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TwinVECTOR

Twinning for Development of World-Class Next Generation Batteries

Project Number: 101078935

Business innovation training guideline

Activity: WP5 – Boosting research capacity in techno-economic modelling

25/04/2024

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5	TEKNOLOGIAN TUTKIMUSKESKUS VTT OY	VTT	Finland

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Executive Summary

Deliverable 5.2’s objective is to serve as a business innovation training guideline. Its main purpose is focussed around understanding the business modelling process and shaping business innovation related to sustainable battery energy storage systems (BESS) through identifying BESS use cases that may serve as viable business cases.

To achieve this, in this report, the business modelling process is first motivated and explained by touching upon aspects such as the drivers for new business model development in the energy sector, outlining the business modelling process setup, discussing how business modelling relates to techno-economic assessments, and giving information on how to interpret business models. Moreover, an overview of business modelling methods is given, namely the Business Model Canvas, the Business Model Navigator, and the Odyssey 3.14 approach. In addition, it is explained how these methods can be applied in the context of the renewable energy sector. Furthermore, the role of public, private, hybrid, and other financing options in the business modelling process is explained. Lastly, use cases and marketing options for BESS are discussed by first presenting considerations that have to be made before deciding on potential use cases, and then giving details on concrete use cases such as peak shaving, exploiting spot market price differences, providing balancing services, using the BESS to reduce imbalance settlement costs, and value stacking. These use cases may serve as interesting business cases for a (sustainable) BESS, depending on its specifications.

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1 Introduction

In the following, the project TwinVECTOR is first summarized in Section 1.1. After that, the role of work package (WP) 5 within the project is described (Section 1.2), the purpose and scope of this deliverable is outlined (Section 1.3), and its process of development is specified (Section 1.4). Lastly, acronyms and definitions used in the deliverable are stated in Section 1.5.

1.1 The project TwinVECTOR – an abstract

The TwinVECTOR project aims to create a centre of excellence at the Tomas Bata University in Zlín (TBU), focusing on next generation battery sustainable design, energy business models, and sustainability assessments, with the support of upgraded research and administration unit (RAU). The RAU therefore coordinates the capacity building measures of the partners' activities to emphasise the synergy and the creation of the centre of excellence at TBU. Hence, TBU teams up with excellent institutions: VTT, AIT, KIT, and BAYFOR. The whole spectrum of activities is intended to activate knowledge at TBU, set up knowledge pool and capacity building activities enabling flexible, multidisciplinary project teams to address the topic of the next generation of batteries with the help of life cycle thinking via sustainability assessments. Additionally, advanced battery technologies also need to be assessed via a combination of techno-economic simulation tools, profitability analysis, and business model innovation. The widening country of Czechia, specifically the Zlín region, aims to increase scientific expertise and capacity in these areas and methods. The consortium members will share the expertise so that TBU can boost the research capacity to undertake world-class R&D activities in the energy storage field and bring them to the market. The ability to produce original ideas will be reflected in multiple outcomes expected in the short-term horizon: EU projects submitted in cooperation with excellent partners, scientific papers, conferences, and business agreements. High-impact research is expected long term with technology transfer into practice. The existing research capacity of all members will be strengthened via additional capacity-building activities in partnership with BAYFOR.

1.2 Role of WP5 within the TwinVECTOR project

For a comprehensive assessment of the possible implementation and operation of battery technologies in energy storage systems, it is – among others – necessary to conduct profitability assessments and develop business model (elements), as well as technology scalability studies. The main objective of WP5 is thus to achieve improved excellence, strategic networking, and raised research profile in the TEA of battery technologies across the whole value chain for researchers at TBU.

Within WP5, knowledge transfer on TEAs, profitability analyses, and business model development will be provided by AIT. Moreover, expertise on fostering innovation through the identification of new research questions and the successful acquisition, execution, and exploitation of research projects

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will be shared. For those purposes, different teaching activities namely workshops, researcher exchanges, and a summer school are conducted. Moreover, supplementary teaching materials and training guidelines are provided. Examples of topics and methods covered within WP5 include foundations of energy economics, profitability assessments, and marketing options for renewable energy assets, techno-economic models and analytical tools, and business modelling methods.

1.3 Purpose and Scope of the Deliverable

This Deliverable serves as a business innovation training guideline for teaching activities within WP5. It explains the business modelling process and provides information on the development of suitable business cases based on the results of a techno-economic assessment (TEA). In addition, business modelling methods are outlined, and the role of financing is covered. Moreover, suitable use cases and marketing options for BESS, that may represent profitable business cases, are discussed.

Deliverable 5.2 may be used by researchers who have no prior knowledge on business innovation to familiarize themselves with this topic.

This document is structured in the following chapters: First, the foundations of business modelling process are presented in Chapter 2. Next, business modelling methods are outlined in Chapter 3. After that, the role of financing is provided in Chapter 4, and use cases for BESS are discussed in Chapter 5. Finally, in Chapter 6, this document's overall progress and current status is reported, and conclusions are drawn in Chapter 7.

1.4 Process of Development

The document has been created based on the comprehensive expertise and experience gained by AIT over many years of being active in this field. The general regulative issues of the TwinVECTOR project, written in both the Grant Agreement and the Consortium Agreement, have been followed and addressed.

1.5 Acronyms and Definitions

Acronym	Definition
aFRR	Automatic frequency restoration reserve
BESS	Battery energy storage system
BMC	Business model canvas
CSR	Corporate social responsibility
DSO	Distribution system operator

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EBIT	Earnings Before Interest and Tax
EC	Energy community
EIB	European Investment Bank
EIF	European Investment Fund
EU	European Union
EVA	Economic Value Added
FCR	Frequency containment reserve
IMF	International Monetary Fund
IPR	Intellectual property right
mFRR	Manual frequency restoration reserve
PPP	Public-Private Partnership
PV	Photovoltaics
RES	Renewable energy sources
SMEs	Small- and medium-sized enterprises
TEA	Techno-economic assessment
TSO	Transmission system operator
UN	United Nations

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2 The business modelling process in a nutshell

This chapter explains how a business modelling process is being set up and explains its major phases of implementation. It can but does not need to be composed in the way as described below. The following sections should rather provide an understanding on what is to be taken into consideration and which role do the different parts of the process have. The explanations should therefore be used as a kind of an inspiration to develop an own bespoken process.

2.1 The energy sector's hunger for new business models

The energy sector faces and will in the future be even more facing major changes in business setups. The business operations of companies need to be adapted and new roles in the market emerge. There is a plenty of literature on why and how this happens, in most cases summarised under the quite comprehensive term 'energy transition' (originating from the German word *Energiewende*). The bird's eye view, as used in the energy policy approaches, reveals that the whole sector is facing changes that are being allocated to certain global trends in the society and economy. Researchers from the Wuppertal Institute summarise these under the 5D-approach with the effects of the following major trends [1]:

1) Decarbonisation – the change from fossil fuels to renewable energy sources, also considering energy efficiency as a significant energy resource;
2) Digitalisation – utilisation of new technologies for the energy transition, facilitation of new business models enabling the energy transition;
3) Decentralisation – changes in the energy supply from large, centralised generators to small-scale renewable energy sources
4) Democratisation – involvement of people, more possibilities for participation in the energy system, empowerment of customers, acceptance of energy infrastructure;
5) Diversification of service – development of new energy services, flexibilization of the energy system, development of new business models.

