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# DELIVERABLE: 3.1

## Study on emerging and market-proven service and X-as-a-Service business models in the building sector

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Building Up Next-Generation Smart Energy Services Offer and Market Up-take Valorising Energy Efficiency and Flexibility at Demand-Side.

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## Disclaimer

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## Nomenclature

| | |
|---|---|
| AI | Artificial Intelligence |
| API | Application Programming Interface |
| BUC | Business Use Cases |
| B2B | Business-To-Business |
| B2C | Business-To-Consumer |
| CAPEX | Capital Expenditure |
| DTs | Digital Technologies |
| ESBs | Energy Service Business Models |
| ESP | Energy Service Providers |
| EU | European Union |
| EV | Electric Vehicle |
| FMCG | Fast Moving Consumer Goods |
| HEMS | Home Energy Management Systems |
| HVAC | Heating, Ventilation and Air Conditioning |
| ICT | Information and Communication Technology |
| IoT | Internet Of Things |
| MS | Member States |
| OEM | Original Equipment Manufacturer |
| OPEX | Operational Expenditure |
| PSS | Product Service System |
| QDA | Qualitative Data Analysis |
| ROI | Return On Investment |
| SAREF | Smart Appliances Reference |
| SLA | Service Level Agreement |
| SRI | Smart Readiness Indicator |
| WP | Work Package |
| XaaS | X-as-a-Service / Anything-as-a-Service |

# 1. Executive Summary

The energy system is changing rapidly from top-down centralized generation to a system marked by decentralization and an actively participating demand-side. The line between production and consumption blurs: prosumerism becomes a key concept. Simultaneously, the perception of energy changes from a product consumers buy per kwh to a service that provides users with the direct benefits of utility or comfort – a warm home, a lighted building.

**Anything-as-a-service (XaaS)** is the business model that enables companies to operationalize this trend. The X is a placeholder for the different services that can be offered in the form of this model. This report provides a study on emerging and market-proven services and X-as-a-Service business models in the building and energy sector. Our methodological framework combines desk research with surveys, semi-structured interviews, and feedback to effectively validate the insights gathered from business stakeholders.

**The first part** captures the context and state of the literature for XaaS. Besides the policy and the methodology, the main component of part 1 is a literature review on energy services. This encompasses case studies on best practices from different services offered across Europe. **The second part** is empirical. We conducted a survey and semi-structured interviews among companies practicing XaaS and captured their point of view on:

a) Benefits and motivations
b) Barriers to implementation
c) Current performance of XaaS
d) Risk perceptions
e) Regulatory support.

Taken together, the two parts capture the status quo of the implementation of XaaS business models and provide insights on how to apply these findings to policy and business. The following summarizes the main findings.

In the **policy context**, we have identified a number of initiatives that aim to shape the framework for the operation of XaaS business models in the energy sector. Notably, these efforts come from the energy sector (e.g., renewable energy directive), digitalization (e.g., smart readiness indicator), and standardization (e.g., interoperability framework). This emphasizes that servitization is a cross-cutting issue that connects several mega trends.

The findings from the **literature review** show that there is not yet a consolidated definition or terminology around service-based business models. Instead, the servitization in the energy sector can be described as a collection of overlapping, interconnected models that build on new opportunities from digitalization and decentralization of the energy system. The proliferation of XaaS goes hand in hand with an evolution in the business model from electricity generation to service provider. Under this umbrella, the implementation of XaaS has recently been applied to deliver a host of different services with increasing complexity, culminating in "sustainability-as-a-service". The report captures this diversity in the form of nine business cases from companies that offer a variety of different services across the European Union, as summarized in Table 1.

*Table 1: Overview of presented business cases in Part 1*

| | | |
|---|---|---|
| **Comfort-as-a-Service in France** | **Charging-as-a-Service in Germany** | **Energy-as-a-Service in Germany** |
| **Flexibility-as-a-Service in Spain** | **Light-as-a-Service in Ireland** | **Solar-as-a-Service in Germany** |
| **Charging-as-a-Service by a Multi-National** | **Battery-as-a-Service in Germany** | **Heating-as-a-Service in Sweden** |

Three main findings emerge from the analysis of current business cases and service types. First, companies often combine multiple business models, both regarding the types of services and the revenue models. Second, the degree of servitization varies substantially, ranging from offering zero-investment services to the consumer to financing investments with supporting services. Third, there is a forward-looking sentiment with expectations of further integration and expansion of XaaS across services and even sectors.

In the **empirical analysis**, we present the results from both an online survey and semi-structured interviews. The data collected here confirms the findings from the literature review that many companies operate multiple business lines and revenue models in parallel. The most important benefit from XaaS according to the survey is transparency and better engagement with end customers. Additionally, the interviews indicate that the return on investment does not materialize faster, but rather the quality of these returns increases with XaaS. The shifting of the initial investment risk from the customer to the company is noted as a concern with practicing XaaS.

The two top challenges are: a) technical and informational interoperability of services and b) availability and access of data to design a new XaaS service offering. In this context, it is noteworthy that interoperability is discussed as a broader problem than technical interoperability. Legacy systems, lack of digital processes, and conservative attitudes are also referred to in this context. Digitalization remains a cross-cutting topic, with concerns regarding data availability, accessibility, and sharing of data. Yet, there is also perceived opportunity, e.g. for new payment models becoming possible precisely through digitalization.

Regulatory risk is the top-ranked risk category in the survey by far, followed by market and financial risk. This risk perception includes also barriers from bureaucracy, red tape and lack of standardization. Related to regulation, the perception is that the current government support for XaaS is mainly low or moderate. The importance of the European Union as a driver of ongoing progress is however acknowledged in the interviews.

Regarding the objectives of the **BungEES project**, the empirical analysis shows that service-based business models are coming up in several sectors, but that their current growth is still hampered by the factors discussed above. In particular, the issues of interoperability and regulatory risk are highly pertinent to the implementation of the next generation of smart energy services.

Concluding the report, several recommendations are presented. Consumer focus and careful tailoring to target groups is important, even though that may imply different revenue streams in parallel. Dependencies on other actors in the value chain should receive more attention beyond technical capabilities, which can be done by drawing on social science approaches to stakeholder mapping. Interoperability concerns are manifold and would be best addressed with a comprehensive approach, i.e. an energy data space with transnational and cross-sectoral reach.

In brief, this report gives an overview of the state of play in XaaS markets. The findings show a growing number of use cases promoting sustainability and circular economy. Expectations among businesses within field to grow further in the coming years. Barriers, however, continue to exist especially in the realm of missing interoperability and unfavorable or uncertain regulation. The contents of the report provide insights on the entire value chain of service-based business models in the building sector, spanning the bridge from the operational level to customer preferences. *Figure 1.1: Application of XaaS in the Building Sector* serves as a visual overview cover page for this contents of the overall report.

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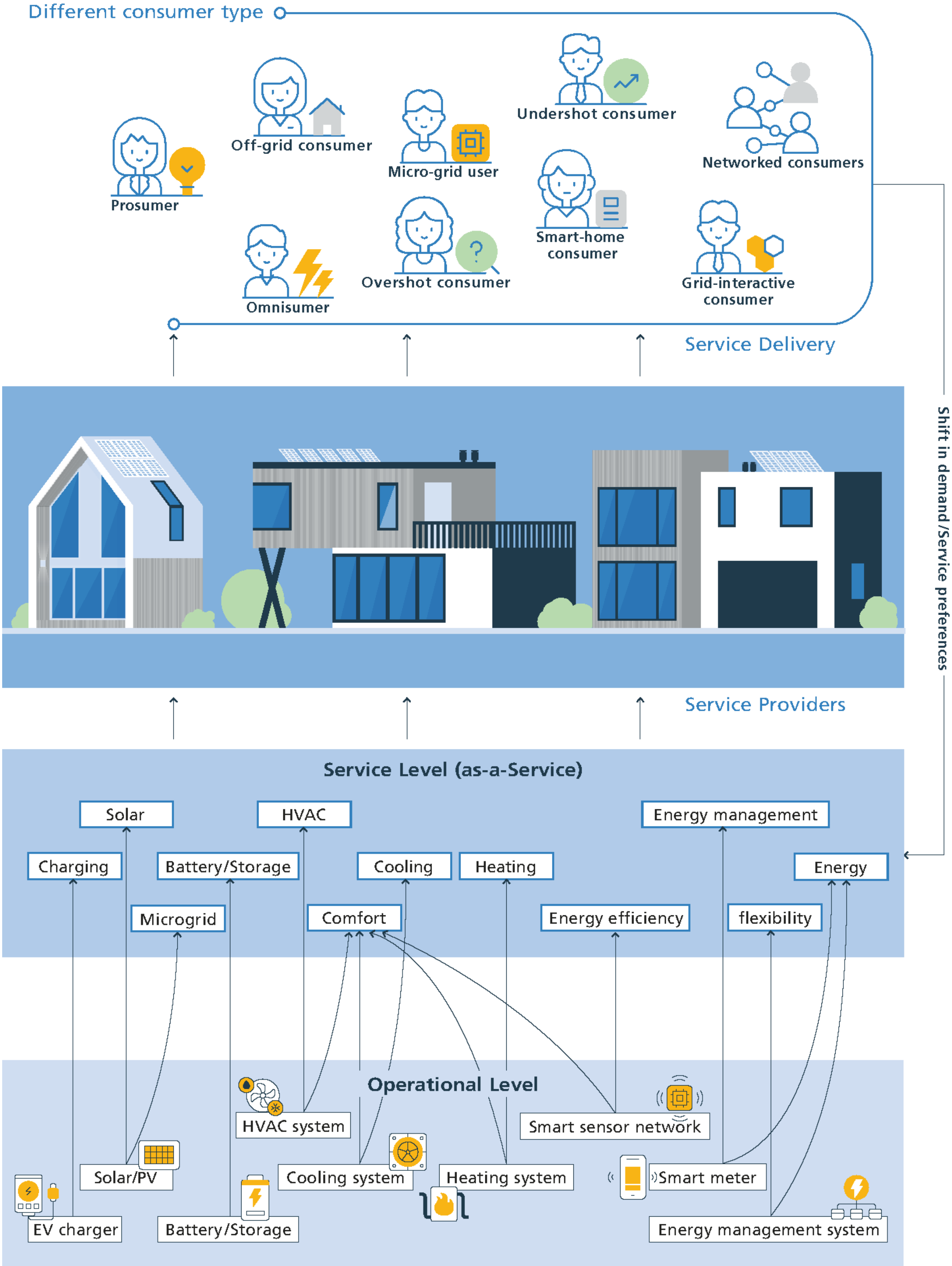


*Figure 1.1: Application of XaaS in the Building Sector*

# 2. First part: XaaS in context and literature

## 2.1 Introduction

The European energy sector has experienced significant changes in recent years, driven by factors such as the digitalization of the energy industry, the rise of prosumers, the increased adoption of renewable energy sources, and the pressing need for energy security. Nevertheless, the journey towards establishing a fully decarbonized and climate-neutral energy system remains a formidable challenge that will require concerted efforts over the coming years. Along with other contemporary sectors, the building sector contributes a significant part to final energy consumption. Moreover, decarbonizing the building sector presents several major challenges. For example, the high upfront costs of clean energy technologies, coupled with the non-energy-efficient operation of building appliances and services, could further delay the full decarbonization of the building sector.

In an effort to tackle these obstacles and advance sustainability goals, the European Union (EU) and its Member States (MS) have developed and implemented an array of policies and directives aimed at nurturing the growth of energy-efficient buildings.

As a result of new digital technologies and the rising consumer expectation for digitalized energy services, a number of innovative business models (BMs) are spurring in the building sector. In fact, many of these business models have shifted from being business-centric to being consumer-centric, offering tailored end-energy services. Digital technologies (DTs), including Artificial intelligence (AI), the Internet of things (IoT), Blockchain (BC), and advanced data analytics, are enabling both consumers and energy service providers (ESPs) to create and engage in a digitalized and connected energy service (ES) ecosystem (Singh et al. 2021b). In this context, ESPs are harnessing digital technologies to foster innovative service-oriented business models. Anything-as-a-Service or X-as-a-Service (XaaS) are a prime example of such innovative business models that have been implemented by numerous startups and established energy companies.

A substantial share of ESCs and startups are actively engaged in innovating energy services. Embracing a customer-centric approach to servitization facilitates the creation of new customer base models, more accurate profitability estimations, and enhanced transparency. Shifting from traditional products to digital services also captures the attention of investors due to the relatively straightforward assessment and validation of both existing and potential markets. However, these new business model archetypes are still in the experimental phase and limited to certain member states and markets. Therefore, they are experiencing challenges in terms of market maturity and customer acceptance.

As part of the BungEES project, a specific task has been included to explore and comprehend the challenges and obstacles associated with the adoption of XaaS energy services within the building sector. A short project and task description is provided below.

**About BungEES**

BungEES aims to address opportunities and barriers to servitization in the European energy system along with the need for decarbonization of the European building stock. As market complexity increases and digitalization progresses, energy efficiency services are a key piece for coordination between energy efficiency measures and demand response for the future of the European Energy Market. The main objective of BungEES is to explore how energy efficiency services can evolve to deliver total energy solutions that combine services into integrated/one-stop-shop and end-to-end solutions. The project takes account of the interdependence between emerging technologies, new demands by active prosumers, and the changing energy market structure. Our vision is to conceptualize how energy efficiency and distributed generation, demand response, e-mobility, energy storage and the variety of energy uses in a building can be linked. Such integrated models could allow the market for energy efficiency services to develop fully and contribute to its full potential to achieving carbon neutrality by 2050. To this end, the project includes the above survey on emerging and market-proven service and X-as-a-Service business model in the building sector.

**Work Package (WP) 3, Task 3.1**

Table 2 summarizes Work Package 3 (WP 3). This report is within the framework of WP 3, *Implementing and data acquisition for smart energy efficiency services (EES) validation*, *Task 3.1 Study on emerging and market-proven service and X-as-a- Service business model in the building sector*. Various use cases involving emerging XaaS (X-as-a-Service) and connected energy service (CES) business models are being analyzed. The primary objective of this study is to encompass best practices, challenges, and regulatory aspects of such business use cases (BUC).

*Table 2: Overview of Work Package 3 within the BungEES project*

| Nr | Title | Objectives | Summary |
|---|---|---|---|
| 1 | **Study on emerging and market-proven service and X-as-a-Service business model in the building sector** | Challenges and barriers to consumer's participation in energy service. A new framework for service level agreement and management is proposed to address interoperability challenges in building services. | Incorporating multiple service management framework, tools and techniques improving services business models. |
| 2 | **User-centric appliances** | Installation of user-centric devices/appliances (e.g., smart thermostat, heating system with occupancy counter) at ongoing energy efficiency project site and impact monitoring. | Assessing potential impact of ICT enabled devices/appliances on ESPC operation and user behaviors. |
| 3 | **Automated measurement and verification tools** | Demonstration of proposed automated measurement and verification tools in different building type (Sub-task 3.2.3). | Assessing energy saving opportunities and new business models for energy efficiency service providers by deploying, automated measurement and verification techniques. |

| | | | |
|---|---|---|---|
| 4 | **Energy and non-energy visualization tools** | Use of effective energy and non-energy benefits visualization tools (Subtask 3.2.2) in different sites. | Improving user participation via communicating over advanced visualization tools. |
| 5 | **Demand Response Platform demonstration** | Use of effective energy and non-energy benefits visualization tools (Subtask 3.2.2) in different sites. | To assess potential energy savings through short curtailments of appliances and relevant load reduction. |

The report is structured into the following two main sections.

