RE-IMAGINING ENERGY SERVICES: EMPIRICAL ANALYSIS OF DEMAND-SIDE AS-A-SERVICE BUSINESS MODELS AND USE CASES IN ENERGY SECTOR

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ABSTRACT

Purpose: Study on emerging and market-proven services (as-a-Service) business models for delivering digital services in the energy and building sector.

Design/Methodology/Approach: Online survey and semi-structured interviews combined with desk research.

Findings: The most important benefit from XaaS according to the empirical results is transparency and better engagement with end customers. Additionally, the interviews indicate that returns to investment do 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 downside of 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. Regulatory risk is the top-ranked risk category, followed by market and financial risk. This risk perception includes also barriers from bureaucracy, red tape and lack of standardization.

Originality/Value: Empirical evidence on practitioners' views of XaaS, the status quo of implementation regarding energy-related service offerings and an outlook on XaaS development

KEYWORDS: Energy service business models, XaaS, Energy services, Connected energy services

1. INTRODUCTION

The energy sector is experiencing the emergence of innovative service business models (SBMs) due to digitalization of the energy sector and the growing demand for new digital energy services. These SBMs are shifting their focus from businesses to consumers, offering personalized energy services. Digital technologies like artificial intelligence (AI), internet of things (IoT), blockchain, and advanced data analytics enable both consumers and energy service providers to participate in the digitalized connected energy service ecosystems. Energy service providers are utilizing these digital technologies to create business models that prioritize service delivery. One notable example of such innovative business models is Everything-as-a-Service or X-as-a-Service (XaaS), which has gained popularity among startups and is increasingly attracting the attention of established energy companies. Table 1 summarizes notable use cases of such business models that are pioneers in the market.

Table 1: Example use cases of demand side as-a-service business models

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

However, these new business model archetypes are still in the experimental phase and limited to certain markets, both in terms of the geographical location and the types of services they offer. Therefore, the early practitioners of XaaS business models are experiencing challenges in terms of market maturity and customer acceptance, but also in terms of the regulatory conditions that subject them to high levels of uncertainty. As the transformation of the energy sector is progressing rapidly with decentralization and digitalization as megatrends, this presents an important research gap in understanding the landscape of digitally connected XaaS services. The empirical study presented in this paper combines desk research with empirical methods, i.e., an online survey and semi-structured interviews conducted among leading executives of innovative companies practicing XaaS in the European Union. The main contribution of this work is following:

- Firstly, the paper highlights the current state of active demand side XaaS energy services in the energy sector along with how are energy service companies incorporating the as-a-service model into their value Propositions.
- Additionally, it discuss different concerns/fears and challenges from energy companies in adopting such innovative business models.
- Finally, it provide a practical and detailed exploration of XaaS business models for demand side energy services.

In addition to above, the presented work offers detailed insights, business cases, and best practices to contribute to the existing knowledge. The examination encompasses the perspectives of stakeholders, organizations, and startups that have implemented and promoted the as-a-service business model in their service portfolios. In addition, the findings discuss the various risks and challenges faced by businesses in the implementation of as-a-service business models in the energy sector. In the discussion, the empirical insights are linked back to the existing literature to identify areas where the practices validate the empirical insights, but also to identify gaps in knowledge for implementation and policy going forward.

2. THEORETICAL BACKGROUND AND LITERATURE

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). 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). 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). XaaS is one of the terms used to describe business models that aim to deliver these types of 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). Park's three elements are a useful benchmark in the selection of use cases rather than an exclusive definition. 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). With XaaS, there is instead a continuous process of value creation and value delivery, the lines between the two functions blur increasingly (Xu et al. 2018). Despite the lack of a clear definition, XaaS can be described as group of parallel concepts that each provide a different service (Singh et al. 2022), where services can occur jointly in a sector or market. For example, electricity, heating, solar power and increasingly battery can all be the X in XaaS for applications in the building sector. Park (2022) shows that new forms of XaaS take increasingly higher levels of complexity and abstraction. For example, the terms zero-carbon-sustainability and reliability-as-a-service are now offered to industrial clients in several early-adopter projects. 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). 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 integration, 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). In terms of market participants, XaaS has created some buzz around the concept, but not been adopted at scale. 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. XaaS is sometimes easier to adopt by startups who do not have legacy systems, but established companies (incumbents) can have it easier to leverage economics of scale (e.g., Palmié et al. 2021), which is also reflected in our research.
Overall, 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 generator to service provider. This background motivates that empirical study of this paper, which explores what is already forming as business practice by innovative companies.

3. RESEARCH METHODOLOGY

The methodology adopted in this work depicted in Figure 1. In a first step, desk research is conducted regarding the current state-of-art of energy services. The underlying objective is to provide an understanding of the research basis and practical implementation of as-a-service business model in the energy sector. This includes an analysis of business model insights and a review of the associated academic publications.

