermediary role for utilities, in which the value is basically added in matching supply and demand [133], [199]. In that sense, the value proposition will be two-folded. For consumers, it will be the offering of a wide range of individually optimized, low-cost, highly renewable, smart and local energy products and services [132], [166]. These could for example include consulting, financing, installation, operation, maintenance of DERs [146]. Consumers can generate additional revenue or reduce electricity costs by supplying excess energy into the grid, or allowing the utility to control their s (through pooling in for example a VPP) [166].

On the other hand, value will be created for grid operators, who we have seen to face significant challenges in grid stabilization. Through the pooling of many smart decentralized assets, utilities can enable reductions in peak loads [166]. In that way, grid operators have a preferable alternative over conventional (expensive) grid expansion. Moreover, ancillary services can now be provided by local flexibility instead of large centralized plants [166].

However, a final note with respect to the rapidly changing energy industry must be taken into account. As Bryant et al. [23] strikingly put it: ”Ultimately, if all business typologies are to attempt to adapt to increasing levels of VRE in the energy market and to address the financial viability concerns of their current models, the future energy market could become a much more fragmented landscape. Energy utility and utility equivalent businesses could start to provide very specific offerings to customers, and carve out their own defensible niches, rather than providing only slightly differing commodity-driven models as are currently available” (p.1041).

All in all, no human being is able to predict the future. In such a rapidly developing environment, with decreasing profitability of incumbent business models and the emergence of a large number of innovative startups ready to conquer the energy market, the challenge is clear. Especially incumbent utilities must fundamentally change, and they must change now [144]. This fundamental change, or *Business Model Innovation*, is not as straightforward as it sounds. Especially large organizations are struggling with BMI and can experience many potential hurdles that need to be overcome. In that respect, utilities are seeking ways that will enable them to change easier and at a faster pace.

Furthermore, in line with the uncertain energy future, (incumbent) utilities do not seem to aim at putting all eggs in one basket. They rather set their sights on exploring different options and bet on a wide range of business models and technologies, which must support them in innovation of their Business Model by removing potential hurdles and strengthen enabling factors. As mentioned in the introduction of this thesis, a Corporate Venturing approach, or more specifically Corporate Venture Capital, can be a suited solution for this.

D.3. Typologies of Business Model Innovation

Just as is the case with definitions of Business Model Innovation, as presented in Table C.2, there is also considerable difference amongst research on the dimensions of the concept and the ways in which it can occur. To provide additional background information on the *typologies of BMI*, as explained in section 5.1, this section will describe this subject in more detail.

In the work of Massa & Tucci [120] it was proposed to use two different terms to describe Business Model Innovation, which gives already an idea about the term's dimensions. According to them, business model innovation can either refer to *business model design* (development of entirely new business models for new organizations) or *business model reconfiguration* (reconfiguration and/or acquisition of organizational resources to change the BM of existing firms) [120]. Further, the latter can have a varying degree of radicalism [120]. For both cases holds however, that to be considered a form of business model innovation the output should have some degree of uniqueness or novelty.

Geissdoerfer et al. [74], [75] agreed with this explanation and distinguished four generic types of business model innovation, of which an overview is provided in Figure D.2. Furthermore, as also follows from their definition of the term, according to Geissdoerfer et al. [75] business model transformation can range from affecting individual (combinations of) business model components to the entire (architecture of a) business model. This already unveils one important dimension of business model innovation: the degree of change, or in other words, its *scope* (the terms are used interchangeably). However, the second dimension of the term remains largely unclear. In that respect, there seems to be agreement amongst researchers that BMI can also be dimensionalized in terms of *novelty* [120], [167].

Despite the consensus on the dimensions themselves, their exact characterization varies. For example, Stampfl [167] distinguishes three possibilities for 'degree of novelty': new to the world, new to an industry, or new to a company. Further, according to him 'degree of change' can include either reconfiguration of an existing BM, or the development of a new BM [167]. We have already seen that more researchers take this perspective (e.g. [120], [74]. However, according to author this does not explain the dimension degree of change, but rather addresses complete different typologies of business model innovation. This is confirmed by other scholars (e.g. [75], [110]), that perceive the scope of BMI to be ranging from changes in one or a few elements of a business model to the entire model (or its architecture).