Due to the significance for the exploitation of research results and their transfer to the business life, business modelling became an integral part of applied research projects. Business modelling usually constitutes a whole project work package or at least several tasks in European research projects. Business modelling activities are usually placed towards the final stages of the project or accompany the project implementation and incorporate project results at the end of the day. Yet already the project proposal stage requires a debate on the commercialisation of results. Besides the identification of the target groups and their perception of added value, intellectual property rights and results utilisation need to be deliberated upon at this early stage.

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2.2 Business modelling process setup

An example of a process leading to the definition of business models in energy research projects is shown in Figure 1. At this stage it needs to be pointed out that this process is not standardised. This means it can consist of other elements or skip some of them. The visualised (generalised) process is based on the experiences of researchers participating in the TwinVECTOR project. Also, after setting the scope, the process is usually customised depending on the needs of the actors who will apply it.

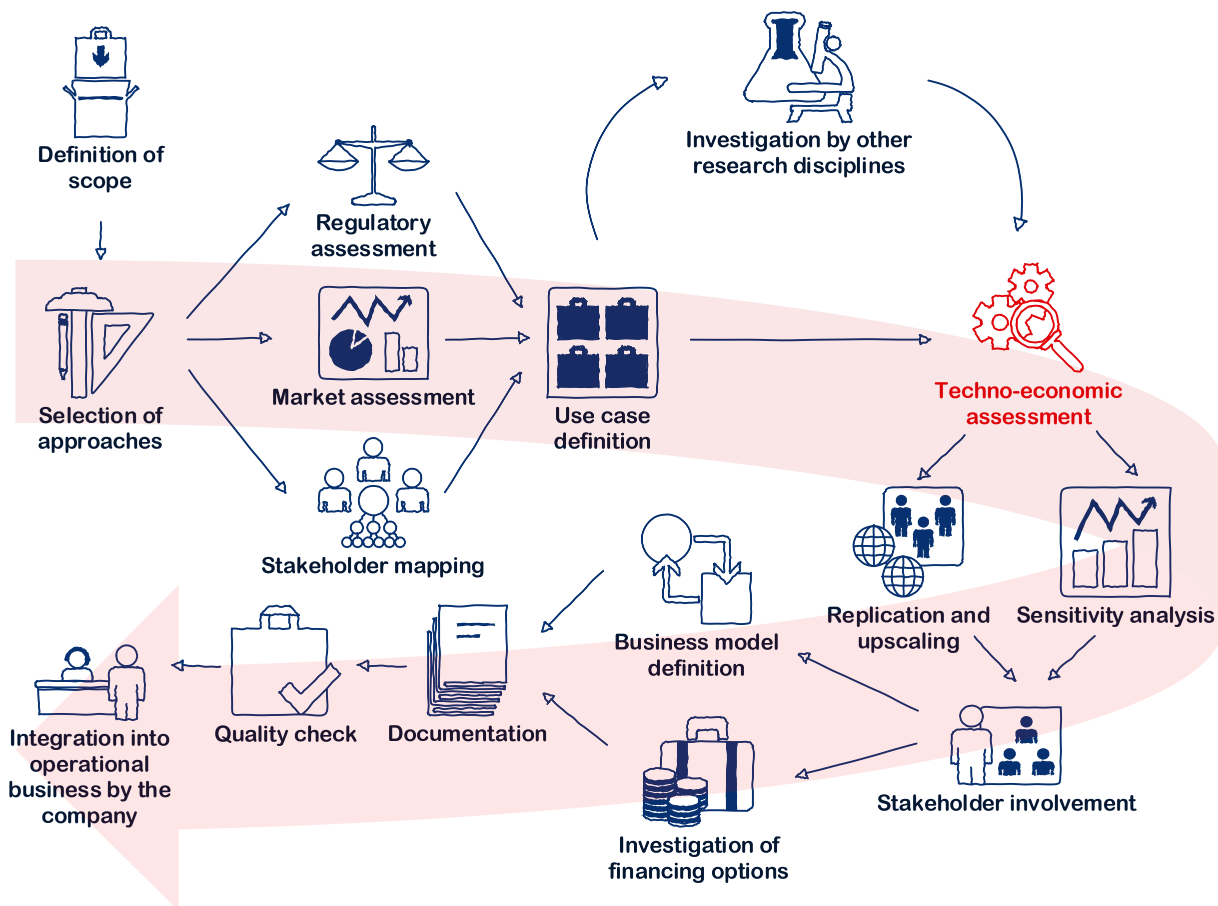

Figure 1: Business modelling process setup.

The whole process consists of several major steps that build up on each other's results. It starts with the assessment of the underlying framework incl. regulatory assessment, the assessment of

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market conditions, and assessment of stakeholder interaction and stakeholder environment. This is followed by the definition of the underlying use cases. An integral part of the business modelling process in research projects is the techno-economic assessment (or any other form of the analysis of costs and revenues). The assessment investigates the performance and impact resulting from the application of the beforehand defined use cases. It is usually followed by a sensitivity analysis, risk analysis, and/or replicability and scalability analysis. The results of these steps are then presented to the concerned stakeholders for their consideration. This forms the basis for the selection and outline of business models. Also, the investigation of financing options happens usually at this stage, although it can be performed before or later too. The results are then being documented and delivered to the company. The integration of the business model into the operational business of the company needs to be performed by its staff since internal knowledge is necessary to perform this step.

2.3 Prearrangements and framework assessment

In the launch phase, the business modelling should start with a common agreement, either within a kick-off meeting (as in each research assignment) or in any kind of a documented discussion. At this step, the needs, expectations but also the results are outlined and documented. Important in this regard is the definition of scope. Although business modelling is quite comprehensive taking into consideration different perspectives, it should be streamlined to ensure the significance of the results for the later application.

A variety of methods is available and can be selected based on the context, expectations of concerned actors, or availability of information. Contrary to basic research, applied research assignments rely to a certain extent on the collaboration of concerned actors. Therefore, the selection of the approach needs to take their involvement into consideration leaving out methods that are too complex or too difficult to be explained. In this regard, simpler approaches can be more suitable than more accurate ones.

The initial phase of the project is usually dedicated to the assessment of framework conditions for the implementation of the business model. In most cases this includes the regulatory assessment but can also comprise a market assessment and/or stakeholder mapping. This step is necessary so that the framework of implementation is known. The framework forms a space in which the business model is embedded. More recent research approaches allow to go beyond the existing legal frame, especially when introducing technologies with no regulation or where a technology or a business model requires major adaptation of the existing legislation. The so-called regulatory sandboxes are then used as protected temporary living labs. The main difference is that in such cases, the technology shapes the rules and not the other way round. However, also in these cases, the project usually requires profound knowledge of the current legislation in a particular field.