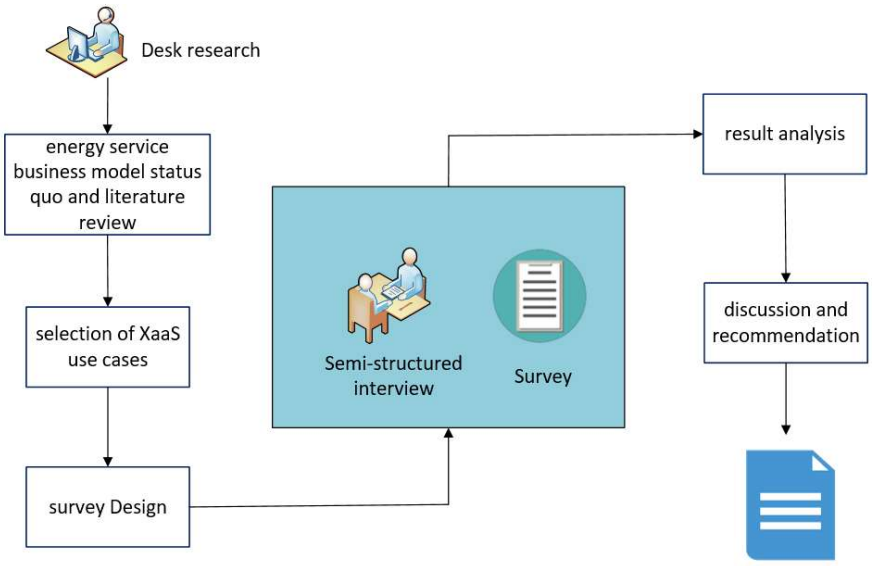

Figure 1: Process diagram of research methodology

A particular focus here is to cover the breadth of energy services that matter in the demand side energy sector. 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. Where applicable, insights are also drawn from evidence on servitization trends in related sectors, such as mobility and cloud services. 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. 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 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.
The survey is structured to collects general information about the company and their business model. Moreover the survey asks about the energy services currently offered, the business model/target group, and revenue streams.
Furthermore, semi-structured interviews are conducted to get deeper insights about the specific use cases of XaaS business models. The interviews follow the same questionnaire as the online survey. The interviewees are guided through the questions by the researcher and encouraged to share more specific insights and perspectives from practical experience. This approach ensures that the online survey and the interviews are aligned for comparability.

4. EMPIRICAL FINDINGS

4.1 Description of sample and business models captured

In the sample, 55% of the sampled data represented startups, followed by mid-size companies and large enterprises.

Table 2: Classification of Participating Firms by Energy Services Offered and Revenue Models

Company category	Energy services	Revenue models
Startup/SME	"Flexibility service", "EV charging point service", "Energy software solution provider", ''Battery or storage services'', ''Wholesale trading platform'', ''Local P2P energy exchange platform'', ''Energy community service provider'', ''Energy management and metering services'', ''Renewable or self-consumption service (Solar/Wind/Bioenergy/Micro grid)'', ''Energy consulting services''	Subscription fee, Equipment leasing fee, Pay-per-use/service, Commissioning and Maintenance fee, Consulting fee
Mid-size company	"Energy software solution provider", ''Energy supplier'', ''Energy community service provider'', ''Energy management and metering services'', ''Renewable or self-consumption service (Solar/Wind/Bioenergy/Micro grid)'', ''Energy efficiency services''	Subscription fee, Direct product sell, Consulting fee
Large Enterprise	"Flexibility service", "EV charging point service", "Energy software solution provider", ''Energy marketplace'', ''Energy community service provider'', ''Energy management and metering services'', ''Heating and cooling services/Comfort services'', ''Battery or storage services''	Equipment leasing fee, Pay-per-use/service, Commissioning and Maintenance fee, Consulting fee
Other	"EV charging point service",	Pay-per-use/service

In line with the literature review in section 2, the companies also reflected a mix of new entrants and incumbents. 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. There are 22 entries in total, with 8 companies falling under the B2B model, followed by Other, Platform, and XaaS. To further understand the business models, the

subsequent questions focused on the revenue streams of the participating companies. Pay-per-use/service, subscription fee, and consulting fee are the primary revenue models among the participating companies. Table 2 presents the categorization of revenue models and energy services based on the different types of firms. 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. Participants were also asked to provide information about energy service offerings for end-consumers, which reveals that companies operate in multiple energy service categories. 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.

4.2 Benefits and Motivation

Regarding benefits of practising 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.