The work of Foss & Saebi [67] corresponds to this explanation. They dimensionalized business model innovation in terms of *scope* and *novelty*, with the scope ranging from modular to architectural. Their explanation originated from the notice that there exists disagreement amongst scholars on how many elements of a business model have to change for it to be considered business model innovation [68]. Secondly, according to them the degree of novelty can range from being new to a single firm to new to an entire industry [67]. As a result, Foss & Saebi [67] developed a framework that outlines four different BMI classifications, as presented in Figure D.3.

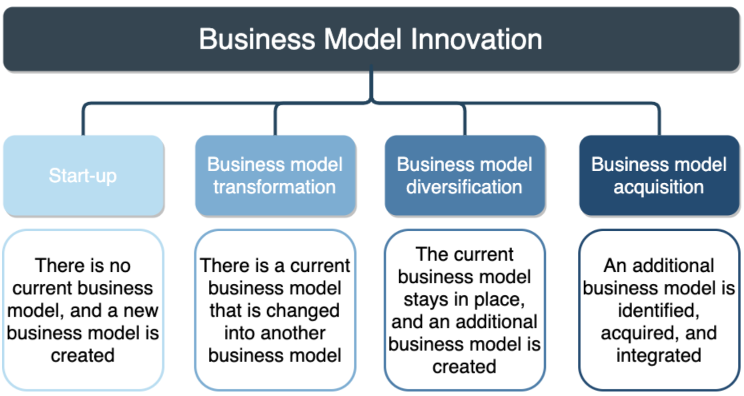


Figure D.2: Types of business model innovation. Adapted from Geissdoerfer, Vladimirova, and Evans [75].

	Scope		
Novelty		Modular	Architectural
	New to firm	Evolutionary BMI	Adaptive BMI
	New to industry	Focused BMI	Complex BMI

Figure D.3: Business Model Innovation typology. Adapted from Foss & Saebi [67].

A more detailed explanation of the different classifications will further clarify their implications. First of all, *evolutionary BMI* can be explained as natural changes to individual business model components over time, or in other words, a fine-tuning process [68]. Secondly, *adaptive BMI* refers to changes in the overall business model, but without necessarily high novelty characteristics (e.g. only novel at firm level). As Foss & Saebi [67] explain it, ”these are cases where the firm adapts the architecture of its BM in response to changes in the external environment, such as in face of competition from a new business model in their industry” (p.217). A specific example of this can be found in the pharmaceutical industry, in which more service-based BMs are increasingly seen; this also implies that both internal and external relations will change [68]. Thus, these changes are new to the firm, but are the response to developments in the industry structure. This will likely be the case for the energy sector as well.

Thirdly, *focused BMI* can be explained as innovation in one specific area of the business model, with a rather high degree of novelty (e.g. disrupting market conditions) [67]. We speak of focused BMI for example when a firm targets a new market segment that has been disregarded by its competitors, while it keeps its value proposition, value delivery, and value capture mechanisms unchanged [67]. Finally, in the case of *complex BMI*, firms actively engage in architectural BM changes that are new to the entire industry [67]. An example of complex BMI can for example be found in a traditional brick-and-mortar company that is shifting towards an online platform where sellers of products and services and customers can meet.

Now the term ’business model innovation’ has been defined and dimensionalized, it is insightful to identify the different activities which it can involve. Again, various descriptions of this sub-classification of BMI exist, of which a few are provided in Table D.2.

Although differently put, it stands out that there is a considerable amount of overlap between the various descriptions. In fact, the division of BMI activities in ’content’, ’structure’, and ’governance’ as proposed by Amit & Zott [7] is comparable to ’industry’, ’revenue’, and ’enterprise’ as proposed by Giesen et al. [76]. The description of BMI activities proposed by Massa & Tucci [120] also shows some overlap with the other two, but to a lesser extent. However, the essence is clear. With this overview of various dimensions and the ways in which BMI can occur, all aspects of the term have been covered.

Table D.2: Various existing descriptions of the ways in which Business Model Innovation can occur.