The legislative / regulatory assessment is being performed on different levels, in international projects also as comparative assessment of the framework for different countries. This is particularly

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relevant for replication or for the introduction of a technology or service into multiple markets. The assessment follows the gradual structure of the legal system, which e. g., in Austria, is composed as shown in Figure 2. This structure is similar in most (not all) European countries.[1] Most of the rules and laws that are relevant to business models in the energy sector can be found in the law adopted by the institutions of the European Union (regulations, directives, decisions, recommendations, etc.), the national law, and in ordinances of executive bodies (Ministries, Departments, regulation agencies or similar) [2].

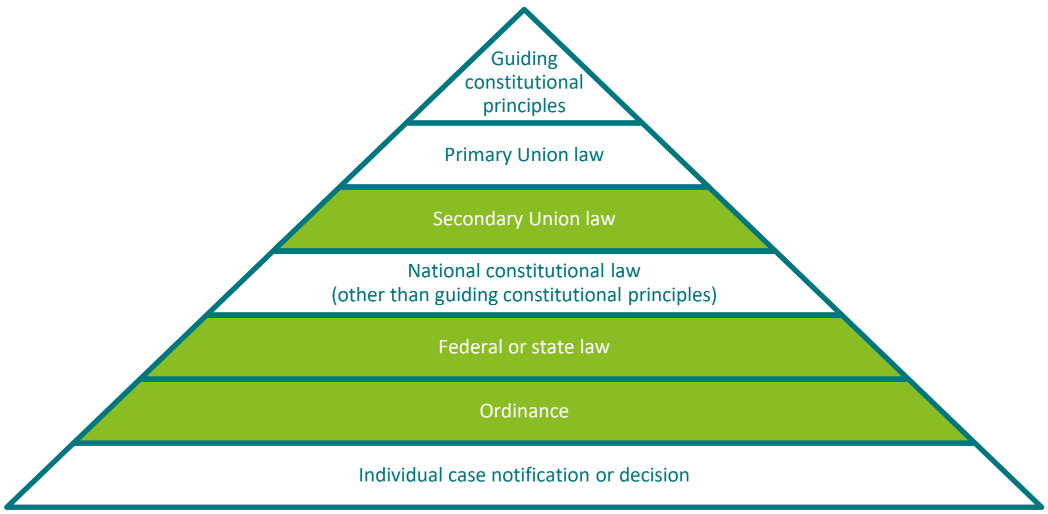

Figure 2: Gradual structure of the legal system, the most relevant levels for energy regulation are highlighted (own scheme based on [2]).

In addition to those mentioned, the regulatory assessment can also include technical standards. Technical standards aim to relieve the burden on governmental regulation. They form the lowest level of regulation, that, even if not always obligatory[2], has an important role in the design of solutions and services. Technical standards can also be issued on different levels depending on which organisation has issued them, e. g. ISO, CEN, CENELEC on international level and on national level ČAS in Czechia, ASI in Austria, DIN/VDE in Germany, SFS in Finland.

In case a market assessment is performed, it aims to provide a picture of conditions in the underlying market(s) and its (their) expected development in the future. One of the key questions is the grade

[1] In countries without a federal system, i.e. in the Czech or Finish legal system, the “federal or state law” level is to be replaced with the more comprehensive term “national law”.

[2] The obligation to consider a technical standard can result from a reference in law or by representing a common and/or good practice.

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of competition with highly competitive markets (e. g., energy suppliers) on one side of the spectre and monopolists on the other side (infrastructure operators such as DSOs and TSOs). Other relevant properties include the expected development of the market, diversification, development of margins, the geographical extent, inter- or intra-market dependencies, types of services or products offered and many others.

Stakeholder assessment or business environment assessment in a broader sense can be performed as a part of the market assessment or as a separate step. It aims to map actors relevant for the introduction of the business model. The backbone is often the value chain. It includes actors performing the business, an entity in a direct relation to them (customer, contractor, supplier), actors who are able to influence the solution (e. g., decision maker, regulator), who is being influenced by the implementation of the business model (someone in the geographical proximity), who possess necessary good or data, etc.

For the purpose of business modelling, the stakeholders are categorised or clustered, often in primary stakeholders (with direct influence or contractual relation), secondary (indirect influence, interest), and others. A variety of methods is available for the assessment. Results are being described in a schematic or tabular way (e. g., matrix, process diagram, block diagram, mind map, tree map). The framework assessment(s) is/are also used to launch the collection of data for quantitative assessments that follow. Within the regulatory assessment, grid tariffs are being collected[3]. Market assessment can be used to collect prices, cost structures, or market data.

At the end of the initial phase, use cases are outlined. These represent all possible and thinkable ways of implementation of the business model. In energy research projects, this is one of the major steps since the use cases are not only selected for the purpose of business modelling but are the basis of investigation of all other research disciplines collaborating within the project. Their definition should be a result of a discussion among the participating researchers and should lead to a consensual agreement for further steps. The use cases can be seen as a simplified form of the later setup. Their design is not standardised and depends on agreement needs in the particular project.

Some examples of how use cases are being described in energy sector research project are provided below. Due to their significance for the research work in different work packages of a research project, these form a separate report usually consisting of schemes, tables and qualitative description of the setup (see schematic diagrams in Figure 3 and Figure 4).

[3] Due to strong regulation of infrastructure monopolists, pricing is fixed by the respective authority and is available in an ordinance or at the regulator's website, e. g. by e-control in Austria, ERÚ in Czechia, energiavirasto in Finland, BNetzA in Germany.

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Existing flexibilities	Flexibility potential	Influence from/on electricity markets			Possibility of offering other services	
		Day-ahead market	Intraday market	Balancing market (here: aFRR/mFRR)	Demand response	Redispatch
Cable cars and ski lifts	low					
Snowmakers and pumps:		① Minimisation of day-ahead purchasing costs by using existing flexibilities			Possible future applications	
- for basic snowmaking	low					
- for renewal of snow cover	medium					
- for water reservoir filling	high	② Maximisation of revenues by offering existing flexibilities on balancing markets, while minimising day-ahead purchasing costs				
- possible part load operation (flexible pumps)	high					
- mixed-air compressors	high	③ Minimisation of day-ahead and intraday costs (purchase and sale) by using existing flexibilities				
Buildings	medium					
Power generation facilities (hydro power plant)	high					

Figure 3: Tabular description of use cases in the national research project CE4T [3].

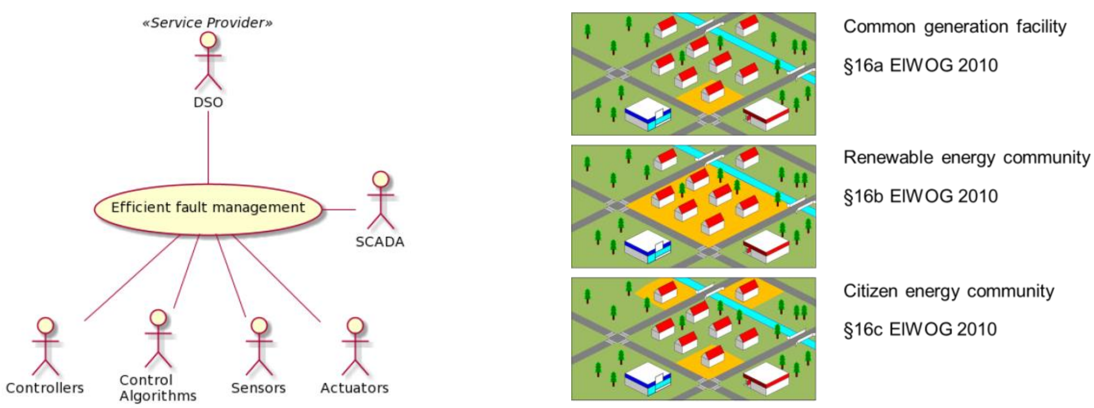

Figure 4: Examples of schematic use case definitions, on the left H2020-project Hyperride's use case for fault mitigation [4], on the right use cases for communal energy use in the national research project SYSPEQ [5].