**Part 1** provides the background, methodology and literature review. This initial section introduces various XaaS business cases within the building sector and draws insights from the broader energy sector and sector coupling. The objective is to give an overview of the current state of the academic literature and implementation examples already in the market. This part is based on desk research and lays the foundation for the empirical analysis in the second part. To this end, Part 1 also includes our research methodology.

**Part 2** presents the results from a survey and interviews on XaaS business models that was carried out with businesses active in the space. Accordingly, the second section presents the research findings by summarizing both survey and interview results, as well as identifying common insights through qualitative data analysis. Additionally, this section offers recommendations and concluding remarks.

### 2.1.2 The European policy context

Energy services and the viability of business models are heavily influenced by policy frameworks. The following text gives an overview of high level initiatives that are crucial for energy services in the building sector.

**Smart Readiness Indicator (SRI)**
In Europe, the SRI is considered as a crucial policy instrument to accelerate the adoption of innovative digital technologies and data-driven energy services in the building sector.[1] The SRI is an assessment system that is aligned with the EU's ambitious energy policies such as the energy performance of buildings directive (EPBD) and the energy efficiency directive (EED). The SRI initiative provides a common definition of the smart readiness of buildings and an EU-wide methodology for calculation. Moreover, it establishes a consistent and transparent rating of the smart readiness of buildings. By evaluating building's readiness to harness digital solutions for energy efficiency and comfort, the SRI contributes to the creation of smart and sustainable environments.

The SRI evaluates how well buildings (or individual building units) can fulfill three important functions: (i) enhancing energy efficiency and overall operational performance during use, (ii) adjusting the operations to meet occupants' needs, and (iii) responding to grid signals for

[1] See: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator_en

energy flexibility. Digitalization of end-consumer energy services is highly emphasized in the SRI. As a result, a "smart-ready service catalogue" categorizing building services into nine technical domains is included. Additionally, the SRI framework highlights the significance of data sharing and transparency, enabling building owners and occupants to access valuable information regarding energy consumption and performance. This aspect is meant to empower individuals and organizations to make informed decisions, optimize energy usage, and minimize environmental impacts.

The SRI clearly supports the advancement of cohesive and interconnected energy services, by endorsing the utilization of renewable energy sources and fostering innovation in building management systems. It actively promotes the adoption of digital technologies like IoT devices, Artificial Intelligence, and Blockchain within the energy service value chain.
Currently, the SRI is in the test phase, although a number of use cases have been developed to demonstrate the SRI rating and the digital ready energy services it aims to assess. Beyond these efforts, eight member states already have committed to adopting the SRI at national level.[2]

**Energy Union and Climate Action (governance regulation)**
The EU Energy Union and Climate Action policy packages place a high emphasis on buildings.[3] Recognizing the crucial role of buildings in energy consumption, greenhouse gas emissions, and energy poverty, the policy aims to improve energy efficiency and the necessary domestic energy services needed to guarantee basic standards of living in each member state. This includes encouraging the renovation of existing buildings to enhance energy performance, promoting the use of renewable energy sources, and implementing smart technologies for efficient energy management. By prioritizing sustainable building practices, the EU aims to reduce carbon emissions, enhance energy security, and contribute to a greener and more sustainable future.

**Data Act and Digital Markets Act (DMA)**
Beyond the policies directly addressing energy and related services, there are other policies relevant in shaping the ecosystem in which energy services are being built. For example, the Data Act complements the Data Governance Regulation proposed in November 2020. It promotes a fair and innovative data-driven economy and provides a legal framework for companies and businesses to share data.[4] The legislation also aims to stimulate a competitive data market and innovative services and strives for a fair, yet accessible data market for non-personal data. In addition, it facilitates the sharing of data within the framework of business relationships between companies and authorities, which is often inefficient via existing channels. Data has significant value in the energy and building sector. Fair data sharing could act as a catalyst in building new innovative energy services, while also improving the value inherent in existing energy services.
In parallel to the development of the Data Act, a variety of digital services and platforms are already emerging in the energy sector. In particular, a wide range of platforms are already

[2] The current status by country is found here: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator/sri-test-phases_en
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0564
[4] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022PC0068

implemented and actively serving the end-consumers. Platforms often act as an interface between companies and end-users, lowering transaction costs and facilitating integration across service types and sectors (e.g., Parvin et al. 2022). The DMA regulates competition between relevant platform services and also obliges fair competition for gatekeepers and transparency in horizontal and vertical markets. These central platform services include intermediary services (e.g., marketplaces and app stores). While the DMA encourages data sharing, there is regulation constraining data use by platforms, especially through the **Digital Services Act.** Energy platforms are also regulated by the DMA in order to maintain competitiveness for new market participants that will bring new actors in the energy service value chain. The Data Act would establish ground rules for data sharing and portability in the energy sector. Third parties could connect access to data from multiple sources in order to offer digital services/solutions to end users, while following a framework that ensures fair use.

**European Interoperability Framework (EIF)**

The interoperability of energy services is a highly debated topic among the various stakeholders (Reif 2020). Along with end-consumers, energy service providers, and Original Equipment Manufacturer (OEM)s are have interests to participate in a fully interoperable energy service network, but this level of connectivity is currently not implemented yet. At this juncture, the EIF guidelines are a set of recommendations for achieving interoperability at different levels of business processes. The EIF framework introduces different levels of interoperability (e.g., organizational, technical, and informational) to streamline the flow of data in end-to-end digital services.[5] It supports the adoption of open-source software technologies, databases and products to avoid lock-in effects. The energy sector is of great importance in the context of the interoperability of technologies and information. If successful, the EIF would help implement interoperability at every stage of the energy services value chain. Moreover, initiatives such as **Smart Appliances Reference (SAREF)** build common ontologies for energy and building sectors. SAREF is well supported by manufacturers, service providers and public bodies. Pan EU adoption of SAREF is likely to bring new interoperable energy services and actors into the competitive landscape of energy services.

**Renewable Energy Directive (RED III)**

The newly introduced RED III directive is an important policy initiative to enable the energy transition, including a target of 49% renewables for heating/cooling in the building sector by 2030.[6] RED III emphasizes the electronic exchange of data, in particular to facilitate demand response. This exchange will cover assets such as: battery storage system, EV charging points, heating and cooling system locations, building energy management and data from aggregators and other emerging players. The current re-cast of the RED reflects the changing energy market that is transforming under the megatrends of decentralization and

[5] https://eur-lex.europa.eu/resource.html?uri=cellar:2c2f2554-0faf-11e7-8a35-01aa75ed71a1.0017.02/DOC_1&format=PDF

[6] https://www.consilium.europa.eu/en/press/press-releases/2023/03/30/council-and-parliament-reach-provisional-deal-on-renewable-energy-directive/

digitalization.[7] To fully exploit the potential of new technology and broadening stakeholder participation, the framework conditions have to evolve in parallel. For energy services in particular, this development could facilitate new service offering and value propositions that are currently technologically feasible, but not viable due to economic and regulatory barriers. In addition, RED III promotes the system integration of renewable energies in a digital way.[8] It makes the issuance of certificates of origin mandatory and ensures transparency among those involved.

### 2.1.3 Research statement: objectives and contribution

Considering the background of business and policy outlined above, Task 3.1 in the BungEES project aims to analyze the current XaaS practices on the demand side. This study provides this analysis. Additionally, other business cases in the building sector are examined to showcase the wider range of as-a-service business models because these experiences are transferrable to energy services in the building sector.

To this extent, the following research objectives are pursued in this work:

- What is the current state of active XaaS energy services in the building sector?
- How does it relate to developments in the associated sectors regarding mobility, and end-consumer digitalization?
- How are organizations currently incorporating the *as-a-service* model into their value propositions?
- What are the primary benefits and motivations behind implementing the XaaS business model?
- What risks are associated with servitization and what are the major challenges?
- How do current regulatory practices either support or encourage the development of XaaS business models in the energy sector?
- What are the primary technical complexities involved in adopting XaaS as the main business model for companies providing energy services?

The first three questions drive the literature review in Part 1, while the questions four to seven are the primary targets of the empirical analysis. Based on this background, the contribution of the report is twofold.

1. The comprehensive understanding of the XaaS business model in the context of energy services, specifically focusing on the demand side. This contribution is delivered by including detailed insights, business cases, and best practices.
2. The examination of the perspective of stakeholders, organizations, and startups implementing and promoting the as-a-service business model within their service portfolio.

[7] cf. Paragraphs 48 to 56 of draft: https://www.europarl.europa.eu/doceo/document/TA-9-2023-0303_EN.html
[8] See related press communication: https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1259

## 2.2 Overall Methodology

In order to address the research question mentioned above, the following describes the adopted methodology. The process is depicted in Figure 2.1.

**Preliminary research**
In a first step, desk research is conducted regarding the current state of energy services. The objective is to provide a solid understanding of the research basis and practical implementation. This consists of an analysis of business model insights and a review of the associated academic publications. A particular focus here is to cover the breadth of energy services that matter in the building sector. In particular, XaaS is considered in relation to the broader group of service-based and digitally connected business models, which is important in order to understand the appropriate scope for the survey later on. Where applicable, insights are also drawn from evidence on servitization trends in related sectors, such as mobility and cloud computing, which play into the context of BungEES.
Based on the findings from this preliminary analysis, the next step is the selection of XaaS use cases. This step encompasses the description of the value forms that can be offered as a service, e.g., flexibility, solar, energy (see the Cover Page). From the generic description, selected businesses are identified that are already successfully implementing these business models. The selected examples are described according to a common structure (see Boxes 1-9 throughout the literature review) following the logic of the business model canvas. These use cases from practice are then discussed in relation to the general business model descriptions to provide the link between concept and practice.

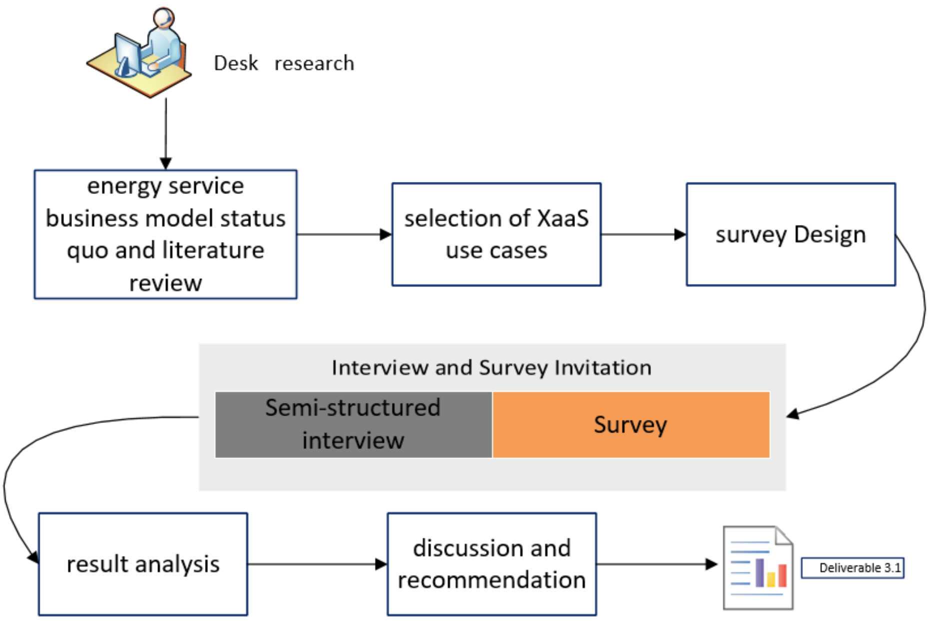


*Figure 2.1: Process diagram of research methodology*

**Survey design**

The survey is structured in three blocks. Block 1 collects general information about the company and the business model. This section asks about the energy services currently offered, the business model/target group, and revenue streams. In all cases, multi-selection is possible because the desk research identified the co-existence of multiple business models as a key factor for XaaS. The aim is to capture the scope of the business' value creation and delivery modes.

Block 2 is specific to XaaS. It begins with awareness of the model and the attitude towards adoption for the future of the business. Then, the survey collects information on the perceived benefits of practicing XaaS, as well as the motivation for implementation in the respective company's value chain. These questions are formulated as closed lists asking for selection of top answers to ensure that answers can be compared despite differences in terminology across fields and sub-sectors. Subsequently, barriers to XaaS implementation are assessed using sliding scales from "no challenge" to "extremely challenging". This encompasses 4 questions related to the following points: availability and access to data, requirement of digital infrastructure, interoperability, and connected asset availability. In a follow-up question, participants are asked about the growth of XaaS in their own company performance. The second block closes with an assessment of risks. The potential risk factors are again presented as a list for selection and prompt the participant for a ranking. To avoid diverging interpretations, the names lists are supplemented with explanations/examples.

Block 3 builds on the prior questions, now adding a focus on the bundling of multiple services. The objective is to understand the perceived viability and current practices toward the one-stop-shop packages envisioned in the BungEES project. This starts with two items on current business opportunities (sliding scale) and multi-service contracts (single selection). Since this aspect is highly context-dependent, the survey then asks about perceived policy support for digitally connected XaaS. In contrast to the previous sections, block 3 does include a closed list of factors, because the regulatory conditions differ widely across countries and sectors. Instead, interviewees are prompted to elaborate on the situation in their country through the semi-structured interview. The survey closes with an open-text question encouraging the sharing of additional information.

**Survey execution**

Potential candidate companies are identified through three sources. First, collaboration with the project partners, who know their country-specific markets in detail. Second, business cases come from the results of the desk research above. Third, the survey is circulated through networking with the relevant business associations in the project countries where possible.

Participation in the survey occurs through semi-structured interviews. The online survey is used as a presentation to support these interviews and ensure comparability. The duration is set to 30 or 45 min depending on participants' time constraints. The interviewers guide the participant through the survey, and prompt them to elaborate on points raised by the interviewee him/herself throughout the process. Given the relatively wide range of candidate companies which come from different fields, it is expected that some questions will not apply directly to each company. In such cases, interviewees are encouraged to adapt the question to their business context and explain the circumstances. The interviewers researched each

company prior to the interview to anticipate where such guidance might be helpful or necessary.
To allow for participation that is flexible time-wise, the survey can also be filled independently by the companies. This dual mode of participation was considered in survey design and motivated the relatively structured organization of the survey at the design stage.