Research	Description
Amit & Zott (2012, p.39) [7]	”Business model innovation can occur in a number of ways: 1. By adding novel activities, for example, through forward or backward integration; we refer to this form of business model innovation as new activity system ’content’. 2. By linking activities in novel ways; we refer to this form of business model innovation as new activity system ’structure’. 3. By changing one or more parties that perform any of the activities; we refer to this form of business model innovation as new activity system ’governance’.”
Giesen et al. (2007, p.28) [76]	”IBM’s framework for business model innovation: 1. *Industry model innovation*: Innovating the industry value chain by moving into new industries, redefining existing industries or creating entirely new ones, also by identifying/leveraging unique assets 2. *Revenue model innovation*: Innovating how we generate revenue through through offering re-configuration (product/service/value mix) and pricing models 3. *Enterprise model innovation*: Innovating the role we play in the value chain by changing our extended enterprise and networks with employees, suppliers, customers, and others, including capability/asset configuration”
Massa & Tucci (2013, p.435) [120]	”BMI can support companies in exploiting new opportunities (seizing ’white space’) in three different ways: 1. By supporting the development of new value propositions that would address an unsatisfied ’job-to-be-done’ for existing customers 2. By tackling new customer segments that have traditionally been overlooked by existing value propositions 3. By entering entirely new industries or a ’new terrain’ ”

E

Background Information on Corporate Venture Capital

This appendix provides additional background information on different aspects of Corporate Venture Capital. As such, it elaborates upon subjects discussed in Chapter 6. Section E.1 addresses the potential barriers and stimulating factors which can affect the impact of CVC activities. Thereafter, in section E.2, the potential benefits of CVC activities for ventures are presented, as well as the potential barriers for the impact of CVC for ventures.

E.1. Barriers and Stimulating Factors to the Impact of CVC

CVC activities can bring a wide range of potential benefits for corporations. However, the effect of these benefits is subject to a range of *barriers and stimulating factors that can hinder or boost the effect of CVC activities*, as was described in section 6.1.3. In this section, these factors will be discussed to provide more background information about CVC activities.

First of all, a range of potential barriers exist that can hinder the benefits of CVC investments to be reaped. Throughout the years, multiple barriers have been identified that CVC programs can be facing. For example, Napp & Marshall [128] found several challenges firms can face in their CVC practices to support innovation. These are difficulties in (1) balancing strategic and financial objectives, (2) capturing explorational value, (3) capturing exploitational value, (4) matchmaking between startups and specific business units, and (5) measuring the innovation-enhancing value of CVC programs [128].

Difficulties in capturing exploitational value can be two-folded. On the one hand, if corporations already have a high level of innovation performance, the number potential benefits of investments is less, and investing in ventures might thus be too risky [140]. On the other hand, the most innovative startups may be not interested in CVC funding as they fear imitation of their products [140]. So, less innovative startups will be available to corporations to invest in. Both cases lead to a limited growth potential. [140]. Also, conflicts may arise with internal R&D efforts [140]. The difficulty in capturing exploitational value is also reflected in the fact that only one fifth of CVC investments contributes to obtaining access to innovative opportunities or scale efficiency gains [8].

Difficulties in capturing explorational value for example occur with learning, as learning effects are related to CVC investments with an inverted U-shape [140]. This implies that due to the increased complexity that comes with more CVC investments, the capacity of corporations to absorb the new knowledge will decrease [140].

Furthermore, specifically concerning (European) electric utilities, three other specific barriers were found to be important. The first and most obvious challenge for CVC executives is to establish linkages and synergies between the investing company and the ventures [111]. Besides this, they experience difficulties in aligning the time frame of the corporate business units with that of fast moving startups[111]. Finally, another important potential barrier that CVC executives experience is to set up a commercial collaboration between utilities and its portfolio ventures that is mutually beneficial [111]. For example, startups do not want to be constrained in choosing their partners, and in their perspective the internalization of their technology by the investing company is not the objective of the collaboration.

Finally, another interesting potential barrier has to be concerned by CVC executives: to manage the relationships between technical experts from corporate business units and entrepreneurs [13]. It was found that technical experts can get too emotionally attached to (technologies of) ventures.