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2.4 The role of TEAs in business model development

Although both, the business modelling and techno-economic assessments can be applied separately, in relation to the introduction of new products and services in the energy sector, they are being embedded in a common process setup resulting into instructions for business innovation. Techno-economic assessments form a core part of business modelling approaches, providing quantitative assessments of the use cases defined beforehand. As mentioned before, use cases are the basis for any kind of investigation that has been planned in the research project (proof of concept, application in a pilot, different kinds of observations, performance or impact assessment, etc.) producing results that need to be interpreted and incorporated to the business logic of a company that aims to apply them. They form a basis for cost-benefit analysis that answers the question regarding their profitability. Since for the particular case of the integration of BESS (or another energy system component) into the energy system, the iteration between the technical assessment and the economic assessment is key, both assessments have been integrated into a single comprehensive step called techno-economic assessment.

This does not only provide benefit to the one performing the TEA but also to the company implementing it, as the variation of technical parameters directly influences the economic performance of the solution, thus being nearer to the logic that companies use while designing their solutions and services. The same is true for the following step of the sensitivity analysis or the approaches for upscaling that can be integrated if the underlying question requires it. Details of the TEA are not explained at this stage since they are subject of the TwinVECTOR deliverable D5.1 and explained in detail therein. In the business modelling process, TEA results are used as a basis for the discussion with concerned stakeholders. Usually, they are presented in an interactive workshop as inputs for the appraisal of the applicability of use cases. This is especially important in cases, where non-monetary benefits play a major role. An example for such application can be the case of application of BESS for blackout prevention[4]. The discussion is important because it can happen that it is hardly possible or feasible to encompass all information or not all information can be disclosed.

For a business model to be successful, it needs to consider perspectives of different stakeholders. These are being taken up in the stakeholder mapping exercise and then decided which perspective is the major one and which need to be taken into account. While some setups can lead to a profit for a party, they can be seen as disadvantage for another. Especially in more complex setups this fact can play a key role. For the business modelling process this means that either the TEA-approach consider this, and the results are displayed in multiple ways, or the perspectives are taken into consideration during the stakeholder workshop.

[4] Although also this can be monetarised in certain cases or provided with a value as this is the case in a CBA-approach.

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2.5 The interpretation of the business model and its application

The last phase aims to introduce the model into the operational business of an enterprise. This starts with the above-mentioned interactive workshops where companies or stakeholders are asked to take an active role and take over a part of the assessment or interpretation of the results. The method used to do so can be selected based on the needs of those concerned or chosen based on conditions. An overview of the commonly used methods is provided in the next chapter. Also, the investigation of financing options happens in this phase. Apart of the identification of financing sources for the implementation, this also includes a debate on the conditions of the financing and aspects that influence them.

The overall result of this process is a simplified setup description (a model) that can be applied by the company. In general, there are different options for the business model to be applied:

- It can lead to the adaptation of a service / product or the extension of range (e. g., a new pricing scheme for existing service);
- It leads to the introduction of a new service / product by an established market player (e. g., flexibility procurement by a utility);
- A licencing scheme is being developed (e. g., if the model is not in the core business of a company but essential for some reason);
- A startup (or spin-off, usually an SME) is founded, this happens when new roles in the economic sector emerge (e.g., a platform operator for smart metering data).

At the end of the day, the application of the business model needs to be performed by the staff of the company as this differs in each case. The application depends on the structure, internal/external conditions, and the operational practice.

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3 Methodological approaches for business modelling

The following section lists some of the approaches used in the business modelling exercise. Please note, that this list is not exhaustive. Different methods can be selected and used based on the needs of the particular process and the needs of the stakeholders concerned. Three methods are only briefly described, namely the Business Model Canvas in Section 3.1, the Business Model Navigator in Section 3.2, and the Odyssey 3.14 approach for business model innovation in Section 3.3. Details of these methods are not provided. To apply a method, please refer to the website or authors of the platform. Education courses or teaching material is available for sale. Moreover, Section 3.4 outlines how these methods can be applied in the energy sector and specifically to BESS.

3.1 Business Model Canvas

Business Model Canvas (BMC) is a widely used methodology. It has been developed by Alexander Osterwalder and Yves Pigneur. Its popularity is related mostly to its simplicity and its focus on some of the most relevant aspects of a business model. By being designed in a simple way, it is understandable by many people without the necessity of having a deep understanding in the matter. The simplicity is also the reason why one needs to be careful in its application. To be effective, the approach should be embedded in a business modelling process providing more information about the context of the application. [6]

The core of the approach is the proposition of value. The business model, to be effective, needs to satisfy the needs of the customers. A schematic outline of the Canvas and its nine elements can be found in Figure 5. The whole structure follows a process that can be read from left to right – from key partners that are necessary for the business to be performed, through the necessary resources and activities towards the customers on the right side. Beneath these elements, costs and revenues are listed. [6]

<table>
<tr><td rowspan="2">Key partners</td><td>Key activities</td><td rowspan="2" colspan="2">Value propositions</td><td>Customer relationships</td><td rowspan="2">Customer segments</td></tr>
<tr><td>Key resources</td><td>Channels</td></tr>
<tr><td colspan="3">Cost structure</td><td colspan="3">Revenue streams</td></tr>
</table>

Figure 5: Business model Canvas scheme own drawing based on [6].

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3.2 Business Model Navigator

Business Model Navigator is an approach developed in a research program on business model innovation by Oliver Gassmann and Karolin Frankenberger at the University of Sankt Gallen. The approach was made available to the broad public with their book *Business Model Navigator* [7], that became a bestseller. [8]

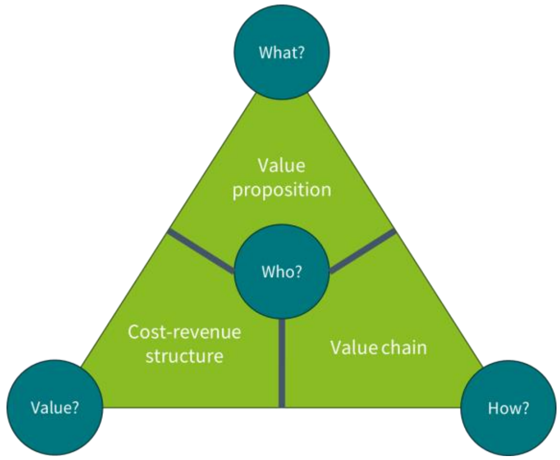

Figure 6: Schematic of the Business Model Navigator approach. Own figure based on [9] and [7].