**Results analysis**
The data are analyzed using computer-assisted qualitative data analysis (QDA). The methodology is implemented using the software program MAXQDA. The survey answers are collected for analysis in the program, the semi-structured interviews are first transcribed. The methodology for the analysis is chosen to match the research objectives. One the one hand, the findings need to allow a comparison across respondents to identify patterns and communalities. The survey design considers this through the focus on rankings and categorical answer choices. On the other hand, there is high value in the textual data collected as part of the semi-structured interviews. However, the participants come from different sub-fields and are expected to use nuanced terminology and context-specific examples. Structuring QDA with MAXQDA software allows the balance between both: the quantitatively comparable results can be evaluated directly, and the textual data can be used to broaden and deepen the analysis. Importantly, the latter is done systematically within the program, to mitigate the loss of information by cross-referencing related points that may be made under different questions.

**Discussion and recommendations**
In the final section, we synthesize the results from part 1 and part 2. The objective is first to reflect on the learnings, in particular analyzing alignments and discrepancies between the practical learnings from the surveys and the status quo of the literature. Subsequently, the findings are also applied to the contents and objectives of the BungEES project. This is related to both the consecutive work in work package 3, and the cross-cutting themes to the other work packages.

## 2.3 Literature Review

Energy services are a highly dynamic field, which is constantly evolving as the energy system comes under major transformation (decarbonization of power generation, electric mobility and high-efficiency flexible loads) and digitally connected business models develop also in neighboring fields. Within this context, the relevant literature can be divided into three strands. Academic literature explores the concept of energy services, characterizes the business models and discusses the connection to broader phenomena such as digitalization and decentralization. Research projects, consulting firms, and business associations contribute grey literature that is mainly concerned with the potentials and the barriers for XaaS. Finally, private companies provide information on their offerings, which inform what is already happening on the ground. The literature review aims to link these three strands to provide an overview of the status quo in the XaaS market.
To this end, nine selected use cases are placed in boxes throughout the text. The nine cases are analyzed using the business model canvas as proposed by Osterwalder and Pigneur

(2010). The concept is applied in a condensed version with four building blocks. These are infrastructure, value proposition (also called offering), customers, and finances. Infrastructure covers the key activities, resources, and partnerships of the business. The value proposition explains the company's added value in the market. The customer block covers the target group(s), including the associated relationships and channels. The finance block encompasses the cost structure and revenue streams that allow the company to capture value.

### 2.3.1 Energy services in the building sector

**Definition of energy services.** The idea behind energy services is that consumers buy energy only as an intermediate good, while the actual value lies in the service derived from energy consumption (e.g., Fell 2017; Brown et al. 2022). In economics, the concept of an energy service has long been the base of theoretical models (Hausman 1979), and also empirical evaluations (e.g., Greening et al. 2000 for an early review). However, the term energy service is not clearly defined. For example, in the context of heating, the "service" can refer to a certain temperature or a certain comfort level (Fell 2017). Sovacool (2011) makes a distinction, arguing that the comfort level is not the service itself, but rather a driving factor for the consumption of the service. Considering what is happening in the market today, this distinction appears to have blurred by now (see e.g., Gillham et al. 2023, Bertoldi et al. 2019). The more abstract the service, the higher the obstacles to designing a business model around the service (Gillham et al. 2023), and the higher the requirements on data (Park 2022). With the advent of digitalization and associated advances in data recording/processing, the energy service concept became practically relevant and has proliferated to many definitions, use cases, and industries outside of the traditional energy supply (Xu et al. 2018; Park 2022).

**XaaS and energy service business models.** Accordingly, energy services have garnered attention in business model research, which has led to different concepts that overlap and interconnect. XaaS is one of the terms used to describe business models that aim to deliver energy services, although there is no commonly agreed definition (Fell 2017). Park (2022) defines as-a-service business models by three elements. They are (i) subscription-based, (ii) output-oriented, and (iii) data-driven (p. 3). Within this typology, however, the value offered by the companies through XaaS ranges from guaranteed energy savings (negawatts), to abstract comfort levels, and to full-scale management services for smart buildings (Bertoldi et al. 2019; Kindström and Ottosson 2016). Park's three elements are a useful benchmark in the selection of use cases rather than an exclusive definition. Specific to energy-as-a-service (EaaS), some scholars distinguish XaaS from related models such as energy performance contracts and energy services agreements based on the unit value of the value proposition (Brown et al. 2022). At the same time, the business model itself is increasingly an ongoing process with constant adjustment, so the service offering is not a stable content anymore (Kindström et al. 2017). Agility, which is cited as a key benefit of XaaS (Deloitte 2018), can help cope with this process. According to Xu et al (2019), the shift goes even deeper: In the traditional product business, creating value comes from identifying customer needs and devising a solution. With XaaS, there is instead a continuous process of value creation and value delivery, as the lines between the two functions increasingly blur (Xu et al. 2018).

**Market offerings provided with XaaS.** The above discussion circled around the S in XaaS. The next step is to analyze the X. An open question in the literature is what market offerings can be developed using XaaS and what barriers are faced in implementation (Gillham et al. 2023). The different types can either be described as building on each other in a sort of evolutionary process: this view of a vertical ordering of layers comes from cloud computing (e.g., Mell and Grance 2011). A different perspective is that XaaS describes a group of parallel concepts that each provide a different service (Singh et al. 2022). This view is better described as a horizontal ordering, where services can occur jointly in a sector or market. For energy services in the building sector, the combination of horizontal service types to packages is appropriate to describe the market structure. In recent years, the number of services in XaaS has grown substantially. Park (2022) uses media data to trace the development from 2015 and 2020. The study shows that new XaaS models are coming up, and that these new forms take increasingly higher levels of complexity and abstraction. For example, the term zero-carbon-as-a-service and sustainability-as-a-service are now offered to industrial clients in several early-adopter projects.[9] Additionally, there is a feedback mechanism between demand and supply. Social influence can shift the adoption curve forward in time, and with XaaS, companies can generate buzz *before* the product is launched as there is no need for a physical prototype (Libai et al. 2023).

**Demand side pull factors and adoption.** Fellers (2022) identifies four key benefits for customers. First, XaaS widens the portfolio of offerings available to customers because these business models allow a faster proliferation and adaptation of new services (and products as well). Second, XaaS lowers costs and increases flexibility. This second point is especially important for goods that are not under constant use, such as the cost of ownership for a car – an investment in a good that is used less than 5% of the time. Mobility-as-a-service, by contrast, allows payment only for services consumed. Third, XaaS frees up resources because the business model delivers on outcomes or results without intermediate steps. Clearly, the second and third point are related, as it is economically inefficient to pay for ownership when willingness-to-pay is tied to timely consumption (Gillham et al. 2023). Fourth, XaaS models are better suited to modular approaches, which is valued by customers in a rapidly changing environment. This last point is especially valuable for businesses with a highly digitally connected offer. Overall, a survey by Ernst&Young (2022) suggests that businesses not only respond to customer demands, they are in fact moving to anticipate such shifts, which accelerates XaaS growth in certain sectors already. However, the demand side of XaaS business models encompasses B2B and B2C approaches. While the benefits broadly apply to both groups, the challenges for adoption differ across groups. For end consumers, there is both an increased demand that acts as a driver for XaaS and a slow adoption that hinders the spread of XaaS. On the one hand, consumers demand higher service levels and continued value creation, as well as a better alignment of market offerings with normative values (KPMG 2022). In the energy market for example, it has been noted that prosumerism is a major driver that contributes to breaking up the established top-down value chain (Xu et al. 2018). On the other hand, there is skepticism and a lack of acceptance of digital technologies, especially

[9] https://www.johnsoncontrols.com/media-center/news/press-releases/2021/07/07/johnson-controls-launches-openblue-net-zero-buildings-as-a-service

when it comes to the collection and processing of data (ZIRIUS 2023; Kindström et al. 2017). While some end-consumers actively demand co-creation, others prefer for companies to take over and provide a low-effort solution (Gonçalves and Patrício 2022)

Against this background, the landscape of XaaS can be structured in different ways. Our analysis considers two classifications: the division by business model type, and the break-down into the different services offered.

### 2.3.2 Key business models in the energy and building sector

The XaaS business model differs fundamentally from the traditional structure of the energy sector with centralized generation, structured distribution, and passive end consumers. Simpler forms of servitization occur at various points of the value chain, including the purchase of services by energy companies and the offering of additional services around a core product by those same companies (Park 2022). This extends to OEMs of energy-using durables, which connect the energy and building sector. Beyond that, the evolution of technology along with the decentralization trend has allowed for more complex servitization strategies that now consider, target, and reach the end-user (Goulden et al. 2018). XaaS models build outcome-based business models and exploit IoT technologies and advanced data analytics in the business model (Deloitte 2018). With progressing technology development and closer cross-sectoral, the next step in the evolution is the development of connected energy services (CES) that bundle multiple services horizontally or vertically (Singh et al. 2022; Brown et al. 2022). Figure 2.2 depicts this ongoing evolution, which is conceived as a gradual process with building blocks as described above.

Outcome-based service business models are already well-established in several sectors. Industries such as manufacturing, software, retail, and entertainment have been early adopters of service-driven business models. However, in the energy sector, the adoption of such business models is relatively slow due to a complex regulatory framework.

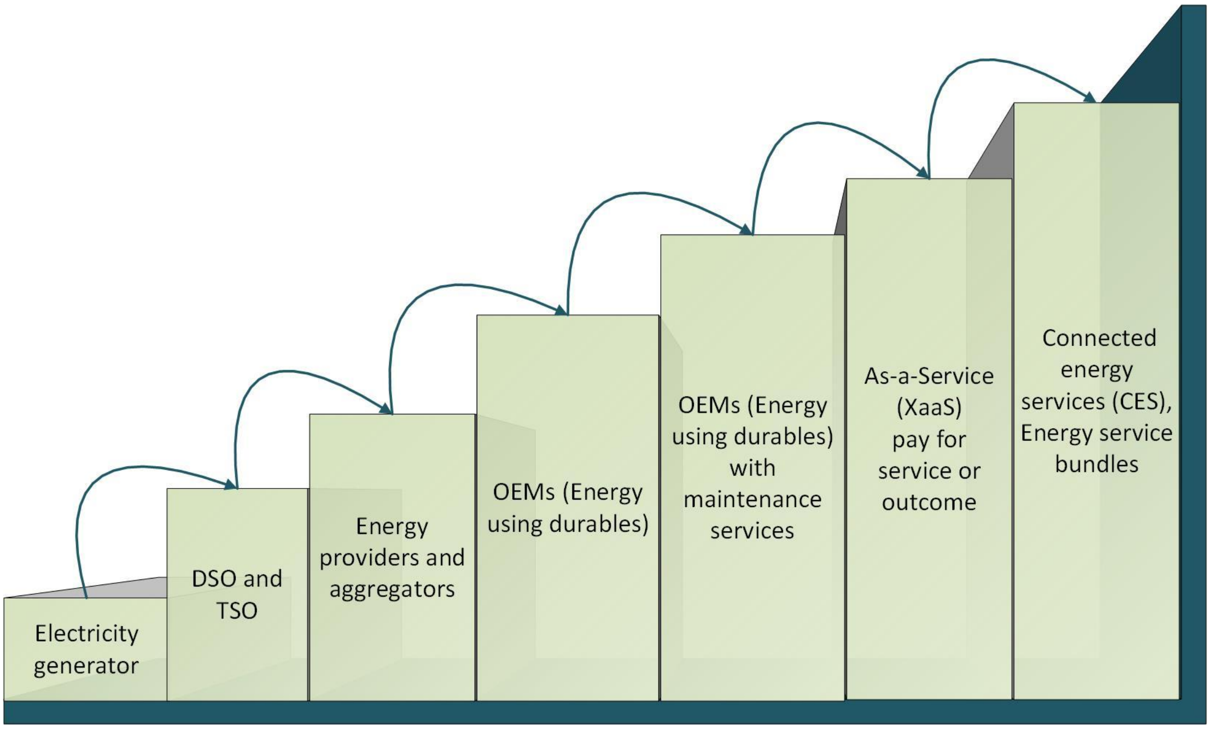


*Figure 2.2: Evolution of XaaS business model from generator to service provider*

The majority of these business cases are implemented by innovative startups. In digitally connected value chains, innovative models become possible through new forms of collaboration, e.g., co-opetition, in a networked environment (Moqaddamerad et al. 2016). Startups are less bound by legacy systems that prevent the adoption of these opportunities. Nevertheless, established energy service companies, original equipment manufacturers (OEMs), and utilities are also starting to embrace the XaaS business model (Ernst&Young 2022). Companies rooted in the traditional energy sector are slower in catering to consumers and less agile with innovation, so their core capabilities are not aligned with XaaS (Xu et al. 2018). Palmié et al. (2021) compare the role of startups and incumbents in green transitions: startups are ahead regarding digitalization and consumer orientation, whereas incumbents leverage advantages in handling complex value processes and high capital requirements (p. 45).

In practice, there are four primary XaaS business model archetypes that can be distinguished (SystemiQ 2021, see also Jonker and Faber 2021). They are:

**Product-oriented**: This type of XaaS business model combines products with service bundles. Energy OEMs take ownership (in some cases also shared with users) of assets and guarantee the availability of services. One example of such Energy Service Business model (ESB) is the on-site installation of energy storage (e.g., energy community storage or collective storage), in which the service provider, along with OEMs, manages everything related to energy storage and provides XaaS services like Energy storage, Energy community, and Energy flexibility as a service to end-users. In return, users have to pay a rental or leasing fee against the service. An example for implementation of this type is GIGA storage, which optimizes storage usages to buffer electricity price volatility.[10] Product-oriented services can also help overcome financing constraints as these models transform CAPEX to OPEX, which is a major benefit depending on a clients' balance sheet regulations (see for example Connected Energy in the UK[11]).

**Pay-for-use/Pay-per-use*:*** This category of ESBs enables users to personalize their service usage and pay based on what, how, and when the service is consumed. It encourages end-consumers to pay for the final service rather than the energy itself or the sub-services required to provide that specific energy service. For instance, options like battery swapping or pay-as-you-go battery charging allow end-users to utilize battery charging as a usage-based payment model. Typically, these ESBs are responsive to price and time signals. This business model is especially valuable for products that are used irregularly, as the XaaS model decouples fixed investment costs from actual usage intensity. In the mobility sector, there are several examples (see Swobbee and Shell ReCharge in **Boxes 7 and 8** below[12]).

**Business Case 1: Comfort-as-a-Service (CaaS): Helexia, France**

Activities/Infrastructure:

- Provision of thermal comfort through energy-efficient appliances
- Building-specific optimization plan

Value proposition:

- Guaranteed performance minimizing risk to client
- Remote control and monitoring
- Full-service package includes alignment to regulatory standards

Customer:

- B2B, but with link to end user comfort

Finances/Pricing.

- Novel version of energy performance

**Outcome or performance based**: This group of ESBs involves energy service companies promising to deliver a desired level of service quality and outcome. Consumers are required to pay for both the desired outcome and the utilization of the service. Service providers and beneficiaries enter into contracts to align service expectations from both sides. These business models are particularly well-established in the ESCOs industry, where service providers guarantee energy efficiency as the service outcome, often measured by energy savings. In addition to the traditional ESCOs business model, some innovative ESBs have also emerged following the outcome-based XaaS approach. For example, 'comfort-as-a-service' ensures the desired indoor temperature (or comfort level) without the need to manage capital-intensive upfront costs. Furthermore, these business models often include product-service bundles. An example of this approach is Helexia in France and Belgium (**Box 1**).[13] In contrast to the traditional ESCO model, Helexia's approach also works for greenfield projects because the model anchors performance to comfort rather than a baseline of historical data (KMO 2019).