Research has also discussed more specific barriers that could directly lead to one of the abovementioned, more general potential barriers. However, these barriers are often rather reflected in their opposite form in the set of potential stimulating factors to CVC activities, or are directly related to one of the stimulating factors. For example, Teppo & Wüstenhagen [178] found that an important barrier of CVC in general can be insufficient fund autonomy, in turn leading to lack of a clear mission, lack of patience, or lack of flexibility. However, researchers generally describe this as 'sufficient autonomy' and classify it as one of the stimulating factors of CVC investments [122].

Furthermore, other recognized barriers are inadequate venture manager incentives [55], [73], [178], [180], internal politics [55], [178], [180], inadequate financial commitment [178], [180], lack of top management commitment [55], [73], incompatible organizational cultures [73], [180], and information asymmetries [55]. Again, all these barriers already appear in their opposite form as stimulating factors, or can be directly related to one or more of the named stimulating factors. Therefore, they are addressed in the remainder of this section. As such, the potential barriers to the impact of CVC programs, which is presented in Table E.1, only contain the more general ones.

Finally, although not explicitly appearing in literature, consultation with an industry expert [48] delivered another potential barrier. As the other potential barriers are all internal, it may seem that the external aspect is not important. However, obviously this is not the case. As such, the innovation and startup climate - which differ significantly across countries - is a highly important prerequisite for successful and intensive sharing of knowledge and ideas, the development of startups, and thus as well for the success of CVC activities [48]. Therefore, a lack of a favourable environment for innovation can be an important potential barrier as well.

Table E.1: Potential barriers to the impact of CVC activities for corporations.

Barriers	**Related papers**
Difficulties in balancing strategic and financial objectives	[128]
Difficulties in capturing explorational value	[128], [140]
Difficulties in capturing exploitational value	[8], [128], [140]
Inadequate matchmaking between corporate business units and startups	[128]
Inadequate measuring of innovation-enhancing value of CVC	[128]
Difficulties in establishing linkages and synergies between parent company and venture	[111]
Difficulties in time frame alignment of corporate business units and fast moving startups	[111]
Difficulties in setting up a mutual beneficial commercial collaboration structure	[111]
Inadequate management of relationships between technical experts from corporate business units and entrepreneurs	[13]
Lack of a favourable environment for innovation and startups	[48]

With respect to the stimulating factors to the ability to reap the benefits of CVC investments, there are a few conditions under which CVC activities are found to have the most positive impact on parent company innovation performance. First of all, this will be especially the case when firms are targeting ventures in related industries [49] [122], so there exists a tight link between the operations of the parent company and its portfolio ventures (as in line with the upper half of Figure 6.1). Furthermore, innovation performance is related to portfolio diversity with an inverted U-shape [49], [192], [193]. This means that moderately diverse portfolios of start-ups lead to the highest corporate innovation performance. Also, this relationship increases with higher availability of knowledge resources in the portfolio [193].

Besides 'normal' innovation, research also looked into the creation of exploratory innovation, e.g. "innovations that embody knowledge that differs from knowledge used by the firm in prior innovation efforts" (p.147) [192]. It was found that a firm's creation of exploratory innovation is enhanced by three portfolio characteristics: start-ups must be moderately diverse, mature, and must possess codified technological knowledge [192]. Moreover, a moderate diverse portfolio is also being related to strong financial performance [49].

Success of CVC programs is also dependent on the ability to build strong internal and external relationships [49]. External relationships include for example direct relationships with independent VC funds, which can enable favorable investment opportunities and learning about investment practices [49], [122]. Strong internal relationships are characterized by active involvement and frequent communication with portfolio companies [49], [122], [171], [191]. Other stimulating factors at the (investing) firm level include top management commitment [111], a supportive organizational culture [180], a strong technological and marketing resource profile [11], as well as absorptive capacity [49], [54], [122] and the availability of cash flow [49].

At an industry level, it was found that CVC activities of incumbent firms are induced in dynamic industries with rapid technological change [11], [52], [111], environments of weak intellectual property [11], [54], [122] and high competition [11]. Moreover, firms are more likely to pursue CVC when market uncertainty is high [49]. Obviously, the energy sector has turned out to be a solid example of these industry-level conditions [111].