The Business Model Navigator approach is based on an empirical review of hundreds of innovative business models. This assessment showed that the vast majority of new business models are recombinations of already existing business models. Moreover, a total of 55 distinct business model patterns were identified in the review. Each of these patterns represents a different approach to organizing and generating value within a business. The discovered patterns thus provide blueprints that can be applied in the design and development of new business models and business model innovations. More specifically, these blueprints detail how the four most critical aspects of a business model can be structured (see Figure 6), namely:

- “WHO” (customer segments): Who are the customers?
- “WHAT” (value proposition(s)): What value is promised/provided to the customers?
- “HOW” (value chain): How is the value (i.e., a product or service) being created (i.e., produced or provided)?
- “VALUE” (cost-revenue structure): How is value being generated for the product/service?

According to the Business Model Navigator approach, customer segments and value propositions are external dimensions of the business model, while the value chain and cost-revenue structure

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are internal dimensions. Business model innovation occurs when at least two of these four dimensions are altered. [7], [9]

For getting familiar with the Business Model Navigator approach, literature is available, courses are offered, and an online database is available, that can be browsed through. [8]

3.3 Odyssey 3.14 approach for business model innovation

The Odyssey 3.14 methodology, devised by Laurence Lehmann-Ortega, Hélène Musikas, and Jean-Marc Schoettl at HEC Paris, offers a comprehensive approach to business model description and innovation. Introduced through a Coursera online course [10] and detailed in their book *(Re)invent your business model: With the Odyssée 3.14 method* in 2022 [11], this method simplifies the BMC by consolidating its nine elements into three focal points: the value proposition, the value architecture, and the profit equation (see Figure 7). The rationale behind this simplification lies in enhancing clarity and reducing complexity, making it more accessible to users. Additionally, the methodology advocates for a top-down approach to business model development and innovation, emphasizing the importance of initially concentrating on these three fundamental pillars before delving into finer details.

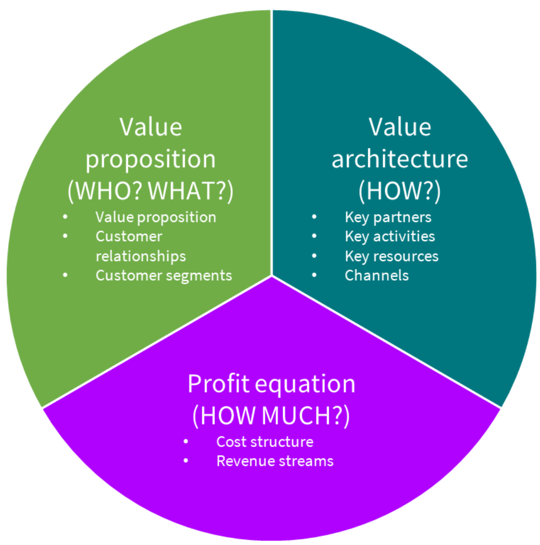

Figure 7: Graphical illustration of the Odyssey 3.14 approach. Own figure based on [10].

Moreover, the Odyssey 3.14 approach emphasizes the importance of harmonizing different aspects of the business model by first experimenting with and ultimately defining the core elements. Unlike the BMC method, the profit equation in Odyssey 3.14 considers not only costs and revenues but

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also the “capital employed”, consisting of a company's working capital and necessary assets for operation. The inclusion of capital employed is believed to significantly influence the cost structure within the business model, as stated by its creators.

Furthermore, the methodology incorporates additional tools such as the value curve and value chain. The value curve shows and clarifies the value attributes of the proposed innovated business model and the extent of offer for each attribute, providing insights into the value proposition. On the other hand, the value chain visualizes the value architecture by outlining the sequence of activities required for market delivery of products or services. The concept of the value curve originates from *Blue Ocean Strategy* by W. Chan Kim and Renee Mauborgne [12], while the value chain’s application in business model development was introduced by Michael Porter in *Competitive Advantage: Creating and Sustaining Superior Performance* [13].

3.4 Application of business modelling methods in the renewable energy sector

The business modelling approaches outlined in Sections 3.1, 3.2, and 3.3 represent valuable frameworks for analysing, developing, and innovating business models within the renewable energy sector. In this context, the BMC is most suitable for either describing existing business models to gain insights on them, e. g. for understanding how stakeholders employing fossil energy sources do their business, or for devising entirely new business models, as is necessary for example for newly developed renewable energy technologies. Furthermore, the Business Model Navigator can also be applied to develop new business models for renewable energy technologies by looking at existing successful business models in other sectors and deriving how their concepts can be applied to the technology at hand. Moreover, the Navigator is suitable for overhauling an existing business model through looking at how other businesses succeeded in innovating their existing business models. Lastly, the Odyssey 3.14 is most useful for innovating existing business models. With regards to the energy sector, it can be applied e. g. for decarbonizing business models relying on fossil energy or for finding new fields of application for renewable energy technologies.

In the following, examples for each of the discussed methods are given with regards to business modelling in the context of BESS:

The BMC can help map out the key components of a business model for BESS. It starts by identifying customer segments, which could include utilities, enterprises, or residential consumers seeking energy storage solutions. The value proposition could for example focus on enhancing self-sufficiency from an existing RES plant, avoiding curtailment due to grid limitations, or enabling electricity spot market participation. The value chain outlines the activities involved in deploying and managing the BESS, from manufacturing to installation and maintenance. Revenue streams may come from system sales, providing BESS operation optimization software, or acting as a service provider for enabling market participation. By utilizing the BMC, stakeholders can gain clarity on the various elements and relationships within the BESS business model.

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The Business Model Navigator provides a comprehensive framework for analysing and innovating BESS business models. It recognizes that many innovative business models are reconfigurations of existing ones, suggesting that BESS business modelling can learn from successful and innovative models in other industries. For instance, it could be explored how ideas like leasing models common in the car industry could be adapted to BESS. By focusing on customer segments, value propositions, value chains, and cost-revenue mechanisms, stakeholders can identify opportunities to create value and differentiate their offerings in the BESS market. Additionally, the internal and external dimensions highlighted by the Navigator can guide strategic decision-making and foster business model innovation.

The Odyssey 3.14 approach emphasizes simplifying the business model development process while ensuring clarity and coherence. For BESS providers, it encourages focusing on fundamental pillars such as the value proposition, value architecture, and profit equation. This means articulating the unique value that BESS offer (e. g. through the use cases outlined in Chapter 5), designing a coherent value architecture that aligns with customer needs and operational capabilities, and optimizing the profit equation considering costs, revenues, and capital employed. By employing tools like the value curve and value chain, BESS stakeholders can moreover refine their value proposition and operational processes, gaining a competitive edge in the renewable energy market.

In summary, through applying the aforementioned frameworks, stakeholders in the energy sector can navigate the complexities of the evolving energy landscape, identify strategic opportunities, and create sustainable value for themselves and their customers.

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4 The role of financing in business model development

Financing issues are essential for the success of a business model. The way how information, data, and results are processed and presented during the business modelling process has an influence on the succession of financing. Different factors play a role for financing conditions, however, the most important is the perception of the investment risk. To keep the risk perception low, the information needs to be prepared and presented in a transparent, credible, and simple way. This fact should be one of the guiding principles for business modelling as it is much easier to prepare the information when the data and results are available in the suitable form already. This can be solved by defining and agreeing on the criteria for the disclosure of results already at the beginning of the process.