[10] https://giga-storage.com/en/storage-as-a-service/
[11] https://connected-energy.co.uk/news/at-your-service-battery-energy-storage-as-a-service/
[12] https://swobbee.de/, https://shellrecharge.com/en-us/solutions/product/charging-as-a-service
[13] https://helexia.be/fr/webinaire/comfort-as-a-service

**Business Case 2: Charging-as-a-Service (CaaS): Me energy, Germany**

Activities/Infrastructure:

- Charging stations without grid access
- One-stop-shop from consulting to delivery and operation

Value proposition:

- Networked charging stations
- Charging infrastructure management
- Increased property & business value

Customer:

- B2B, incl. temporary events
- Public sector, e.g. federal states

Finances/Pricing:

- Available for lease, rent, or sale

**Sharing platform*:*** Over the years, sharing services have gained prominence in the energy sector, offering several key advantages, including maximizing service capacity utilization, extending their reach to a broader range of end consumers, and efficiently managing supply and demand (Szichta and Tietze 2020; Stanelyte et al. 2022). Often, these sharing XaaS models utilize platform ecosystems to deliver their services. Service providers collaborate with OEMs, contractors, subcontractors, and sub-service providers to establish a reliable value chain for their offerings (see e.g., Laukkanen and Tura 2020). Users are typically required to subscribe and pay a fee to access these services through digital platforms such as mobile apps, websites, Application Programming Interface (APIs), and more. An example of this operational model is seen in EV charging as a service, where users pay a subscription fee to locate EV charging stations and charge their vehicles. The network effect among end-users plays a pivotal role in attracting more customers, resulting in substantial profits (Singh et al. 2021a). The sharing model can also help companies selling physical products to scale and build up their business. One example of a hardware start-up with a sharing component is Me Energy (**see Box 2**). The core business is the manufacture of rapid charging in stations that do not require grid access, so the product is location-independent and can be offered as-a-service. The sharing model is attractive for collaboration with public sector entities like the Berlin public transport agency, who use it for charging electric buses with stations installed at bus stops.[14] In the residential sector, established energy suppliers are also working on establishing platforms to leverage their large existing customer base. In Shell Re-Charge for example, the objective is to connect charging at home and on the road.[15]

Nonetheless, a clear separation between these four categories is not always possible. In many cases, a combination of these business models appears to offer additional value propositions to the end consumer. For instance, pay-per-use or outcome-based ESBs can be easily combined with product-oriented XaaS business models.

### 2.3.4 Demand-side XaaS service business models

The service business models intersect in the building sector, but their origins come from several different industries and sectors, each with a different market structure and classic product offering. This in turn affects the strategies pursued in the servitization of the product. The following summarizes the established models and connects them to the practical use

[14] https://meenergy.earth/referenz_bvg

[15] https://shellrecharge.com/en-us/solutions

cases. The different services are organized according to the energy value chain into electricity demand, supply and sector coupling, although overlaps exist between the groups.

**Electricity demand**
XaaS models are breaking up the traditional view of consumers as passive actors served with electricity paid per kWh and the payment pre-determined by the existing building characteristics and consumption profile. The following services belong in this group.

***Energy-as-a-Service:*** Energy-as-a-service (EaaS) is enabled by smart grid technology and coincides with the disintegration of the traditional energy supply chain. The EaaS model is being adopted by ESCOs, where service providers install and manage all energy-related appliances, sensors, and energy management platforms to deliver energy savings. However, with EaaS, all the upstream activities are bundled into one performance indicator that determines payment (Brown et al. 2022, p.8). EaaS models started with larger projects, e.g., public buildings and industrial plants. In recent years, the spread of smart grid technology and the rise of prosumerism in the residential sector have made the model attractive in the residential sector (Xu et al. 2018). Startups have filled this space and offered innovative service models that push the idea of the energy service beyond cost/resource services (Singh et al. 2022). As a result, EaaS now takes many forms that are tailored to evolving customer demands. Naturally, this means that EaaS are beginning to overlap with sector coupling technologies. Models developed for electricity supply (e.g., Solar-as-a-service or Microgrid-as-service) can align with the EaaS model, although they initially fill a different need. Some companies are starting to integrate these services. For example, Gridx (**Box 3**) built its EaaS model around a central platform (XENON), but is now offering different modules that can be added to the service, such as peak energy optimization or flexibility.[16]

**Business Case 3: Energy-as-a-Service (EaaS), Gridx, Germany**

Activities/Infrastructure:
- Smart-grid platform
- Modules for optimization, sector coupling, and customer access

Value proposition:
- Monitoring and load management
- Demand response
- Design, installation, maintenance and performance management of energy services

Customer:
- B2B in energy and building sector

Finances/Pricing:
- Modular approach tailored to client

***Lighting-as-a-Service:*** Lighting-as-a-Service (LaaS) is mainly offered to large industrial clients in B2B models (e.g., Urbanvolt, Signify). The concept is to outsource the installation, management, and maintenance of lighting, typically at the building or plant-level to a third party – the service provider. This frees up resources for the customer's core competence and often comes with the optimization of lighting concepts as a functional improvement to the business and the switch to energy-efficient LEDs as an energy-saving benefit (Guidehouse 2021). The service can be offered as stand-alone or as part of an energy performance

[16] https://de.gridx.ai/

contract. Two main drivers for the adoption are the EU regulatory initiatives that mandate energy efficient lighting and the increase/volatility in electricity prices.[17]

A 2019 study for the German market identified LaaS as the fastest growing segment in the industrial lighting market with a growth rate of 40% (Schrüfer 2019). Compared to other energy-saving potentials like insulation or heating systems, LaaS requires relatively little disruption to the building itself, which lowers the barriers to adoption on the demand side. For example, the company Deutsche Lichtmiete offers to do the transition while the business remains in operation (Mauer 2021).

The supply side of the market is split between incumbent lighting specialists like Phillips, and emerging businesses that have specialized in the niche, for example Signify or Urbanvolt.[18]

**Business Case 4: Light-as-a-Service (LaaS): Urbanvolt, Ireland**

Activities/Infrastructure:
- Installation of energy-efficient LEDs
- Optimized operation of light system

Value proposition:
- Turnkey solution for plant lighting
- Remote access through app for monitoring and management
- Reduced energy cost and lower environmental footprint

Customer:
- B2B: Industrial plants

Finances/Pricing:
- Subscription fee starts after installation for 5-10 year contract
- Extra services, e.g., solar available

**Box 4** shows the example of Urbanvolt, which provides LaaS to clients such as Pfizer or Heineken. The company positions itself as a full-package service provider, which handles lighting from installation to maintenance. A unique selling point is that Urbanvolt's technology app allows remote measurements of the site, so the pre-transition phase can be handled remotely. This serves as an example how XaaS models make use of data analytics and digital tools to support their business model (Aranda et al. 2023; Park 2022).

***Flexibility-as-a-Service:*** Flexibility-as-a-service developed out of the needs of grid operators for system flexibility, but digitalization and prosumerism have unlocked opportunities for end users to benefit (Xu et al. 2018). The distribution system operators (DSOs) have an interest in flexibility because of network congestion and resource optimization. Making use of platform economies, households can be digitally connected and remunerated for the provision of flexible loads. These flexibility platforms connect consumers to grid operators, which can work either directly or more commonly with the participation of intermediaries (e.g., aggregators) that facilitate market access. Bamboo Energy in Spain is an example of such a company.[19] This use case is summarized in **Box 5**. The core capability of Bamboo is to be a technology provider, with the key business model being the platform for trading both in real-time and day-ahead markets. Flexibility potentials increase when households have additional technologies like electric vehicles or storage (FFE 2023). With IoT platforms, these elements can be linked and made available for use through a digitally connected business model. However, to provide flexibility services, companies have to gain market access, which is typically not feasible for small loads. In the residential sector, aggregators and Virtual Power Plants (VPPs) are hence a key

[17] https://www.signify.com/de-de/lighting-services/managed-services/light-as-a-service

[18] https://www.urban-volt.de/ and https://www.signify.com/de-de/lighting-services/managed-services/light-as-a-service

[19] https://bambooenergy.tech/en/about/

> **Business Case 5: Flexibility-as-a-Service (FaaS): Bamboo Energy, Spain**
>
> Activities/Infrastructure:
> - Technology in software platform
> - Market access strategies
>
> Value Proposition:
> - Demand-response marketplace
> - Load management
> - Savings-based incentives
>
> Customer:
> - Aggregators and retailers
> - Flexumers
>
> Finances/Pricing:
> - Platform fees for software use
> - Tailored B2B service packages

intermediary to provide flexibility services. With a European perspective, the regulatory barriers differ substantially and accordingly, the development of flexibility markets is closely related to the national regulatory frameworks (see e.g., Annala et al. 2018). XaaS business models overcome some of the barriers to flexibility markets, but their success hinges on adjustments in the external environment.

***Energy Efficiency and Energy management-as-a-Service:*** Offering energy efficiency as a service creates a business model that monetizes energy *not* consumed. The potential value of these "negawatts" has long been recognized (e.g., Joskow and Marron 1992), but only digitalization enables its implementation. Energy efficiency can be defined either as energy saved relative to a pre-determined benchmark, or as energy consumed per unit of output. While ESCOs offer energy efficiency services for larger clients (Brown et al. 2022), the market is still largely untapped for SMEs.[20] One key barrier for the energy provider is the high investment risk and limited capital access that persists as long as the business model is not mainstreamed in the SME segment (BASE 2023). An extension of energy efficiency services is energy management –as-a-service (EMaaS). While the ultimate target of proven energy savings is the same for both concepts, the focus in EMaaS is more heavily on monitoring and data analytics. For example, the company EWEN (based in Portugal, part of Helexia group), operates this business model.[21] The value proposition is that EMaaS centers on specialized capabilities of real-time data monitoring, which allows companies to improve energy performance while sparing internal resources. While the above business models are mainly employed for B2B, there is potential also in B2C markets. This arises because energy efficiency and flexibility services are connected: both contribute to the demand-side management needed for grid stability when supply volatility increases. However, a business survey in Germany shows that energy efficiency is more widely adopted by industry clients, and that the regulatory hurdles for flexibility are higher (Wohlfarth et al. 2020). There are some countries that experiment with negawatt trading, also for prosumers, but this cloud-based service is so far not viable at scale (Tushar et al. 2020).

**Electricity generation**

Further opportunities are found upstream in the energy value chain, as XaaS models are also changing electricity supply or generation.

[20] https://energy-base.org/projects/efficiency-as-a-service-eaas-in-europe/
[21] https://ewen.energy/en/servicos/gestao-de-energia/energy-management-as-a-service/

***Solar-as-a-Service:*** With solar-as-a-service, the business model is centered on the use of solar electricity as opposed to the sale of the PV plant to home owners. In the residential sector, the business model is often a form of a product-service system, where the customers either pay solely based on subscription, or a split tariff that includes a fixed installation component, and then builds on services. The main motivation for solar-as-a-service is that the prosumer market is lagging behind its potential due to high complexity throughout the process, so one-stop-packages can open up untapped market segments. These models can speed up diffusion beyond early adopters and therefore build economies of scale faster.[22] The value proposition of solar services can be enhanced when the generation is integrated with home energy management systems (HEMS) through an IoT platform. Customarily, solar services are arranged via a leasing or renting agreement, but the contract specifics vary widely, and it is common for the same company to offer parallel models. Typically, however, the service provider continues to own the solar plant, although companies like Enpal or Sunvigo (**Box 6**) offer the customers the option to buy the plant outright after a few years. The value proposition in this split model is that prosumers are relieved from the investment stage but retain the option for ownership if they are content after a trial period. While the model takes the financing burden off the demand side, the business model does not reduce the overall investment – it is shifted to the supply side, i.e., the service provider (cf. Gillham et al. 2023). Hence, financing through investors and formal financial markets are still identified as the main barriers to this business model. Due to the long pay-back periods, solar-as-a-service in the residential sector typically involves long-term contracts rather than pay-as-you-go models, which is a limitation relative to other servitization models that offer more flexibility for the end-consumer.

**Business Case 6: Solar-as-a-service (SoaaS): Sunvigo, Germany**

Activities/Infrastructure:
- Green electricity contracts
- Installation + operation of PV plants

Value proposition:
- Energy cost hedging through renewable electricity
- One stop shop package for installation, maintenance, operation, management and billing
- Co-financing for solar projects

Customer:
- Home owners / Prosumers

Finances/Pricing:
- Subscription includes solar plant

***Microgrid-as-a-Service:*** While the above models serve individual businesses or households, microgrids are a collective-action business model. The appeal of microgrid-as-a-service lies mainly in financing: the business model reduces or even eliminates the need for upfront investment and uncertain maintenance burdens, and therefore empowers collective user groups that would not otherwise be able to invest (cf. Energy supply financing in Brown et al. 2022). A few microgrid vendors are already practicing this business model while developing open architectures and software services to network microgrids with renewable and storage systems.[23]

In the European Union, this business model is currently rare due to relatively strong central grids and high regulatory barriers.[24]

[22] https://www.enpower-podcast.de/podcast/75-solar-contracting-enpal
[23] https://www.energytech.com/distributed-energy/article/21173433/introducing-microgridsasaservice
[24] https://www.microgrids-research.eu/

**Sector coupling technologies**

Beyond a narrow definition of the energy sector, XaaS models are also being developed in the related sectors of mobility and heat. These models are added here briefly, with a focus on the lessons that can transfer to buildings.

***Charging-as-a-Service:*** Vehicles are mobile by definition, and charging needs are not confined to the home. Charging-as-a-service uses Information and Communication Technology (ICT) to connect users with geographically dispersed infrastructure, supplemented with billing and payment services. With the diffusion of electro mobility (or e-mobility), the market for these services is growing. Service providers operating in this sector typically build on platforms, but the pricing models vary widely. The key stakeholders in this business model are not only end customers, but also public and private entities that offer these services on their premises/in their jurisdictions. However, it is difficult to offer fully flexible service models due to the need for immobile infrastructure. In B2B markets, companies like MeCharge (**Box 2**) are changing this, in the B2C market, incumbent players employ charging-as-a-service to add value for an existing core business. The case of Shell ReCharge is presented in **Box 7** below. This use case is important for the building sector because it exemplifies how a value proposition is created by linking customer value inside-the-home and outside-of-the-home.