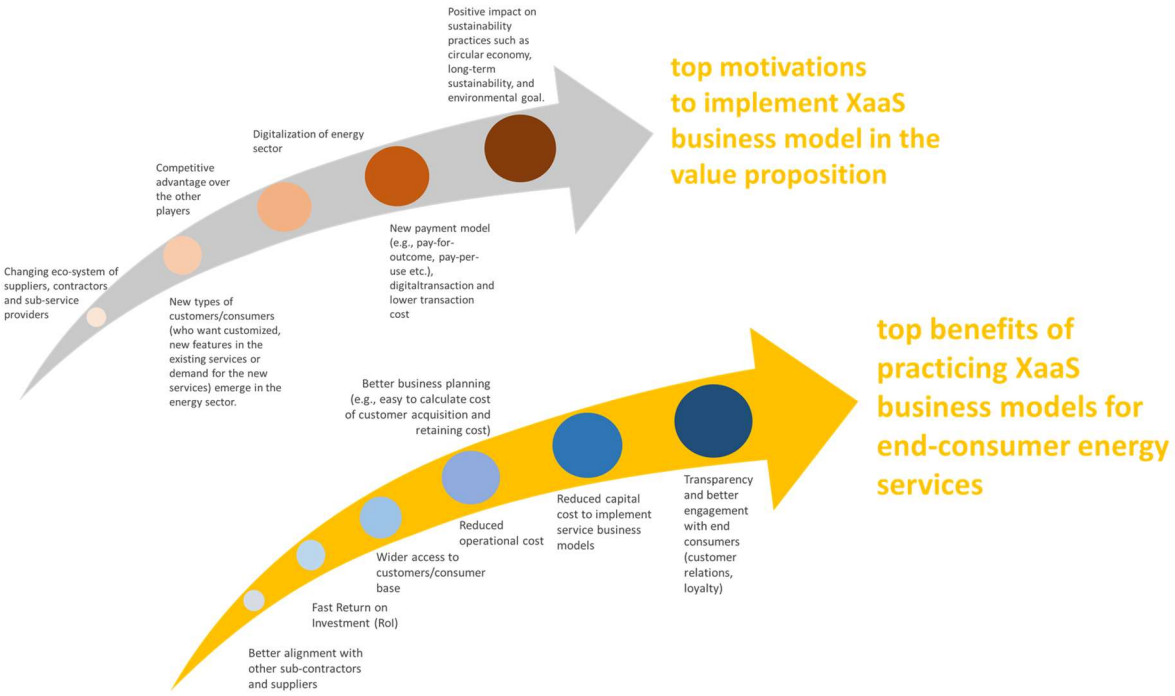

Figure 2: Main benefits and motivation of practicing XaaS business model

The interview results supported that the benefit of transparency 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 timing: 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. Moreover, Figure 2 illustrates the top benefits and motivations of practicing XaaS business models for demand-side energy services.

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 interviews, however, it became apparent that the simple ranking of benefits and motivation leaves out important insights on how companies view, interpret and weigh the listed options. For example, 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 a dimensions of the enabling environment that does not fit an ordering of motivation. This factors was noted as important, but did not *per se* motivate the business for XaaS for some companies.

Two unexpected finding that came out of the interviews regarding benefits and motivation. The first is 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 literature, 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 all 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 trade-off 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.
The second point is that 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 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.

4.3 Barriers and Risks

Participants were asked to rate four technical barriers according to how challenging they perceive these barriers. 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 “high” on average. By contrast, the lack of connected assets at end-users and the requirement for complex IT infrastructure were rated as low on average. 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. The interviews also revealed that clients’ legacy systems present a major barrier. This includes the interoperability of software/hardware on a technical level, but also the organizational structure and conservative attitudes. Resistance to change was highlighted by companies dealing with both the automotive industry and the manufacturing sector. 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. Regarding lack of connected assets, this remains a high challenge for engaging private households, 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. Interoperability was elaborated on with intensity, such that several companies explained the *lack of interoperability as a dealbreaker* for expanding the business model across sector boundaries. Participants were then also asked to provide a ranking of different risks. The Table below shows the categories: By far the top category with much discussion also in the interviews was regulatory risk. 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. Yet there was a sense of optimism, that existing constraints were being addressed – albeit slowly – in the regulatory frameworks.

Table 3: Presentation of risk categories in the empirical study

Risks Category	Description	Risk asessment
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.	High
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.	
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.	
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.	
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.	
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.	Low

Several participants noted that progress on the European level gave them reason to expect improving regulatory condition over the coming years. Nevertheless, country heterogeneity remains high and the combination of different regulations and market conditions across countries forces firms to adapt their value proposition and value delivery in each country. 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. A short description of different risk and their severity assessment is provided in the table 3

5. CONCLUSION

This study has aimed to provide a thorough understanding of the XaaS business model in the context of demand-side energy services. It offers detailed insights, business cases, and best practices to contribute to the existing knowledge. The examination encompasses the perspectives of stakeholders, organizations, and startups that have implemented and promoted the as-a-service business model in their service portfolio. In addition, the findings discuss the various risks and challenges faced by businesses in the implementation of as-a-service business models in the energy sector. Despite the concerns about the regulatory environment and lack of market maturity, the empirical results emphasize a very dynamic environment for XaaS. Companies had multiple plans to either transition towards servitization or cross-sectoral integration, which supports the view that XaaS has high potential going forward. 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 an opportunity that goes beyond a narrow definition of energy services. At the same time, the findings imply that there will be high competition and increasingly competition across sectors, as companies with backgrounds in energy efficiency, e-mobility, and smart buildings all look at these cross-cutting

opportunities. XaaS is not practiced at scale in these industries yet, but the start-ups and innovative service companies we studied present a forward-looking view of growth for this business model, especially if more support can be garnered in terms of regulatory conditions and government recognition of these digital services in the energy transition.

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