As in the case of other steps within the business modelling process, also in the case of financing, the choice of the suitable instrument depends on different aspects. The following section provides an overview of the different financing possibilities for innovations and how to prepare the results in a way that should lead to success. It is relevant for undertakings, where the financing needs to be provided from external sources. In general, three major sources of financing can be obtained:

- Public funding (Section 4.1),
- Private financing (Section 4.2) and
- Hybrid finance instruments (Section 4.2)

These are explained in the following sections and moreover, it is explained how a financing proposal looks like (Section 4.3).

4.1 Public funding

Various sources for public funding are available on different levels. The largest funding pots are managed by the European Union. Overall, three categories of European funds can be distinguished based on the way how these are managed [14]:

- **Direct management**, where the funding is managed directly by the European Commission. These funds provide account for about 20% of the EU budget 2021-2027. Calls for proposals under this regime are published at the Funding and Tenders Portal[5]. A very prominent example for such programme in relation to innovations is Horizon Europe.

[5] The portal can be accessed via the following link: https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home

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- **Shared management**, which is managed by national authorities (ministries and public institutions) and the European Commission jointly. These count for about 70% of European programmes. The main difference to the previous category is, that the decision on who and what receives the funding is done by the national authority in the Member State, that are also in charge of the day-to-day management. This is also why there is no single portal for the management of these funds, but each Member State has an own one[6]. One of the most prominent examples in this category is the Cohesion Fund.
- **Indirect management**, where the management is performed by a partner organisation (i.e., an UN-organisation, World Bank, IMF, EIB, EIF, decentralised agencies, PPPs) or by an authority outside the European Union. Programmes under this management count for approx. 10% of the EU budget. The management is delegated to these third parties. Most of humanitarian aid programmes and international development funds are managed under indirect management.

Figure 8 shows the budgetary proportions in various European funding pots.

Figure 8: Budget volume in the largest European funding schemes with direct and indirect management in 2022 [15].

[6] A list of portals is available at the following website of the European Commission: https://commission.europa.eu/funding-tenders/find-funding/funding-management-mode/national-single-portals_en

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Funding can also be obtained from other sources:

- Other international institutions and donor organisations, e.g., Visegrád Fund, Norwegian Financial Mechanism;
- National level funding schemes;
- Regional or local funding and
- Combinations thereof.

4.2 Private, hybrid, and other forms of financing

Private financing is known to most of us. It forms the daily business of banks, credit institutes, and investors. In general, we can distinguish between the provision of debt or equity. Debt is an obligation between two parties – creditor and debtor – on an upfront payment that is being paid back in the form of principal and interest. On the other side, equity is that part of the capital of a business that occurs in the balance sheet as a positive difference between assets and liabilities. Equity finances long-term tangible assets and investments. The main difference to debt is, that it is not subject to any repayment.

Hybrid financing instruments combine features of debt and equity into a single vehicle. The main aim of these instruments is to imply a greater sharing of risk and reward between the investor and the receiving party of the capital. The investor accepts a higher risk (and expects a higher return) compared to a “pure” debt, but the risk is still lower than in the case of equity [16]. For the purpose of this overview, we also consider other risk sharing instruments or instruments that aim to reduce the risk of the investment in this section. Risk-reducing or risk-sharing instruments often inhere obligations or prescribe conditions under which the financing can be obtained.

The following list summarises the main properties of selected instruments for the introduction of new business models with innovative approaches (applicable mostly for SMEs, please note that this list is not exhaustive) [17]:

- **Direct and equity investments**
    - Real estate and infrastructure funds
    - Widely used, limits need for public funding
    - Can be combined with socially responsible investment criteria
- **Dedicated credit lines** – soft loans
    - Public funding decreases the cost of loans and provides concessions on terms (i. e. payback periods)
    - Retail distribution through networks of private banks

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    - Often complicated, time consuming and static application process

- **Subordinated loans**
    - Loan in junior rank in the case of bankruptcy or liquidation, interest repayments are applied after senior debt holders are paid
    - Higher risk = higher yield,
    - interesting for shareholders or parent companies,
    - increases supervision of financial conditions
- **Risk-sharing facilities** – guarantee funds and first-loss facilities
    - Reduce the risks for banks and equity investors by covering part of the risk of payment default
    - Often extensive and complex handling of risk-sharing facilities for smaller financial intermediaries and first-time users
- **Covered bonds**
    - Corporate bonds backed by a pool of assets (i.e. loans) used to secure the cash flow of the bond
    - Well established instrument for banks to access cheap capital
    - Classified as low-risk through existing regulation on national level
- **Leasing**
    - Use of machinery, vehicles, or equipment on rental basis
    - Can be used to overcome higher upfront costs as payments merge capital and operational expenditures

4.3 How does a financing proposal look like?

At first, there is no one ultimate one-fits-all solution and each investor, public or private, will provide or expect other requirements. One major challenge in this regard is, however, to make it short while still transferring the relevant messages. The following points summarise some of the most important aspects one needs to think of before asking for capital.

1. **Brief description of the idea:** This section is comparable to an abstract in scientific papers. It should be, however, much shorter yet still comprehensive. Few sentences or points are better than longer paragraphs.

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2. **Technological solution:** A brief description of the technology that shows there is a profound understanding without going too much into detail. The questions that can be answered in this regard include:
    - How does the technology work?
    - What are potentials?
    - What knowledge is available?
    - Which references can be provided?
3. **The team:** Presentation of the staff involved and their expertise:
    - Who is who?
4. **Strategy:** This section should explain the strategic level and the relation to existing business. Important at this point is the long-term orientation.
    - Which targets are to be reached?
    - What is the roadmap to reach these targets?
    - What is the follow-up of the market entry?
5. **Market:** The understanding of the market is key. If only a limited knowledge on the market is available, market assessment needs to be done to answer the most crucial questions:
    - What is the extent of the market?
    - What is the market trend? Is growth to be expected?
6. **Customers:** This section should show a profound knowledge of the customer segment and its needs. The questions include:
    - Who are the main customers?
    - What is the unique selling point?
    - Which channels can be used to reach them?
    - How do we generate value for the customers?
7. **Cooperation partners:** These aspects should enlighten the environment of the business. The result is a picture of the whole spectrum of expertise necessary for the undertaking.
    - Who are the partners we need to be operational and/or to be successful?
8. **Economic, environmental, and social effects:** These aspects are not only important for public financing institutions but also for private investors. Especially with the taxonomy

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directive, the aspects of green economy and green investments start to play an important role. Also, the relations to CSR strategies and environmental or social plans can be of a particular importance. Questions that can be placed in this regard are:

- What is the impact of the activities?
- Which employment effects can be expected?
- How do the activities fit into the strategies of the investor?

9. **Intellectual property rights:** Explanation of the approach for intellectual property.

- Do we have patents or IPRs?
- How valuable are these IPRs in the market?
- Do we use open standards?
- Is interoperability and issue and to which extent?