**Business Case 7: Charging-as-a-Service: Shell ReCharge, MNC**

Activities/Infrastructure:
- Smart charging at home
- Charging network in 33 countries

Value proposition:
- Ecosystem for charging needs
- Optimization software for home and workplace stations
- Service support irrespective of charge point or geographical location

Customer:
- Sales focus on B2C, with B2B efforts to increase public network

Finances/Pricing.
- Split-tariff with individual pricing for the service components

***Battery-as-a-Service:*** The focus in battery-as-a-service (BaaS) is to take the battery as an asset out of EV ownership and provide it as a service. The customer benefit is lower risk of losing mobility and better maintenance through the third party. The BaaS model has a strong link to circular economy, as the second life and recycling are considered in the business model, which reduces the environmental footprint of battery materials. The business model can be implemented in several ways. One version provides value through a network of infrastructure for battery swapping. An example of this is Swobbee in **Box 8**. The company offers a subscription model for battery swapping in micro-

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**Business Case 8: Battery-as-a-Service (BaaS), Swobbee Germany**

Activities/Infrastructure:

- Stations for battery swaps/upgrades
- Battery cloud services and asset management

Value proposition:

- Battery on cloud
- Quickly exchangeable battery system
- Multi-modal charging infrastructure

Customer:

- End-customer network (public)
- Fleet operators (private)

Finances/Pricing:

- Subscription and rental fees

mobility, which is organized through an app and implemented through a system of stations in the city of Berlin.[25] Another version of BaaS works with replacement service at the premise/home. Clean Energy Global provides a storage Clean Energy Pack that covers various battery services in an intelligent network and is targeted to B2B customers.[26]

***Heating-as-a-Service:*** To servitize heating, companies are offering smart heating equipment coupled with service packages and data analytics. The scope of the model can vary, as the heat contract may include ambient air, hot water, and digital add-ons such as remote control of heating appliances. Customers pay for a heat plan on a subscription-basis. Experiences in the U.K. suggest that customers have willingness-to-pay in excess of energy consumption,[27] but the academic literature remains scarce. Integration with other smart home devices is possible, but not yet standardized. The increased emphasis on the decarbonization of the heating sector in the European Union brings awareness for this business model.

In particular for heat pumps, the market potential in the residential sector is substantial.[28] The business model is employed by established appliance companies, but also driven by startups that offer innovative service solutions. One of them is the Swedish company Aira (**Box 9**). The degree of servitization in Aira's business model is relatively low because households cover the upfront purchase. However, Aira's value proposition is centered on the promise of service support throughout the lifecycle of the heating equipment, which can help lower barriers to adoption for the new technology.[29]

***Cooling-as-a-Service:*** Cooling refers to both refrigeration and air conditioning services, which can be offered as a pay-per-use model or under split-tariff pricing schemes.[30] As with solar services, the client does not typically own the equipment, but enters into a long-term contract for its usage. Cooling-as-a-Service can overcome the problem of split incentives (e.g., between owners and tenants/lease holders) because the use of more efficient equipment results in unambiguously lower contract prices. The concept is applicable to the residential sector and the industrial sector, although transaction costs erode profitability for small projects

[25] https://swobbee.de/circle/
[26] https://www.clean-energy-global.com/de/
[27] https://es.catapult.org.uk/report/ssh2-introduction-to-heat-as-a-service
[28] ECF-Europes-Leap-to-Heat-Pumps-Report_FINAL_April-2023.pdf
[29] https://www.airahome.com/our-offering
[30] https://www.caas-initiative.org/

Co-funded by the European Union

irrespective of sector. Cooling equipment tends to be high maintenance, so optimizing maintenance with professional support can help with additional cost savings in the long run (Abrahmanskiehn and Richards 2019). Besides the energy savings, cooling services have additional environmental benefits because the refrigerants used also affect the environmental footprint, which is especially a concern in less affluent regions (ibid.). In the Scandinavian FMCG market, a special case of CaaS is being developed for food retail stores by Danfoss and Ohmia.[31] The joint venture offers refrigeration as a service that covers the full lifecycle of commercial refrigeration.

**Business Case 9: Heating-as-a-Service (HaaS): Aira, Sweden**

Activities/Infrastructure:

- Installation of smart heat pumps
- Servicing through in-house staff

Value proposition:

- Energy and C02 savings from superior technology
- End-to-end support packages
- Guaranteed comfort through warranty on performance

Customer:

- Residential households

Finances/Pricing:

- Traditional upfront investment
- Subscription-based service package

***Comfort-as-a-Service:*** The above business models for heating and cooling offer services with a direct link to the energy consumption of the equipment. A higher level of abstraction is reached with comfort-as-a-service, where the service provided is measured against a certain comfort level (technology neutral) rather than the energy throughput. In line with the discussion of how to define energy services, the argument is that the ultimate outcome is the customer's well-being: it is the most user-centric of the XaaS business models discussed here. Typically, the value proposition is shaped with a bundled service package that promises end-to-end coverage. Customers transfer access rights for appliance control, data monitoring, and operation to the service provider and essentially outsource the entire function. The more complex the building (appliances, HVAC, etc.), the higher the requirement for IoT technology. Comfort-as-a-service requires coordination along the value chain from energy supply to remote control inside the home and therefore strong networks in the service provision. The use case of Helexia (see **Box 1** above) is an example of a pioneer company implementing this business model.

### 2.3.5 Synthesis and discussion of status quo

From the literature review, several observations are relevant for the objectives of the report. Generally, it is common for companies to combine multiple business models, both on the service-level and in the pricing structure. XaaS is in some cases used as an entry-offer that opens up a new customer segment towards participation in the core business. In other cases, companies carry several models in parallel, and the degree of servitization is tailored to distinct customer groups. For incumbents in particular, these dual offers may reflect efforts to not cannibalize a core offer with the addition of new services. The difference in dynamics between startups and incumbents that was noted in previous literature (e.g., Palmié et al.

[31] https://www.danfoss.com/en/about-danfoss/news/cf/danfoss-and-ohmia-retail-joint-venture/

2021) is also reflected in our research. The nine use cases cover the full breath of this spectrum, including subsidiaries and spin-offs from larger companies that then specialize in service-based models. We could not verify whether these are used as pilots in transition or to build separate business lines.

It is rare for companies to transition fully to a connected service model that is consumer-centric, with the exception of startups that are native to XaaS from inception. This is in line with recent analysis by KPMG (2022) that surveyed a broader group of industries. In general, pricing models vary widely from pay-as-you-go to unique, tailored contracts. The latter is more prevalent in the B2B segment. In B2C models, XaaS is used in several areas to overcome the barrier of high initial investment. The XaaS model then allows participation by consumers who would otherwise not adopt a technology, e.g., for heat pumps or solar. In these cases, there is however considerable heterogeneity in the degree of servitization, ranging from zero investment (subscription-only) to own investment supported with service subscription. A common challenge for services involving durable goods is the dependence on long-term contracts even in service-based models, or alternatively the need to manage the risk of recovering these investments. The XaaS model represents a risk transfer from the client to the provider, which can overcome the barrier to participation, but creates an additional challenge in the providers' value creation.

There appears to be a forward-looking interest in bundling several services and/or offering more integration along the value chain, both horizontally and vertically. Vertical integration appears to be more developed, for example through one-stop packages covering the path from installation to maintenance, or even second life in the case of batteries. While some businesses have started the process of vertical bundling, several others list the plan on their website as a prospective offer. The third option appears to be a modular approach, where core service can be supplemented (see e.g., GridX or Swobbee). Platform economies, e.g., through sharing or IoT platforms, are identified as enablers of such integration. On a related note, data monitoring and analytics are a major selling point in the studied XaaS use cases.

# 3. Second Part: Empirical analysis of XaaS developments

This section of the report presents the key findings from the survey and semi-structured interviews conducted throughout the project. The content of this study is illustrated in Figure 3.1. During the initial phase, thorough desk research was conducted, resulting in the coverage of a broad range of 'as-a-Service' business model use cases. While these use cases primarily concentrate on the building sector, other cross-sector examples are also considered.


*Figure 3.1: Overview of respondents in the analysis*

The first step was to create a comprehensive list of energy service companies using company databases, publications, and reports. Then, the business models of these companies were examined to identify those with XaaS business models. Additionally, a detailed survey was designed and distributed to energy service companies. The survey aims to understand their experience with implementing XaaS business models, including the challenges, barriers, and motivations they face. Furthermore, a series of semi-structured interviews was conducted to delve deeper into various issues. These interviews focused on topics such as digitalization, circularity, transparency, and sustainability in the energy sector.
As mentioned earlier, 'as-a-Service' business models are widely used in sectors like manufacturing. However, in the energy sector, XaaS models are still relatively new. Therefore, the response rate for the survey is low, despite the presence of available use cases.

## 3.1 Initial data of participants

Services have become an essential component of the energy value chain. In the market, there are several established players working to disrupt the traditional value chain by offering energy services alongside or instead of kilowatt-hour sales. Startups are leading the way as early adopters of innovative service business models, as reflected in the collected data. In the sample here, 54.55% of the sampled data represented startups, followed by mid-size companies and large enterprises, see Figure 3.2 (a). In line with the literature review in part 1, the companies also reflected a mix of new entrants and incumbents. Startups entering the market with a digital, service-oriented offer from the ground expressed different concerns than incumbent firms growing a XaaS model from / alongside existing business models. In some cases, the XaaS was a change in the revenue streams for an existing product, in other cases, the XaaS is better described as the re-modelling of the business to a new value proposition.

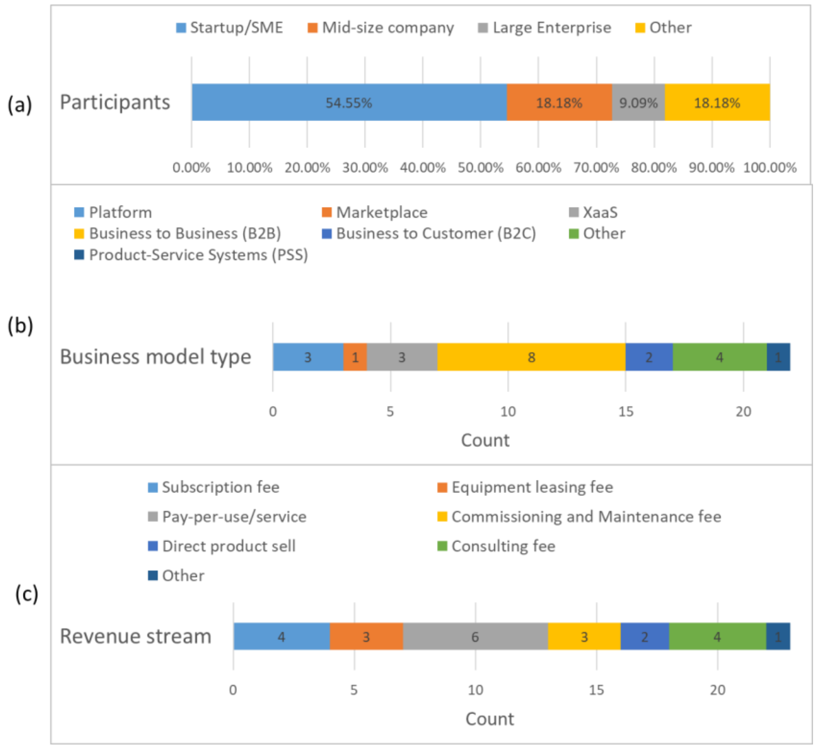



*Figure 3.2: Initial data of participants in the survey*

The participants were asked to specify the type of business model used in their organization. A total of eight categories were defined: Platform, Marketplace, XaaS, B2B, B2C, PSS, Manufacturing, and Other. Some companies belong to more than one category.

In fact, in the semi-structured interviews, only a single company indicated that a single category described their business model well, with overlaps between the customer segments (e.g. B2B) and the tools (e.g. platforms) used to reach them. There are 22 entries in total, with 8 companies falling under the B2B model, followed by Other, Platform, and XaaS. There are no entries in the Manufacturing category. To further understand the business models, the subsequent questions focused on the revenue streams of the participating companies. The question was presented as follows: *What is the main revenue stream model for your organization?* However, multi-selection was possible despite the emphasis on "main".

The results in Figure 3.2 (c) indicate that Pay-per-use/service, subscription fee, and consulting fee are the primary revenue models among the participating companies. Regarding both the business models and the associated revenue streams, many companies have multiple business models in parallel. In the semi-structured interviews, this was typically explained as targeting different customer segments with specific offers, with XaaS among them but seldom used exclusively. For example, there are divisions between a B2B and a B2C segment, or a split between pay-per-use and subscription fees.

In addition, participants were also asked to provide information about energy service offerings for end-consumers. The distribution of service offerings is illustrated in Figure 3.3. Apart from the *Other* category, the top entries include battery/storage, renewable or self-consumption, and energy management services. The data also mentions flexibility services, EV charging, and energy management services. This indicates that companies operate in multiple energy service categories.

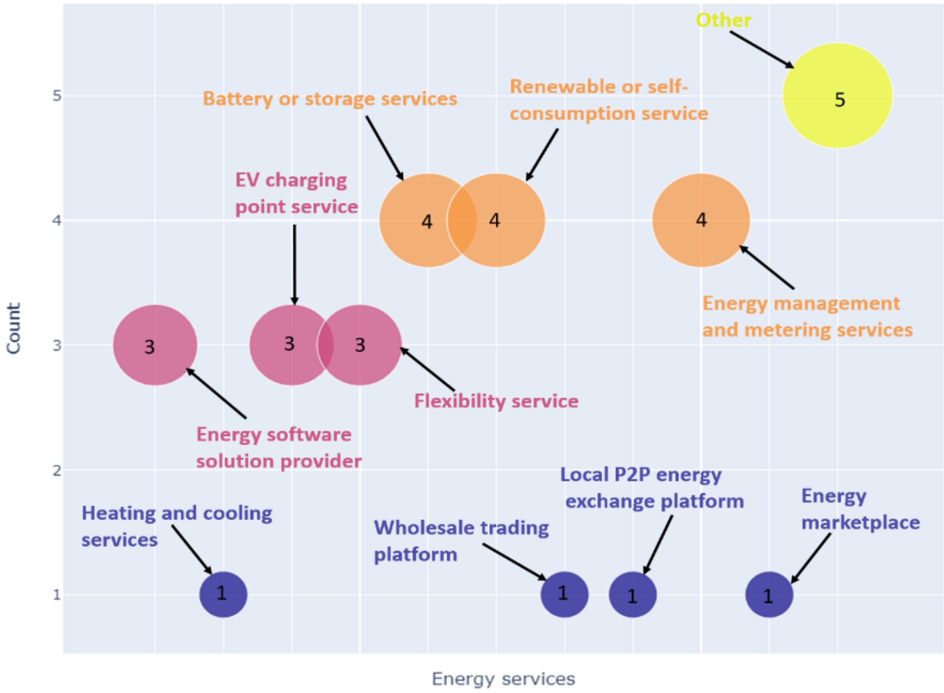



*Figure 3.3: Frequency of different services offered*

The interviewees additionally explained that some of their offerings are related to the above items, but do not fit one particular category. This likely explains the high frequency of the "other" category in the top-right of the graph. From the interviews, the finding is that several companies have a platform as the backbone of their value proposition, but then offer a host of different services originating from this platform. This occurs both in B2B and B2C markets. In another example, the "EV charging point" does not describe the service, but rather EV charging is a key component of the energy management software. Accordingly, there is a link between the lower-right part of the figure that captures a group of entries related to platform-based business models, and the more frequently mentioned categories of energy software and management. An interesting observation came from one interviewee who noted that it would be possible to check more boxes, but that the business specifically did *not* want to be an energy company, so it did not seem appropriate to check models that were (subjectively) associated with traditional energy companies. Frictions with the energy market in general were noted by several participants and are discussed in the sections on challenges and barriers in more detail.