In his study, Maula [122] identified several other stimulating factors of the impact of CVC investments, based on an extensive literature review. However, in his study, similar to other literature on this subject, a sufficient classification seems to be lacking. As multiple types of performance determinants can be relatively easily distinguished, the following classification is proposed:

- **Organizational design and company resources**: this category includes financial and physical resources, as well as human resources and capabilities, and organizational design and culture related aspects
- **Parent company and venture collaboration**: this includes factors acting at the interplay of the collaborations between the investing company and its portfolio ventures
- **CVC unit organization**: this refers to factors related to the organization of the CVC unit, including its personnel
- **Industry characteristics**: this refers to the influencing factors at industry level
- **Portfolio characteristics**: this final category includes factors at the portfolio and venture level

An overview of all potential stimulating factors to the impact of CVC, including classification, is provided in Table E.2.

Table E.2: Potential stimulating factors to the impact of CVC investments. Partly adapted from Maula [122], and extended by other research findings.

Classification	**Elements**	**Related papers**
Organizational design and company resources	• Long term focus • Sufficient absorptive capacity • Top management commitment • Supportive organizational culture and design • Strong technological and marketing resource profile • Availability of cash flow	[11], [49], [54], [55], [73], [111], [122], [140], [178], [180]
Parent company and venture collaboration	• Relatedness of portfolio companies • Active involvement and frequent communications with portfolio companies • Strategic objectives that enable aligned objectives with portfolio companies	[49], [55], [122], [171], [191]
CVC unit organization	• Sufficient fund autonomy • Strong ties to Venture Capital community • Appropriate compensation systems • Team members with venture capitalist background	[49], [55], [56], [73], [122], [178], [180]
Industry characteristics	• Industry sectors with weak IP regimes • Dynamic industry sectors with rapid technological change • Industry sectors with high market uncertainty • Industry sectors with high competition	[11], [49], [54], [52], [111], [122], [140]
Portfolio characteristics	• Moderately diverse start-up portfolios • Maturity of portfolio ventures • Availability of knowledge resources in portfolio ventures	[49], [192], [193]

E.2. CVC in Venture Perspective

This section gives more information about the venture perspective to CVC activities. First of all, it provides *an overview of potential benefits of CVC for ventures*, as was discussed in section 6.1.3. This overview is presented in Table E.3.

Secondly, it it also insightful to address the *potential barriers to the impact of CVC activities for ventures*, as discussed in section 6.1.3. A concise list of a few barriers is provided in Table E.4.

Table E.3: Potential strategic benefits of CVC programs for ventures. Classification partly adapted from Lantz & Sahut [105]. Refers to 'an overview of potential benefits of CVC for ventures' in section 6.1.3.

Classification	Elements	Related papers
Access to resources	• Access to technologies, marketing and distribution networks, production facilities, and brand • Price advantages on some resources • Supply of space and offices	[11], [13] [35], [54], [105], [123], [125], [128], [139], [171]
Access to knowledge and support	• Access to expertise in company management • Access to technical expertise • Access to market-related and operational expertise • R&D and production support • Support for short-term problems • Access to more sophisticated means of financial control	[13] [35], [105], [121], [123], [125], [128], [171]
Advantage of image	• Endorsement and increased credibility • Added attractiveness to other investors	[11], [13] [35], [105], [121], [123], [125], [128]
Network extension	• Access to new markets, customers, suppliers, and partners • Integrated network of entrepreneurial relationships • Starting point for other relationships with the investing company	[13] [35], [54], [105], [121], [123], [125], [128], [139]
General	• Stability • Synergies • Less restricting performance goals than independent VC	[105], [123], [125]

Table E.4: Potential barriers to the impact of CVC programs for ventures.

Barriers	Related papers
Time frame alignment	[97]
Danger for change in investor strategy due to change in management	[97]
Little connection between investor intention and its practical experience	[97]
Poor investor positioning to create new markets	[97]
Difficulties to find the right person to make and follow through on decisions	[97]