10. **Key numbers:** Investors expect the provision of certain key values that should be calculated beforehand. In general, profitability assessment in business modelling should be designed in a way that provides key values for the business such as:

- EBIT Earnings Before Interest and Tax
- EVA Economic Value Added

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5 Use cases & marketing options for BESS

In this section, the most important use cases and marketing options for BESS that represent potential business cases are outlined, namely peak shaving (Section 5.2), exploitation of spot market price differences (Section 5.3), participation on balancing markets (Section 5.4), reduction of imbalance settlement costs (Section 5.5), and value stacking (Section 5.6). Moreover, considerations that should be made before choosing a use case are detailed in Section 5.1.

5.1 Considerations for choosing appropriate use cases

Before the decision on potential use cases for the BESS at hand are made, the following points should be carefully considered:

- **Regulatory constraints**: Assess whether there are any regulatory or legal limitations that could restrict the choice of use cases or marketing options for the considered BESS.
- **Technical specifications of the BESS**: Evaluate the capacity and power specifications of the BESS to determine if they may limit its suitability for certain marketing options, such as providing frequency regulation services.
- **System in which the BESS is embedded**: Identify any technical constraints within the system surrounding the BESS, such as grid connection limitations or requirements related to coupling with Renewable Energy Sources (RES). Determine whether RES energy should be prioritized over grid charging/discharging.
- **Requirements and priorities**: Understand the specific demands that the BESS is expected to fulfil. Determine whether its primary purpose is market-driven operation or if priority is given to demand coverage, grid stabilization, utilization of RES surpluses, or capacity reservation for blackout scenarios.
- **Availability of forecasts and optimization algorithms**: Assess the availability of relevant datasets, forecasting tools, optimization algorithms, and other data necessary for setting the operational schedule of the BESS. Determine whether complex forecasts and optimization algorithms are accessible or if operation must rely solely on rule-based approaches.

By carefully considering these factors, stakeholders can ensure that the chosen use cases for the BESS align with regulatory requirements, technical capabilities, system constraints, operational priorities, and available data and tools. This assessment helps in developing a robust and viable strategy for the implementation and operation of the BESS.

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5.2 Peak shaving

Peak shaving represents one of the most widely applied use cases for BESS that are coupled with RES. It can be employed for self-consumption optimization (Section 5.2.1), grid stabilization (Section 5.2.2), avoiding curtailment (Section 5.2.3), strategically selling RES surpluses on the market (Section 5.2.4), and energy self-sufficiency (Section 5.2.5).

5.2.1 Self-consumption optimization

Self-consumption optimization is particularly relevant in the context of single-family homes equipped with rooftop PV systems. Self-consumption optimization involves strategically charging the BESS during periods of peak generation when demand is low relative to the electricity generated. For instance, in the case of a PV-coupled BESS in a single-family home, the charging typically occurs during midday when solar irradiation is at its peak, coinciding with times when occupants are typically away, resulting in minimal energy demand. Subsequently, the BESS is discharged during periods of higher demand relative to generation, such as mornings or evenings when household energy consumption typically increases. In the same way, larger, community-owned BESS are also applied within ECs to optimize the self-consumption of multiple participants in an EC. Importantly, the operation of a BESS for self-consumption optimization typically occurs without reliance on the public electricity grid for charging or discharging the BESS.

5.2.2 Grid stabilization

Moreover, peak shaving can be used to stabilize the grid: Usually, RES generation peaks, especially for PV, coincide across whole countries or regions. In the same way, household demand peaks occurring during morning or evening hours also align throughout the same areas. These peaks accumulate to either high power generation peaks or high demand peaks, both placing significant strain on the grid, due to the requirement of demand and generation equilibrium at all times. Peak shaving using BESS is a strategy for grid stabilization by reducing these power peaks. Further, commercial customers often have a cost component within their grid charges, contingent upon the highest occurring peak within predefined intervals such as monthly, quarterly, or annually, depending on the grid tariff structures of respective countries. Utilizing a BESS for peak shaving can thus not only improve grid stability, but also reduce grid tariffs.

5.2.3 Avoidance of curtailment

In addition, BESS can be used in the context of peak shaving in order to avoid curtailment of renewable generation. This entails charging the BESS when the RES generation power is greater than the grid connection capacity and feeding the energy into the grid in times of low generation. Especially for wind farms with grid connection capacities smaller than the installed wind capacity, curtailment, resulting in loss of profits due to electricity that cannot be fed into the grid, is often a pertinent concern.

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5.2.4 Peak shaving with market driven BESS discharging

Furthermore, the scope of the peak shaving or self-consumption optimization use case can be extended through participation in energy markets, typically the day-ahead market. In that case, a renewable generation-coupled BESS is charged during peak generation hours and subsequently sells stored energy during periods of high market prices, such as during evening hours. Optimization algorithms are commonly employed to maximize the efficiency of BESS operation in this use case. An example of this application are industrial settings with on-site renewable generation, where daytime energy demand is substantial, yet surplus energy is stored in a BESS. This energy can then be monetized through market participation during peak demand hours in the evenings.

5.2.5 Energy self-sufficiency

Beyond grid-connected applications, BESS can be used to ensure energy self-sufficiency in stand-alone grids or areas with limited access to centralized electricity grids. In these scenarios, BESS function as integral components of microgrid systems, providing a reliable power supply while mitigating reliance on fossil fuels for electricity generation. By integrating RES with a BESS, stand-alone communities can significantly reduce their dependence on costly and environmentally detrimental diesel generators. Moreover, BESS increase energy resilience by offering a buffer against disruptions or natural disasters. This application not only fosters sustainability but also enables communities in stand-alone grids to use their renewable energy resources more efficiently and autonomously, thus promoting energy independence and long-term viability of stand-alone grids.

Overall, these use cases underscore the applicability of BESS not only for optimizing renewable energy consumption, reducing strain on the electricity grid, and supporting the viability of stand-alone grids, but also for enabling revenue generation through strategic market participation. Even so, economic viability has the be carefully investigated through a TEA in each potential case before investing in a BESS for this purpose alone.

5.3 Spot market price differences

BESS can be used to exploit price differences on electricity spot markets, namely the day-ahead (Section 5.3.1) and intraday (Section 5.3.2) markets. Importantly, BESS do not necessarily need to be coupled with RES in this case. However, if the BESS is indeed coupled with RES, it can usually yield greater profits. This is attributed to the ability to charge the BESS without using the grid, thereby avoiding associated grid charges and energy costs, and enhancing overall profitability.

5.3.1 Day-ahead market

The European day-ahead market functions as a platform for electricity trading, where participants submit bids to either buy or sell electricity for the subsequent day. The market clears through a

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process known as “pay-as-cleared”, where the market-clearing price is determined at the intersection of supply and demand bids, based on the merit-order principle. Market participants whose bids are accepted pay or receive the market-clearing price for the electricity they buy or sell.

In order to exploit price spreads on the day-ahead market, BESS operators must accurately forecast the clearing price. This forecasting is crucial as it enables BESS operators to anticipate price differentials between low-price periods, where electricity can be purchased, and high-price periods, where electricity can be sold for a profit. By forecasting the clearing price, BESS operators can strategically schedule the charging and discharging of the battery to capitalize on these price differentials and maximize revenue. In order to develop a good trading strategy for the day-ahead market and optimize BESS operation based on it, advanced forecasting algorithms and real-time market data analysis are essential.