Most survey respondents however indicated multiple entries for the revenue models. There were multiple constellations, for example peer-2-peer trading in combination with battery services, or EV and solar offers. When probing the multi-entries in the semi-structured interviews, three different approaches emerged: (a) operating a single business model that does not fit these categories, (b) companies running parallel business lines on purpose for diversification, and (c) companies orchestrating multiple offers around their core business. Several respondents described an ongoing evolution in the business model beyond this static snapshot (see the following sections).

## 3.2 Adopting XaaS business models: Benefits and motivation

Figure 3.4 reports the top benefits, while Figure 3.5 shows the results for the top motivations.

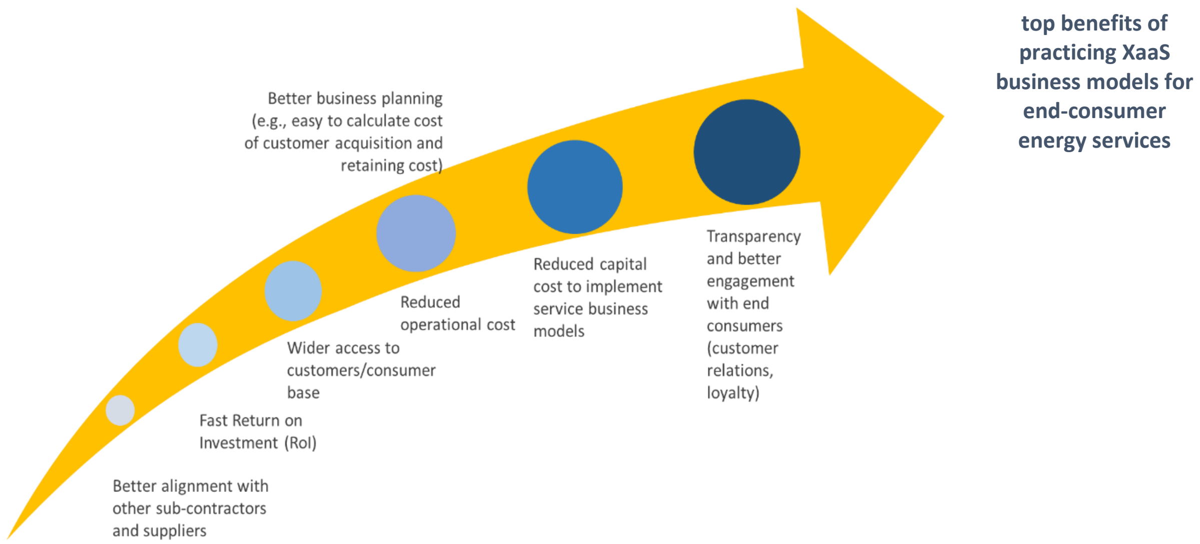



*Figure 3.4:Top benefits of practising XaaS according to survey respondents*

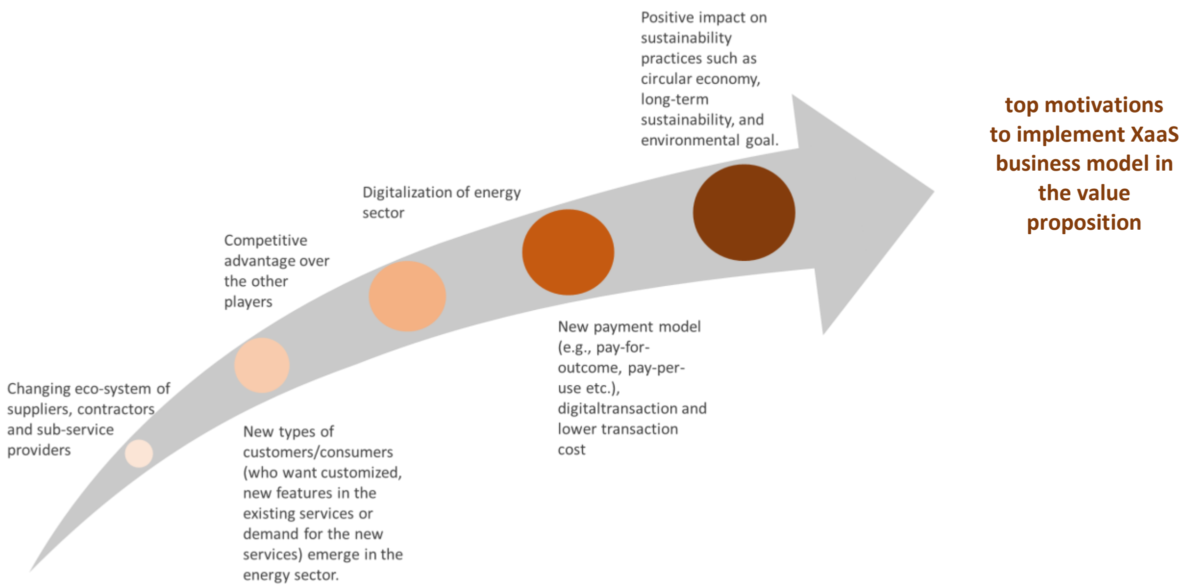



*Figure 3.5: Top motivations to implement XaaS according to survey respondents*

**Regarding benefits of practicing XaaS**, transparency is the top chosen benefit in the survey. This is followed by reduced capital cost as the second most important, with reduced operational costs and better business planning shared as the third choices. Lower orders were assigned to wider access to customer base, faster return on investment, and better alignment in the supply chain. In the interviews, however, it became apparent that the simple ranking leaves out important insights on how companies view, interpret and weigh the listed options. These findings are summarized below.

**Transparency** was emphasized in more than one way for XaaS in the interviews. From the *customer relations perspective*, it was noted that in long-term relationships, transparency pays off only in the long-run. The given example was from Energy-as-a-service, where multi-year contracts give "room to show all the data", and allow customers to also convince their stakeholders/customers. From the *end user perspective*, the XaaS business model provides transparency in the sense of reducing uncertainty. When end-consumers do not have to pay upfront, but only for the service, their payments are directly tied to their benefits. For example, this was highlighted as a distinction of XaaS from solar-power investments that promise value based on ex-ante estimations of the plant's production that materializes with delay. It was remarked that this benefit hinges critically on also providing end-consumers with digital tools that give them this transparency. From the s*upply chain perspective*, one interviewee noted that in working with multi-national corporations, there was "no transparency at all", and this leads companies to miss market opportunities because it is not clear what is out there. This perspective should not be directly taken as a specific issue for the XaaS, but it goes to show just how central transparency is in developing market maturity.

**Return on Investment (ROI)** is listed as low priority in the ranking, but there was intense discussion about the implication of XaaS for the ROI in the interview. The core message was that ROI need not be faster, but that XaaS changes how ROI is achieved. One participant argued that the ROI was not faster, but in fact "better quality". Another interviewee noted that ROI had "different advantages" but was not really faster. The consensus was that building the business still takes years (ballpark estimates were between 3 and 7 years depending on the business). However, the XaaS was viewed as a way to build a long-run, sustainable business. One interviewee summarized the ROI with XaaS as a "new way of having return on investment" because it allows business models that were not possible before or not scalable before. In some instances, the interviewees did not select the faster ROI as an option when their view did not align with the proposed phrase. This indicates that the importance of ROI is understated in the survey results. More profoundly, the finding is that XaaS can challenge the process underlying standard metrics beyond the measurable effect on a single index number.

**Reduced costs** (both for capital and operational costs) were dependent on the business model and the customer segment, but the surprising finding from the interviews was the perception that the reduced costs accrue to the customer, not necessarily to the business. Several interviewees independently of each other noted that the reduced cost was in fact a benefit to the *end-consumer*. For capital costs in particular, this was noted as a potential risk of XaaS from the company perspective. One proposed solution in the business model contained different shares of upfront vs. subscription fees depending on private household's willingness or ability to carry part of the investment in an energy community. In the case of batteries, similar split tariffs with fixed components and pay-per-use were also noted as a compromise between feasibility for the company, and flexibility for the customer. The split was indicated as 60/40. Another interviewee organizing energy cooperatives noted that reduced *operational* cost was a benefit to the end-consumer, with the company putting "a lot on the table" to be able to engage those consumers. Similar approaches were also mentioned by B2B companies, but more with a focus on building up the business as a process. For example, it was noted that a long-term contract would be preferred, but the respondent being a start-up first had to use a smaller commitment through XaaS to establish a relationship with large companies as clients. Another key point was that XaaS can come with relatively high costs for the acquisition of clients in the first place.

Further explanations linked the costs explicitly to risk. The cost reduction to the consumer occurs because the timing of investment and revenue is shifted with XaaS. Several respondents noted that XaaS involves a risk transfer: the investment (if it involves hardware, but also software) is still needed. This burden now falls partially on the company with XaaS but the capital investment is not eliminated in many cases. The benefit for the company is then to unlock a customer segment that would otherwise not invest/participate at all, but can be convinced with XaaS.

Against this background, it should be pointed out that **wider access to customer base** was not listed with high priority, although the findings above still establish a link between this access and the top choices of transparency (through engagement with clear value) and capital costs (through shifting risks away from customers). A notable exception was raised by a non-profit organization with an energy community model, where it was noted that the XaaS can be an add-on to the core business from a customer-centric perspective by adding value for the members.

**Scalability** was added as a separate factor in the interviews that was not on the original survey items. One respondent remarked that XaaS comes with high upfront costs, but then there is "no theoretical limit to how you can scale up", in comparison with alternatives that involve a hardware product. This sentiment was echoed by another participant who had shifted to a platform-based model that allowed for data analysis in a virtual way, as opposed to physical visits for data collection.

**Regarding motivations to implement XaaS,** the top benefit is the positive impact on sustainability practices. This is followed by new payment models as the second choice, and digitalization as the third. Lower rankings are assigned to competitive advantage, new types of customers, and the changing eco-system of suppliers. In the survey, the motivations were presented as side-by-side alternatives. However, the interviewees noted that this structure does not always align with how they view them. For example, digitalization and competitive advantage were described as dimensions of the enabling environment that do not fit an ordering of motivation. These factors were noted as important, but did not *per se* motivate the business for XaaS for some companies.

**Digitalization** stands out for this finding in particular because we recorded different viewpoints. While some participants saw digitalization as a trend in the external environment, others saw it as a factor internal to the company. As an external driver, digitalization was selected as a top motivation, for example *because* it allows for the implementation of new payment models and service offers. One participant summarized this view as "we need digitalization to be able to practice [the model], but it's in an indirect way". As an internal driver, digitalization was explained to be a motivation that companies actually strive for. In this view, respondents saw digitalization as something that their company's activities are aiming for themselves, rather than solely a development they exploit.

**Sustainability and circularity** were explicitly related to **digitalization.** In this line of argument, XaaS models were seen as inherently digital, and the data collected through the model allow for a better control of sustainability impact, e.g. for life cycle assessments. With this business model, one respondent concluded that "you can easily control and make sure the impacts are there". There were two distinct approaches to sustainability by companies in the sample: (a) transforming an existing supply chain towards circularity/sustainability, and (b) offering models that engage a new customer groups by offering them services that allow for participation. An example of the former is the build-up of a circular economy for batteries, which requires building relationships with OEMs. An example of the latter is the engagement of private households in energy communities and/or peer-2-peer markets, where XaaS can help bring in more members to collective schemes.

Sustainability was then more deeply discussed as a forward-looking motivation. Subsequently, several interviews referred to plans and projections they have for the future impact and development of their business. **Flexibility markets** were mentioned repeatedly as a potential expansion, both for companies coming from the energy and the mobility sector. Despite this high interest, there was uncertainty over the timeline, and also uncertainty regarding how to monetize flexibility services from the perspective of the company in a business model. Overall, there was a high motivation to develop the business and make larger contributions to sustainability going forward. In this context, sustainability was also mentioned in relation to sharing and openness of the business model. One interviewee in particular noted that "the more you share something, the more sustainable it becomes". For end-to-end solutions in the building sector, another respondent noted that covering the entire chain of the building ultimately helped them contribute to circular economy.

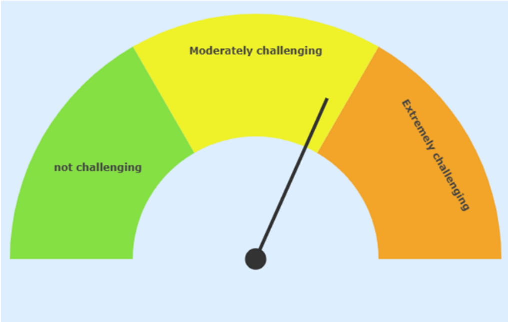
## 3.3 Technical barriers in implementing XaaS

Figure 3.6 shows the average ratings regarding four different challenges or barriers to the XaaS business model. In the survey, the highest challenge rating was given to data access, followed by technical and informational interoperability. These two items were both rated as highly challenging in the aggregate. By contrast, the lack of connected assets at end-users and the requirement for complex IT infrastructure were rated as less challenging.

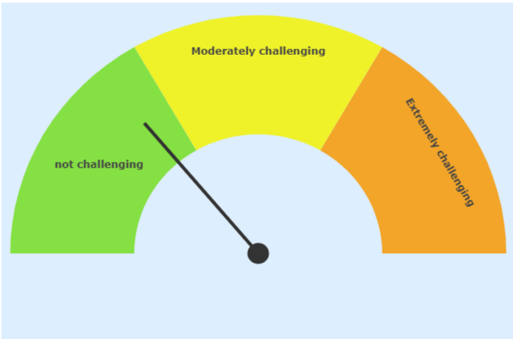
Two new dimensions of aspects in the challenges emerged out of the semi-structured interviews.

First, the view on challenges is dependent on what **in-house capabilities** companies have, and where they are dependent on exogenous developments. For example, one interviewee noted that the lack of connectivity at end-users was less problematic for them because the company itself has the capability to fix this. This was echoed by other respondents with B2B models. Notably, companies with multiple business lines or revenue streams remarked that the challenge differs across business lines even *within* the company.

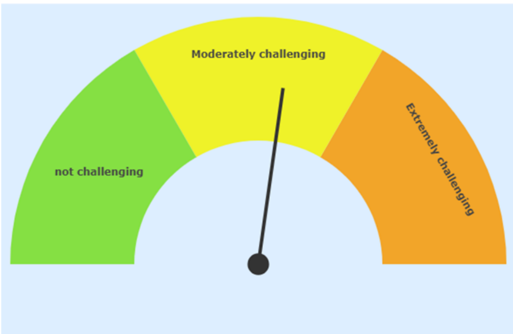
Along a similar vein, the interviews revealed that client's **legacy systems** present a major barrier. This includes the interoperability of software/hardware on a technical level (see the separate discussion below), but also the organizational structure and conservative attitudes.