5.3.2 Intraday market

In Europe, the intraday market operates as a platform for electricity trading where market participants can buy and sell electricity to meet short-term supply and demand imbalances. Unlike the day-ahead market, which facilitates trading for the next day, the intraday market allows for trading closer to real-time operation, offering flexibility for market participants to adjust their positions based on updated forecasts and changing conditions. One distinctive aspect of the intraday market in Europe is the “pay-as-bid” mechanism, wherein participants pay or receive the price they bid for electricity regardless of the market-clearing price. This creates uncertainty as bid prices can vary widely across participants based on their individual strategies, risk tolerance, and market expectations. In addition, only bids for supply and demand which are matched with each other receive money or pay, respectively.

The “pay-as-bid” mechanism introduces complexity to the development of forecasts and trading strategies for BESS. For BESS operators, developing accurate forecasts and trading strategies based on them becomes challenging as they must consider not only market fundamentals but also the behaviour of other market participants and their bidding strategies. Inaccurate forecasts can lead to suboptimal trading decisions, potentially resulting in missed revenue opportunities or even financial losses. This requires sophisticated modelling techniques and real-time market monitoring to adapt to changing market dynamics and optimize trading outcomes.

However, given that an appropriate trading strategy is implemented, the intraday market can be profitable for BESS operators. They can capitalize on short-term fluctuations in electricity prices within the intraday market by buying electricity when prices are low and selling it when prices are high. This can potentially be more profitable than exploiting price differences on the day-ahead market because of greater price spreads due to the high price volatility on the intraday market.

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5.4 Balancing markets (FCR, aFRR, mFRR)

Balancing markets are used for frequency stabilization services in electricity grids. The objective is to maintain a stable frequency by ensuring supply and demand in the grid are in equilibrium at all times. Any deviations from this balance can result in grid instability and, in severe cases, lead to blackouts. Flexible assets such as BESS can be employed to provide frequency containment and restoration measures by absorbing or dispatching power and capacity as necessary in cases of frequency deviation.

In the event of frequency deviations beyond predefined thresholds, frequency containment reserve (FCR) assets are first activated within seconds to mitigate the imbalance. Should the frequency deviation persist, frequency restoration reserve assets are activated, initially through automated protocols (aFRR) and subsequently through manual intervention (mFRR) if needed. This layered approach ensures rapid response to frequency variations, thereby safeguarding grid integrity and minimizing the risk of disruptions to electricity supply.

Compensation is provided to participating / activated assets for capacity provision and / or energy provision depending on the type of frequency regulation (FCR, aFRR, or mFRR). However, the exact remuneration mechanism is dependent on the country in Europe, as there are no harmonized European balancing markets. The rules, procedures, and market design features of balancing markets can thus vary between European countries, influencing how market participants such as BESS operators trade electricity balancing services.

Importantly, strict technical rules and comprehensive prequalification procedures are commonly required before assets are allowed to participate in balancing markets. In addition, there are often minimum bid sizes that exclude smaller assets from providing balancing services if they are not in a pool of multiple assets.

5.5 Reduction of imbalance settlement costs

Imbalance settlement is a mechanism used to account for discrepancies between scheduled and actual electricity generation or consumption. It ensures that the balance between supply and demand in real-time is maintained, as any deviation can lead to grid instability and potential disruptions, such as blackouts. RES generation implies forecast errors and resulting deviations from the schedule. The imbalance settlement pricing scheme usually penalizes these errors, even though depending on the imbalance settlement price, which can be positive or negative, they could also translate into revenues. Even so, in the longer term, costs always outweigh the revenues, as the imbalance price and the forecast error are correlated.

By absorbing or discharging surplus energy during times when there is a deviation from the anticipated schedule, BESS can help prevent imbalances that would incur settlement costs. In this way, BESS can aid in maintaining the schedule and therefore in reducing imbalance settlement costs.

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5.6 Value stacking

Value stacking refers to the combination of multiple business or use cases for a BESS to maximize its economic benefits. This approach involves leveraging the flexibility and versatility of BESS to simultaneously benefit from multiple business / use cases, such as peak shaving, exploitation of day-ahead or intraday price differences, and frequency regulation services.

One of the key advantages of value stacking for BESS is the potential for increased profitability compared to single business cases. By diversifying revenue streams and gaining profits from multiple markets, BESS operators can enhance their overall financial performance and improve return on investment. Additionally, value stacking allows BESS to better adapt to changing market conditions and mitigate risks associated with relying on a single revenue source.

However, to practically apply value stacking, BESS operators must implement complex operational optimization mechanisms that maximize revenue generation across multiple use cases. This involves developing sophisticated forecasting and trading algorithms, as well as control strategies, that take into account factors such as electricity prices on different markets, RES availability, grid frequency, demand patterns, and regulatory requirements, e. g. for frequency regulation. Only then can operators benefit from different markets while ensuring efficient and reliable system performance.

Furthermore, effective value stacking requires careful consideration of the technical capabilities and limitations of the BESS, as well as the specific requirements of each market, especially for frequency regulation services. BESS operators must therefore tailor their operation strategy to balance potential competing priorities and optimize potential profits across multiple markets.

Overall, value stacking has high potential for maximizing the economic benefits of a BESS by combining multiple business cases. However, successful implementation requires complex operational optimization mechanisms and careful consideration of technical, market, and regulatory factors.

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6 Overall progress and current status

This is the finished version 2 of deliverable 5.2, which has been reviewed.

This deliverable serves as a business innovation training guideline for teaching activities within WP5. It explains the business modelling process and provides information on the development of suitable business cases based on the results of a techno-economic assessment (TEA). In addition, business modelling methods are outlined, and the role of financing is covered. Moreover, suitable use cases and marketing options for BESS, that may represent profitable business cases, are discussed.

Deliverable 5.2 may be used by researchers who have no prior knowledge on business innovation to familiarize themselves with this topic.

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7 Conclusion

In conclusion, the comprehensive exploration of business modelling processes, methodological approaches, financing strategies, and potential use cases for BESS presented in this report underscores the critical importance of innovative approaches within the energy sector, particularly in the realm of BESS. The report not only illustrates the evolving landscape of business models but also highlights the intricate interplay between technological advancements, market dynamics, and regulatory frameworks.

Moreover, through giving an overview of various methodologies such as the Business Model Canvas, Business Model Navigator, and Odyssey 3.14 approach, coupled with a discussion on financing options including public funding and private investments, this report offers valuable insights for researchers aiming to navigate the complexities of business modelling in research projects.

Furthermore, the presentation of diverse use cases ranging from peak shaving to market price arbitrage and participation in balancing markets underscores the versatility and potential economic benefits of BESS deployment.

In essence, this report serves as a roadmap for researchers in energy-related disciplines, providing an understanding of business model development, financing strategies, and the identification of viable use cases for BESS. As the energy landscape continues to evolve, embracing innovative business models will be imperative for fostering sustainable growth and resilience in a renewable energy system.

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