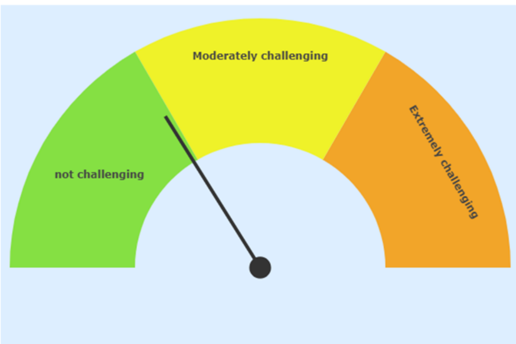

(a) Availability and access of data to design a new XaaS service offering




(b) Requirement of complex IT digital infrastructure




(c) Technical and informational interoperability of services




(d) Lack of connected or connectable assets at end-users

*Figure 3.6: Challenges and barriers*

Resistance to change was highlighted by companies dealing with both the automotive industry and the manufacturing sector. For manufacturing clients for example, it was stated that "clients are reluctant to change their business model". These concerns were also named as a reason for hesitation to fully transition to XaaS as the sole approach. Overall, the semi-structured interviews revealed a more nuanced view that emphasized the perspective: what can be fixed or controlled by the company itself, and what is a challenge that is out of the company's hands. One respondent summarized the critical point as whether the challenge "is something *we* can manage". In addition, to this cross-cutting learning, there was specific input regarding the four challenges.

**Regarding data access**, the challenge can be high at the end-consumer side, because this data either does not exist or is complicated by bureaucratic structures with the electricity system operators. Respondents distinguished between the *technical availability of data* and the *ability to make effective use of data,* with the latter being a bigger issue. For example, data may already be collected through existing devices, but this information is not available to the company. One respondent explained that the traditional energy providers hold electricity data for private households within their realm. For the B2C companies, there is a strong overlap with the challenge of connected devices (see below). For companies holding a middle position with a wider portfolio, it may not be very challenging because this access is part of their own value proposition. This was stated for example in the case of established companies that operate similar to ESCOs, with a strong focus on ICT and IoT. Yet for companies further upstream with larger enterprise clients, the challenge increases again because there is a low willingness to share data or accommodate new systems gaining data access.

**Regarding lack of connected assets,** this remains a high challenge for engaging private households (see data access above), especially regarding smart metering. However, it turned out to be less concerning for B2B operations. One notable distinction in this context is whether the company in question is a third-party provider, or has control over the entire process. The challenge is higher for third-party providers, i.e. those with digital service offers that must operate through the system operators and have dependencies in this regard. For example, one interviewee noted that they offer energy services based on smart meters that they had installed themselves, but still had to go through the system operator (with lower digitalization capabilities) for billing due to market restrictions.

**Regarding interoperability,** the medium ranking on average is only partially reflective of what was recorded in the interviews. Interoperability was elaborated on with intensity, such that several companies explained the *lack of interoperability as a deal breaker* for expanding the business model across sector boundaries.

Several items regarding interoperability were mentioned in this context:

- Data sharing:
  - No common protocol with systems operator
  - Lack of an EU directive to standardize across EU countries
  - Delayed information from energy suppliers for invoicing
  - Dependence on legacy systems in the energy system
- Smart meters:
  - Specifications vary across devices and countries
- IT infrastructure (generally):
  - Previously installed software at clients is incompatible
  - Existing hardware does not support smart services
- Sector coupling:
  - Progress in one sector (e.g. EV chargers) not aligned with others
  - Differences in protocol implementation even with open protocol (example given was Modbus/TCP) across manufacturers
  - High additional requirements for flexibility markets

Some of the above aspects clearly link to legacy systems with established market actors. By contrast, the startups in the sample tended to embrace standardization, this was mentioned as a need for further development multiple times. As one participant put it: "standardization is the way, not exclusivity".

Despite the listed concerns with interoperability, several participants also noted that they were slowly seeing progress on that front. For example, it was noted that there is indeed progress on interoperability with protocols for e-Mobility, but then these protocols do not work for flexibility markets, which have their own structures. This is not a barrier for XaaS when using 1 service, but it becomes a major barrier for business models trying to bundle multiple services, as exemplified by the case described above.

**Regarding the need for complex infrastructure,** the discussion points overlap largely with the other challenges. However, one important point was raised for the distinction in the challenge level between the infrastructure and the interoperability challenge. While the development of infrastructure is in the hands of the company, the interoperability challenge depends heavily on other people. This perspective came through in different forms, hence it motivated the extraction of control as a cross-cutting topic in the beginning of this section.


**54.5%** Fully Convinced and looking forward to setting up XaaS service offerings.

**27.3%** Partially convinced, considering to implement XaaS offerings but not fully convinced yet

**9.1%** Not aware of ongoing discussion at the top management level

**9.1%** Not answered

*Figure 3.7: Conviction about XaaS as a business model*

The majority of respondents is fully convinced about XaaS, with another quarter of participants at least partially convinced (Figure 3.7). This general distribution in the survey fits with the discussions from the interviews. Here, we found that interviewees generally see XaaS as an important opportunity, but hesitate to fully go that route. This comes from two lines of argument. First, some of those who are fully convinced explained in the context of other questions that XaaS was one part of their revenue portfolio, either because of a transition phase or because it was intentional to employ different models. Second, there was a hesitation to agree to fully convinced in cases where the demand-side of the market was still in the early adopter phase and scaling solely through XaaS did not seem feasible. In summary, the partially convinced and fully convinced group may share more commonalities than is apparent from the distribution. In fact, the question of conviction is closely related to the following question about current performance and motivations (see below).

## 3.4 Performance of the XaaS business model

In a separate question, respondents were asked to assess the performance of the XaaS business model in their current revenue portfolio. The responses reveal that most companies fall in the two middle categories: flat growth or moderate expansion. In the interviews, it emerged that companies are often not exclusively focusing on XaaS as the predominant business model in the status quo, but work with multiple revenue streams.

The factors that restrict the growth of XaaS in the company can be divided into:

- External constraints, e.g. regulatory framework, pace of digitalization
- Market development, e.g. general maturity, demand-side adoption
- Company making strategic choice to retain multiple revenue models

The distinction between external constraints and market development is intended to reflect that there are underlying factors affecting multiple markets, and market-specific developments pertaining to actors on the supply and demand side.

This also links back to the results from the early questions about the business models, which revealed that many companies run several business lines or models in parallel. The interviewees explained that different revenue streams are tailored to fit the business model for this particular customer segment. This comes with tradeoffs between the companies' ideal scenario and the customer demand. Where trust is low initially, pay-per-use can lower barriers for customers to adopt the services. Where upfront investments are high, pay-per-use and even subscriptions may be difficult to sustain for the business. Of course, these are generic principles in business model design, but the respondents emphasized these considerations in particular for explaining why or how they operate multiple models side-by-side. Some were saying that they were in transition, with one interviewee noting they expected XaaS to be the main model by 2025. Others, however, explicitly stated that they did not see full commitment to XaaS feasible for their business.

Overall, the growth prospects are mixed. Participants identify chances to develop the business with XaaS models, but also note that the growth path is not entirely in their hands. With regard to building such market maturity, it was also noted that it can be very different to build up a XaaS model in a market that is newly emerging (e.g. e-mobility), as opposed to a long-standing market (e.g., heating). When the market is new, it is harder to build, but easier to forge. One interviewee specifically argued that breaking habits can be harder than when customers are used to a service-type delivery from the beginning. On the flip side, several respondents referred back to the discussion around the ROI, noting that the transition and the ramping up towards a service-based business model takes time.

## 3.5 Related risk in implementing XaaS business models in the energy sector

Respondents were asked to rank the six risk categories in Table 3. The list of risks was supported with the explanations on purpose, to avoid misunderstandings or different interpretations of these terms.

*Table 3: Six types of risk categories in the XaaS survey*

| Nr | Risk Category and Description |
|---|---|
| 1 | **Regulatory risks:** Energy markets are highly regulated and subject to various local, state, national and EU regulations. The regulatory framework for XaaS business models is still evolving, and there is a risk that regulations could change in a way that negatively impacts the viability of the business model. |
| 2 | **Technology risks:** XaaS business models heavily count on technology to deliver services to end-consumers. There is a risk that the technology could fail, leading to service disruptions or other problems. Additionally, there is a risk that the technology could become obsolete, requiring significant investment to update or replace. |
| 3 | **Financial risks:** XaaS business models typically require significant upfront investment in technology and digital infrastructure. There is a risk that the investment may not generate sufficient returns, leading to financial losses for the company. |
| 4 | **Market risks:** The energy service market is highly competitive, and there is a risk that other companies could develop similar XaaS services, leading to price competition and lower profitability. |

| | |
|---|---|
| 5 | **Customer adoption risks:** Customers may be hesitant to adopt XaaS business models for energy services, particularly if they are accustomed to traditional service models and contracting. There is a risk that customer adoption may be slow or may not meet expectations. |
| 6 | **Ecosystem failure risks**: XaaS business models require an ecosystem (e.g., energy suppliers, sub-service providers, digital connectivity, etc.) to function, so there is a greater risk of service failures. |

Figure 3.8 shows the outcomes from the survey. The scale is the inverted measure from the ranking. The highest ranking is 1 point, down to 6 points for the lowest. The points are summed for each risk across all participants, then the inverse is taken. Hence, higher values on the scale correspond to higher risk ratings. The highest ranked risk category by far is regulatory risk. This is followed by market risk as the second point, and financial risk as the third category. Technology, ecosystem failure and customer adoption are rated lower.

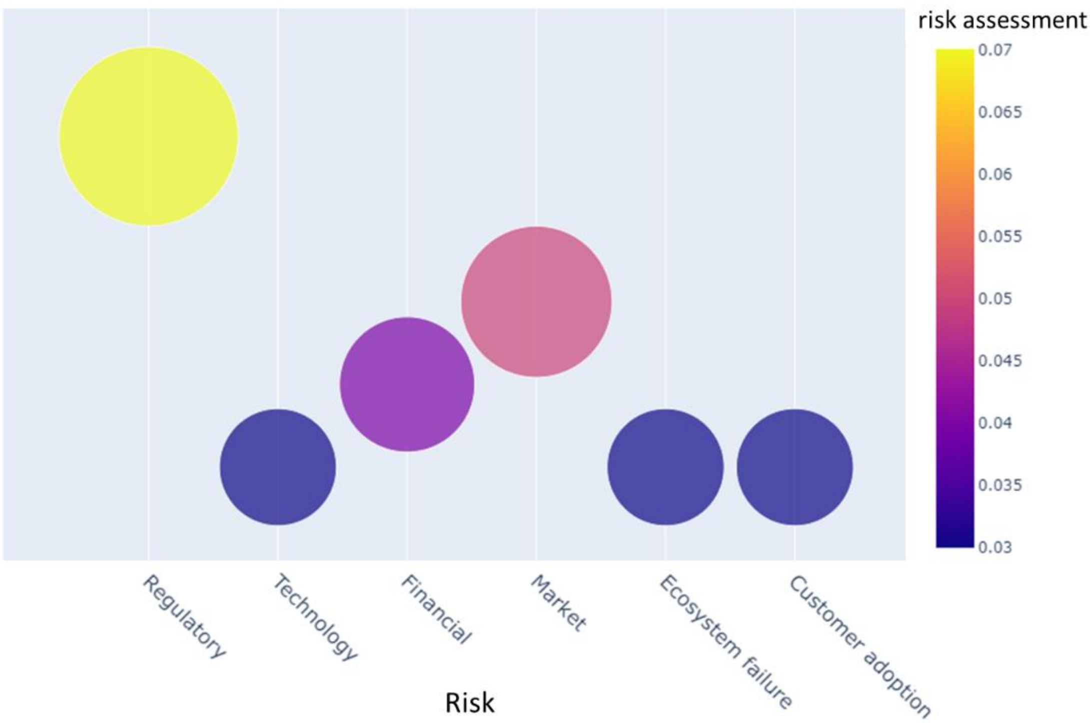



*Figure 3.8: Relative risk assessment in the XaaS context*

In the semi-structured interviews, two lines of argument emerged regarding the risk rankings. First, businesses emphasize different aspects within a risk group. Second, they draw connections across risk types, as they do not see them as strictly independent of each other.

**Regulatory risk** was considered high across all service types in the interviews. On the hand, there was a sense of frustration that current policy is a major constraint for developing the business model, but with hopes for upcoming changes in an evolving environment. Given the high emphasis on sustainability (see benefits) among countries in the sample, it is perhaps not surprising that companies talked more about how they felt held back by current conditions rather than being concerned about negative changes going forward. There was a sense of optimism, that existing constraints were being addressed – albeit slowly – in the regulatory frameworks. Several participants noted that progress on the European level gave them reason to expect improving regulatory conditions over the coming years. Nevertheless, country heterogeneity remains high. One interviewee in particular explained that the combination of different regulations and market conditions across countries forced them to adapt their value proposition and value delivery in each country (e.g., Spain and Italy were named as very different). On the other hand, there was also a negative aspect that comes with the expectation of changing regulatory conditions. Uncertainty over the development and its timeline are an obstacle to business planning. These concerns were especially voiced in the interviews by participants whose value proposition deals with use cases that are not fully established for the residential sector, such as energy communities, peer-2-peer trading, and flexibility markets. Here, one participant noted that the constant change was a major barrier because "without [the] regulatory framework, it's really tricky to put a financial model on the table".

**Technology risk** was not broadly viewed as a major concern. On the contrary, firms were generally optimistic about their offers, in many cases discussing plans for expansion, new developments, and additional services. The bigger issue was concerns about the ability to exploit technological progress, in relation to challenges with legal frameworks and interoperability concerns.

**Financial risks** were viewed as important especially by smaller companies facing high investment costs. In this sense, the discussion overlaps with the observations around costs in the benefit section. When the company carries the burden of investment, this risk tended to be considered as relatively *high.* This links to the discussion around risk shifting and capital costs in the motivations. Larger companies operating in more established market segments were relatively less concerned about the financial risks. Given the small sample, it is difficult to generalize the listed concerns across sectors.

**Customer adoption risks** were somewhat split between B2B and B2C specialists. In B2C, a factor that came up is that customers are not convinced of the value, so XaaS can help overcome the challenge (see benefits and motivation), but it can also be a challenge in itself to win trust when going out with a new revenue model. One interviewee phrased this as "customers don't see the magic behind [the final offer]". In B2B cases, the discussions circled more around "legacy systems" and rigid organizational structures on the client side as a related concern, and customer adoption was not ranked as highly. One cross-cutting factor raised by an international company is that the adoption risks may in fact differ across markets: ownership was argued to be more important in some cultures than others.

**Market risks** were ranked highly in the survey. In the interviews, however, competitive pressure was more emphasized as a motivation of XaaS to distinguish the company from the competition. One interviewee noted that he expected XaaS would become "the new normal", and companies actually walking the talk now would gain an advantage going forward. Others noted that competitive pressure is high and the markets they operate in are very dynamic, which necessitates ongoing adjustments. Additionally, interviewees often pointed to specific frictions of their business with other participants in the value chain. The interviewed businesses generally reported to have some dependency on upstream and downstream actors in their business model, including but not limited to their clients. This goes beyond interoperability as a technical challenge, as mentioned above, but also concerns process integration and effective workflows that contribute to market risk.

**Ecosystem failure risk** was not ranked high in general, but it is worth pointing out that several points raised for the more specific points above relate to the position of a company within that ecosystem. One participant said whether ecosystem risk is relevant depends on how large or small one considers the ecosystem to be. One aspect might fail, but others would stand because that market side can be covered by other actors (governments, DSOs were mentioned). Taking this view, there were indeed several mentions of challenges to operate within a larger system due to the complexity of the value chain and the ongoing development in the building and energy markets. Yet these companies did not choose the ecosystem failure risk as a high priority.

## 3.6 Regulatory support to implement the XaaS business model in the energy sector

The final question was concerned with regulatory support, specifically asking participants to select the level of support they felt was provided for XaaS in their environment. The distribution is shown in Figure 3.9. Overall, more than 70% of the answers fell to moderate support and very little/no support, with a roughly even split between those two categories. The option “highly supportive” is not shown because it was not chosen.

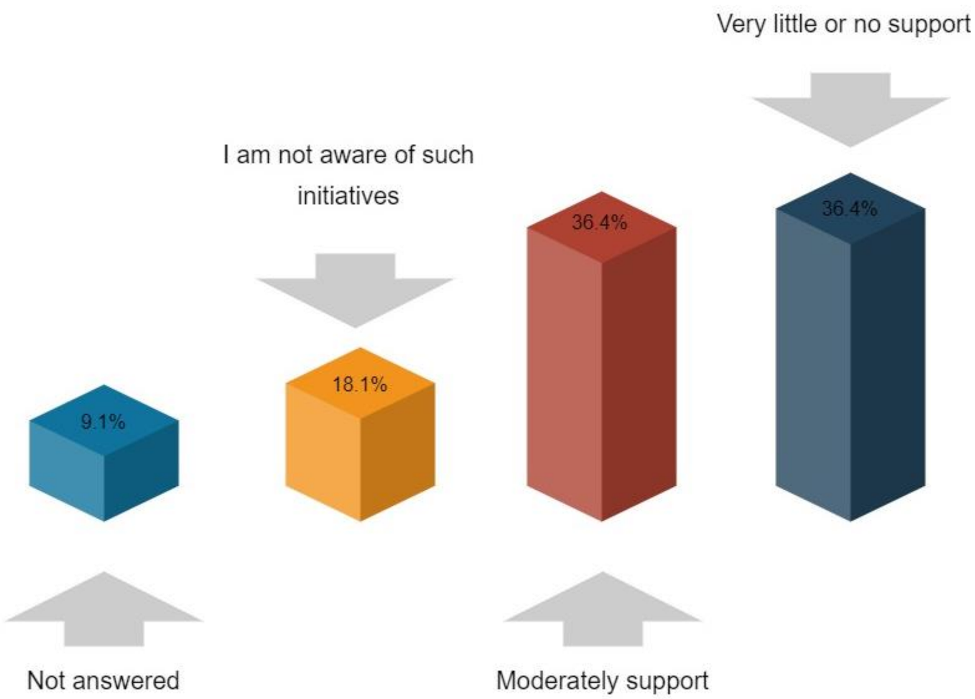



*Figure 3.9: Perceived government support for XaaS*

In the interviews, there was high heterogeneity regarding the specific regulations or support schemes that were named as most critical. The interviewees tended to take a broader view that considered "regulation" to also encompass national funding structures, bureaucracy / red tape, and processes in the energy supply chain (e.g. system operators).

The list of factors specifically raised in the interviews contains these points:

- XaaS models not fitting to national funding and support schemes.
- Established processes by energy suppliers not suited to work with real-time data and digital business models (especially Italy).
- Related: requirement to operate through the energy suppliers as a third party.
- Gaps between emerging EU legislation (favorable) and the national implementation
- Slow permitting and approval with national authorities.
- Constant change in the regulatory environment (especially energy communities)
- Data privacy laws as a constraint (especially in Germany).
- Country-heterogeneity forcing different processes for each country of operation.

The following provides a deeper explanations on key points that were highlighted for XaaS:

One key finding from the interviews is that **government support is rigid** for novel business models in some cases. For example, funding calls can be spelled out in a way that as-a-service business models do not fit the mold and thus are unable to receive the same support as licensing or other traditional business models. Another example given was that battery services do not receive the same support level as the energy companies against which they implicitly compete. This causes frustration especially when the broader sectors of energy and buildings are generally well supported by energy efficiency programs, but the service models do not fit in these schemes. Nevertheless, there was a noted distinction between national schemes and the EU level, the latter being more accommodating to service-based business models (especially for the case of Portugal).

The second point comes from companies operating in **multiple countries**. While interoperability between assets from different sectors was already discussed under challenges above, it was also voiced that conditions differ in each country, and models that are feasible in one country are not feasible due to lack of support in another country. The energy markets have different regulations for each market role, and business models that can assume "all the roles" in one country may not be feasible in others. Another interviewee noted that there are two distinct layers: first, the progress on digitalization (smart meter roll out specifically), and second, the conditions for "designing some services on the top".

The third point is that the **pace of regulatory development** is highly important, as frameworks for service-based and digital business models are not fully in place. In this context, regulation can be both a constraint and a benefit, the latter occurring when regulation raises standards to the benefit of high-quality firms. This example was brought up in the context of safety regulations in battery services specifically as "making a fair playing field". However, there were more critical responses saying that government support lags behind the developments in the market. One respondent made this very clear by referring to three different speeds in descending order: (a) the speed of business model development, (b) the speed of response from the legislation, and (c) the speed of implementing those regulations.

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## 3.7 Implications for XaaS in connected energy services

### 3.7.1 Discussion

To interpret the findings and draw connections across the specific questions above, the following eight points for discussion were identified.

1. Overlapping business models and revenue streams

The survey shows that businesses practicing XaaS tend to not rely on a single business model, but rather offer diversified portfolios. In the questions on: (a) business model, (b) revenue model, and (c) services offered, multi-entries were highly common. This finding from the empirical study is also in line with the use cases that were explored in part 1 of this report. The surrounding discussions from the interviews also support the argument that business models are increasingly changing from a static concept to an evolving process. XaaS allows companies to build new services and improve offers in an agile and scalable way. The implication from this finding is that the business model should be carefully tailored to the customer segments and consider whether a portfolio can improve the positioning relative to a single focus.

2. Benefitting from transparency and alignment

The highest importance in terms of benefits for practicing XaaS was assigned to transparency and better engagement with end consumers. This finding underscores the importance of customer-centricity. The interview results supported that this benefit comes in at least three forms: customer relations, end user satisfaction, and supply chain integration. XaaS can help build up customer relations with new customer groups among final consumers. At the same time, it can help convince larger players in the value chain and thus accelerate disruptive change towards sustainability. An important downside however is the timeline: in use cases building XaaS on initial investments, benefits may not become fully salient to the consumers immediately and the value delivery in the business model has to take this into account.

3. Balancing risks, costs, and customer adoption

One caveat that came out of the interviews regarding benefits and motivation was that cost advantages, especially for capital costs, are a benefit to the customer, but come with risks to the company. This finding shows a gap between the literatures, which names cost reductions as a company benefit, and the practitioners view that the cost advantages accrue on the consumer side.  There can be a major risk transfer with XaaS, business models, as the company may have to absorb the initial investment, and the payback period hinges on customer adoption over a longer time period with pay-per-use and subscription models. These risks have to weighed against scalability as a noted benefit. This tradeoff may be very difficult to estimate for service areas that are relatively novel, where companies can gain only limited insights on market development before entering.

4. Building a “better” Return on Investment

Related to the previous point, the return on investment from XaaS was not found to be faster. This benefit was given a low ranking in the survey, and sparked discussion in the interviews. The lesson here is that XaaS cannot be viewed as a fast track solution. Instead, it presents a more fundamental shift in the way value is created. Ultimately, there is a benefit to the ROI as XaaS was noted to bring deeper, better and more sustainable returns. However, there is a multi-year process behind the realization of this ROI. This implies that traditional financial metrics may understate the economic benefits of XaaS, and different measures would be needed to compare product-based and service-based companies for an unbiased assessment.

5. Taking a wider perspective on interoperability

This point combines findings from the sections on challenges and motivations in the survey. The two top challenges were (a) technical and informational interoperability of services and (b) availability and access of data to design a new XaaS service offering. These two aspects were found to be connected by the broader question of how to operate effectively within the value chain. There were major concerns about technical interoperability and pains with missing protocols, but importantly also regarding the wider processes and systems. Most of the respondents noted dependencies on the developments of other actors for their XaaS business models. The findings on legacy systems and resistance to change on the client side suggest that removing technical barriers will not be enough. This is especially important when the transformation of the energy system is an ongoing process, as described in the literature review. Working with established players in the energy system will thus remain important for several of the identified service offers.

6. Moving from digitalization to data economy

Digitalization is an obvious cross-cutting topic that came up in the study as well, although it was not consistently chosen as a top motivation. However, the findings from the interviews indicate that digitalization can have both roles: a motivation to pursue XaaS and an embedded factor in the enabling environment. Similar discrepancies in interpretation were observed for competitive advantage: XaaS can bring motivation to gain such advantages, but also be considered an outcome of the transition that does not provide direct motivation. This suggests a high interplay between business model development and market development. When digitalization is viewed as an enabling element, the existence of the necessary soft- and hardware is only a pre-condition to the flow of data. This is especially important because the data-driven characteristic of XaaS was identified as a key driver of sustainability as the top motivation in the interviews.

7. Overcoming regulatory risks and limited support

Regulatory risk was identified as the number one concern among risk categories, and this is strongly related to a sense of low or only moderate government support for XaaS. This is critical for the future development of XaaS models because the many individual items named as regulatory barriers come from different policy domains. Hence, addressing this risk effectively would require cooperation among policy makers across (a) sectoral boundaries, (b) government departments, and (c) multiple geographical levels. This becomes even more complicated when considering that companies tend to view regulation from an ecosystem perspective that also subsumes funding schemes and bureaucratic structures. Such a collective effort is unlikely to happen in the short-run, and therefore the regulatory environment will remain a major obstacle to mainstreaming XaaS. Importantly for BungEES, this especially applies to the development of business models that combine multiple services and aim to be applicable transnationally.

8. Adding new services to expand the value proposition

Despite the concerns about the regulatory environment, the semi-structured interviews emphasize a very dynamic environment for XaaS. Companies had multiple plans to either transition towards servitization or cross-sectoral integration. Flexibility services were mentioned frequently across the different questions and sections. Yet there was uncertainty over revenue models and technical requirements for implementing such services. The lesson here is that services that build a new layer on existing business models are seen as having high potential, with flexibility being the prime example. At the same time, this finding implies that there will be increasingly higher competition across sectors, as companies with backgrounds in energy efficiency, e-mobility, and smart buildings all look at these cross-cutting opportunities.

### 3.7.2 Recommendations

Based on the findings and discussion, the following section proposes approaches, solutions, and action items for the XaaS business model in particular and the servitization trend in energy and buildings more broadly.

The first recommendation is to approach business model design with a strong **consumer focus**. The diversity in business models and revenue streams indicates that there may be a high need for tailoring offers to the demands of particular customer segments. In addition, resources should be devoted to monitoring demand-side trends and adoption patterns, so adjustments to the existing model can be made. Nevertheless, the consumer focus also includes a note of caution. End-consumers may not fully grasp the effort and complexity that goes into building the XaaS model. In cases where fixed costs cannot be eliminated, the risk shifts to the company. There is a tradeoff between catering to consumer demands and **risk absorption**. Three items were identified in the study from the case studies (part 1) and the empirical research (part 2): (i) split tariffs that include a fixed component, (ii) digital tools that provide instant transparency over value created, and (iii) support services that reduce uncertainty about a new technology on the consumer side. In brief, XaaS offers the option to improve transparency, this should be exploited to improve consumer experiences.

In addition, many new servitization solutions often lead to a subpar customer experience due to the lack of optimal design in the new working methods (Langley, 2022). Hence, it is crucial to focus on improving the quality and accessibility of services for end-consumers. Creating a dedicated Service Level Agreement (SLA) specifically for XaaS energy services is essential.

Taking a broader view of the value chain, a second recommendation is to identify **dependencies** in the value chain. A mapping of stakeholders should not only include names, but also information on processes, legacy systems, and attitudes. Identifying potential bottlenecks or even deal breakers in a strategic process could help work through these concerns. The guiding question would be: where can the company address roadblocks itself, and where are critical dependencies? For companies that are already operational, having these processes in place can then help when new services are added or service-based models are extended to a new market segment.

The emphasis on **sustainability and circularity** emerged as the top motivation in the survey, and these aspects were also highlighted prominently with separate, dedicated pages on the web presences of the nine business cases in part 1. For startups built on servitization, this may be obvious, but for companies transitioning from a more "traditional" business model to servitization in this market space, the careful clarification of purpose and contribution of the service model to sustainability can be important. This is related to the discussion point about a better ROI.

Data are a critical input *and* output of XaaS models. The flow of data between connected devices and especially across asset types and manufacturers is a challenge for XaaS. **Data spaces** have recently been applied in other sectors as a novel way of creating an infrastructure for data management and also drive progress to interoperability. This would help address many of the concerns around both interoperability and data access. An energy data space that covers the breadth of smart energy services would nevertheless require a data infrastructure that brings together actors across manufacturers and across sectors (e.g., electricity, e-mobility, storage, heating).

The above point on data is critically linked to **interoperability**. Here, the fragmentation in energy services is still high, so effective efforts would have to come from the EU level. This would be in the spirit of the European Interoperability Framework and Smart Readiness Indicators, but go far beyond the current scope. In the context of the interviews, a best practice was brought up with the example of Australia.[32] Since 2019, the country had working groups that combine actors across the energy sector, including:

- Distribution networks
- Retailers
- Equipment manufacturers
- Aggregators

This has led for example to the creation of a common smart inverter profile.[33]

The final recommendation relates to **regulatory support**. There are numerous individual items in national regulatory frameworks that need adjustment, which is beyond the scope of this report. However, there are two items that stand out independent of a particular geography. First, in setting up funding schemes, the wording and requirements should be reviewed to assert that service-based and product-based firms can gain equal access. Second, while frameworks continue to evolve, the further integration of the building, energy, mobility

[32] see the section on the DER Integration API Technical Working Group:
https://arena.gov.au/assets/2020/08/state-of-der-technical-integration-project-summaries.pdf

[33] https://arena.gov.au/knowledge-bank/common-smart-inverter-profile-australia/

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sector should be considered in the process. This could help prevent costly re-alignment at later stages, as there is already a tendency among the studied companies to blur sectoral boundaries and the indicated future plan would likely re-inforce this development.

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